UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

META PLATFORMS, INC.,
Petitioner

v.

MULLEN INDUSTRIES LLC,
Patent Owner.

Case IPR2025-00745
U.S. Patent No. 9,662,582 B2
Issue Date: May 30, 2017

Title: SYSTEMS AND METHODS FOR LOCATION BASED GAMES AND EMPLOYMENT OF THE SAME ON LOCATION ENABLED DEVICES

DECLARATION OF JEREMY COOPERSTOCK, PH.D.

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I, Jeremy Cooperstock, declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

A. Qualifications and Experience

1. I am an expert in the field of interactive computing systems, including virtual and augmented reality systems, as well as mobile and wearable technologies. I have studied, taught, practiced, and researched the design of such interactive computing technologies for over 30 years, and I have been leading research and development activities pertaining to hardware and software designs for interactive virtual and augmented reality computing systems since at least 2007.

2. I have summarized in this section my educational background, work experience, and other relevant qualifications, as reflected in my curriculum vitae, attached to this declaration as **Appendix A**.

3. I earned a Bachelor of Applied Science (B.A.Sc) degree in Electrical Engineering (Computer Engineering Option) with Honors from the University of British Columbia in 1990, a Master of Science (M.Sc.) degree in Computer Science from the University of Toronto in 1992, and a Doctor of Philosophy (Ph.D.) degree in Electrical and Computer Engineering from the University of Toronto in 1996. My dissertation on "Reactive Environments and Augmented Media Spaces" was nominated by the University of Toronto for the Natural Sciences and Engineering

Research Council (NSERC) Doctoral Dissertation Award.

4. From 1987 to 1988, I worked at IBM Research on very large scale integration (VLSI) circuit simulation, and in 1989, I worked at the IBM T.J. Watson Research Center on very long instruction word (VLIW) simulation. In 1990, I worked at Fibronics Research to develop and test an FDDI-to-token ring bridge for network communication.

5. After obtaining my Doctorate degree, I carried out research and development work at the Sony Computer Science Laboratory in Tokyo, Japan from 1996 to 1997, working in part on "smart" consumer electronics.

6. I have been employed at McGill University since November 1997, where I am currently a Full Professor in the Department of Electrical and Computer Engineering, and recently, the endowed Werner Graupe Distinguished Chair in Automation Engineering.

7. I am a member of the Centre for Intelligent Machines, a founding member of the Centre for Interdisciplinary Research in Music Media and Technology, a member of the International Laboratory on Learning System, a member of the McGill Institute for Aerospace Engineering, and an associate member of Biomedical Engineering at McGill University.

8. In this capacity, I conduct and supervise research activities, directing a

group of approximately 50 researchers at the Shared Reality Lab, which focuses on computer mediation to facilitate high-fidelity human communication and the synthesis of perceptually engaging, multimodal, immersive environments. Over the span of my academic career, I have supervised more than 100 graduate students and post-doctoral fellows, and approximately 250 undergraduate research students.

9. I have also developed and continue to teach courses on human-computer interaction, artificial intelligence, embedded systems, haptic interaction design, computer architecture, and operating systems.

10. I led the development and demonstrations of the world's first high-fidelity multichannel audio streaming system over the Internet in 1999 and 2000, recognized by a Distinction Award from the Audio Engineering Society, and followed in 2005 by simultaneous low-latency transmission of multiple streams of uncompressed high-definition video as part of the McGill Ultra-Videoconferencing system. This work was recognized by an award for Most Innovative Use of New Technology from the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) Supercomputing.

11. Among other projects, I led the development and supported ongoing use of a semi-automated classroom environment (the "Intelligent Classroom"), a high-fidelity orchestra rehearsal simulator ("Open Orchestra,"), a simulation

environment that renders graphic, audio, and vibrotactile effects in response to footsteps ("Natural Interactive Walking"), and a mobile game treatment for amblyopia that was licensed to Novartis.

12. The research and development I supervised on the Autour project earned the Hochhausen Research Award from the Canadian National Institute for the Blind and an Impact Award from the Canadian Internet Registry Association. My Real-Time Emergency Response project won the Gold Prize (brainstorm round) of the Mozilla Ignite Challenge. I have carried out significant research involving design and implementation of haptic feedback systems, virtual and augmented reality, and mobile computing applications. My research experience includes design of systems employing virtual and augmented reality devices for simulation, training, gaming, distributed performance, and medical applications, as well as the use of various sensor technologies including GPS, WiFi and Bluetooth, and inertial measurement units (IMUs) for tracking position and orientation of a user.

13. My research activities are funded by industry contracts, collaboration programs, and government grants. In the past 5 years, I have obtained grants and contracts for my research program of approximately three million dollars.

14. I led the theme of Enabling Technologies for a Networks of Centres of Excellence on Graphics, Animation, and New Media (GRAND), and chaired the

Technical Committee on Network Audio Systems. Among other visiting academic appointments, I was a visiting professor at Bang & Olufsen, Denmark, where I conducted research on telepresence technologies as part of the World Opera Project.

15. I have authored and co-authored more than 200 journal articles and peer-reviewed conference proceedings papers, mostly concerning human-computer interaction and applications of these technologies. Eight of my publications were finalists or winners of "best paper", "honorable mention", and similar awards from scholarly societies. A complete list of my publications is contained in my curriculum vitae.

16. My professional affiliations include services in various professional organizations and serving as a reviewer for a number of technical publications, journals, and conferences, which are listed in my curriculum vitae. I served as an Associate Editor of the Journal of the Audio Engineering Society, and presently serve as Associate Editor in Chief for the IEEE Transactions on Haptics, and Associate Editor for the Frontiers in Virtual Reality.

17. I have also served as an expert in numerous legal proceedings, both on behalf of patent owners and petitioners, including proceedings involving industrial design, hardware architecture, and firmware of wearable technologies. A list of cases in which I have provided written declarations, testified at trial or by deposition is

provided in my curriculum vitae.

18. My experience in academic and practical situations as well as my hands-on experience with hardware and software related to virtual and augmented reality systems, provides me with an appreciation of, and expertise in, the technology involved with the challenged patent at issue.

19. I have been retained by counsel for Petitioner to provide my expert opinion in connection with the above-captioned proceeding as set forth herein. I am being compensated for my work in this case at my standard consulting rate. This compensation is not contingent upon my performance, the outcome of this case, or any issues involved in or related to this case. I have no financial interest in this matter.

B. Materials Considered

20. The analysis that I provide in this Declaration is based on my education, research, and experience, as well as the documents I have considered. In forming my opinions, I have read and considered U.S. Patent No. 9,662,582 B2 ("'582 patent") (**EX1001**) and its prosecution history. I have cited to the following documents in my analysis below:

Exhibit No.	Description of Document
1001	U.S. Patent No. 9,662,582 B2 to Jeffrey David Mullen (filed Aug. 20, 2007, issued May 30, 2017) ("**'582**" or "**'582 patent**")
1003	U.S. Patent App. Pub. No. 2003/0177187 A1 to David A. Levine et al. (filed Feb. 20, 2003; published Sept. 18, 2003) ("**Levine**")

II. PERSON OF ORDINARY SKILL IN THE ART

21. I understand that, under the patent laws in effect before the America Invents Act ("AIA") of 2011, an assessment of claims of a patent filed before the AIA took effect should be undertaken from the perspective of a person of ordinary skill in the art as of the earliest claimed priority date (i.e., the "time the invention was made"). I have preliminarily for purposes of my Declaration only assumed that date to be September 2, 2003, the filing date of the earliest application to which the '582 patent claims priority (provisional application no. 60/499,810).[1]

[1] I express no opinion on whether the '582 patent is actually entitled to the benefit of the provisional application to which it claims priority (60/499,810). This issue is not relevant here because the prior art relied upon predates that date. In the event entitlement to the provisional filing date may later become relevant, for example

22. I have also been advised that to determine the appropriate level of a person having ordinary skill in the art, the following factors may be considered: (1) the types of problems encountered by those working in the field and prior art solutions thereto; (2) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (3) the educational level of active workers in the field; and (4) the educational level of the inventor.

23. The '582 patent states that it "relates to video games and video game systems." ('582, 1:22-23.) The patent states that it provides an "actual, reality-based video game in which a user's physical (actual) location on a playfield, reflects a virtual game character's virtual location in a video game environment." ('582, 2:28-33.)

24. In my opinion, a person of ordinary skill in the art as of September 2003 would have possessed a bachelor's degree in electrical engineering, computer science, or similar field, with two years combined experience in designing and/or developing interactive location-based computer systems/software, such as video

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based on arguments later presented by Patent Owner, I reserve my right to provide opinions on that issue at that time.

games or other simulations incorporating location information (such as GPS information associated with a user's physical location). A person could also have qualified as a person of ordinary skill in the art with some combination of (1) more formal education (such as a master's of science degree) and less technical experience, or (2) less formal education and more technical or professional experience.

25. My opinions regarding the level of ordinary skill in the art are based on, among other things, my experience in the field of computer science, my understanding of the basic qualifications that would be relevant to an engineer or scientist tasked with investigating methods and systems in the relevant area, and my familiarity with the backgrounds of colleagues and students, both past and present.

26. Although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art defined above, my analysis and opinions regarding the '582 patent have been based on the perspective of a person of ordinary skill in the art as of September 2003.

III. STATEMENT OF LEGAL PRINCIPLES

A. Claim Construction

27. I understand that a purpose of claim construction is to determine what a person of ordinary skill in the art would have understood the claim terms to mean.

Claim terms are generally given their ordinary and customary meaning, which is the meaning that the term would have to a person of ordinary skill in the art in question as of the effective filing date.

28. I understand that the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. I understand that the patent specification, under the legal principles, has been described as the single best guide to the meaning of a claim term, and is thus highly relevant to the interpretation of claim terms. And I understand for terms that do not have a customary meaning within the art, the specification usually supplies the best context of understanding the meaning of those terms.

29. I further understand that other claims of the patent in question, both asserted and unasserted, can be valuable sources of information as to the meaning of a claim term. Because the claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

30. I understand that the prosecution history can further inform the meaning of the claim language by demonstrating how the inventors understood the invention

and whether the inventors limited the invention in the course of prosecution, making the claim scope narrower than it otherwise would be. Extrinsic evidence, such as dictionaries, may also be consulted in construing the claim terms.

31. I understand that, in *Inter Partes* Review (IPR) proceedings, a claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in a U.S. district court (which I understand is called the "*Phillips*" claim construction standard), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

32. I have been instructed by counsel to apply the "*Phillips*" claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require an explicit construction. The description of the legal principles set forth above thus provides my understanding of the "*Phillips*" standard as provided to me by counsel.

33. For purposes of my analysis here, I do not believe express claim constructions are necessary because the prior art renders the claims obvious under any reasonable construction.

B. Obviousness (§ 103)

34. I understand that a patent claim is obvious if, as of the effective filing date, it would have been obvious to a person having ordinary skill in the field of the technology (the "art") to which the claimed subject matter belongs.

35. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that certain other facts known as "secondary considerations" such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others may be utilized as indicia of nonobviousness. I understand, however, that secondary considerations should be connected, or have a "nexus," with the invention claimed in the patent at issue.

36. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

37. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid "hindsight bias" and *ex post* reasoning in performing an obviousness analysis. But this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

38. I understand that when determining whether a patent claim is obvious in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid.

39. I understand one way that a patent can be found obvious is if there existed at the time of the invention a known problem for which there was an obvious

solution encompassed by the patent's claims. I understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide a reason to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to known methods, the combination is likely to be obvious when it does no more than yield predictable results. Thus, if a person of

ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

40. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the art, or from sources such as explicit statements in the prior art. I understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his skill to combine the known options in order to solve the problem.

41. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art:

(1) Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;

(2) Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;

(3) Combining prior art elements according to known methods to yield predictable results;

(4) Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

(5) Applying a technique or approach that would have been "obvious to try" (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);

(6) Simple substitution of one known element for another to obtain predictable results; or

(7) Use of a known technique to improve similar products, devices, or methods in the same way.

42. I understand that, when determining whether a claimed combination is

obvious, the correct analysis is not whether one of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I understand the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

43. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. The test for obviousness, in other words, is not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

IV. THE '582 PATENT

A. Overview of the Specification

44. The '582 patent purports to provide "an actual, reality-based video game in which a user's physical (actual) location on a playfield, reflects a virtual game character's virtual location in a video game environment." ('582, 2:28-33.) A user may play the game on devices such as a "wireless telephone" or other devices such as "laptops, Personal Digital Assistants (e.g., PDAs), Blackberries, Personal Electronic Device (PED), iPODs, or any other portable electronic device . . . ." ('582, 7:21-27.) Each player may choose from one of a variety of "characters" to

play. (’582, 11:51-57.) In addition to human players who control characters, the game may include “software-controlled gaming characters (e.g., video game characters with artificial intelligence).” (’582, 14:48-52.)

45. I discuss additional aspects of the ’582 patent in my analysis of the claims below.

B. The Challenged Claims

46. This Declaration addresses claims 1, 2, 11, and 13 of the ’582 patent. Independent claim 1 is representative and recites:

1**[pre]**. A non-transitory computer-readable medium having program logic provided thereon for providing a location-based game comprising:

[a] a virtual playfield;

[b] a first character, wherein the location of said first character in said virtual playfield is displayed on a display and is determined utilizing a first control signal from a first locating device that is based, at least in part, on a physical location determined by said first locating device; and

[c] a second character, wherein said second character is computer controlled via artificial intelligence and said artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character; and

[d] an impenetrable object, wherein said first locating device is operable to

travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield, and said first character is impacted when said first character contacts said impenetrable object.

('582, 23:61-24:15 (Claim 1; bracketed notation (e.g., **[a]**) added).)

47. I address the claims further in my detailed analysis in **Part V** below.

V. APPLICATION OF THE PRIOR ART TO CHALLENGED CLAIMS

48. I have reviewed and analyzed the prior art references and materials listed in **Part I.B** above. In my opinion the claims of the '582 patent would have been obvious to a person of ordinary skill in the art based on the following prior art.

Ground	Claims	Basis for Challenge Under § 103
1	1, 2, 11, and 13	Obvious over Levine

A. Brief Summary and Overview of Prior Art

(a) Levine (EX1003)

49. **Levine**, U.S. Patent App. Pub. No. 2003/0177187 A1, is entitled "Computing Grid for Massively Multi-Player Online Games and Other Multi-User Immersive Persistent-State and Session-Based Applications." I am informed that Levine qualifies as prior art because it was filed on February 20, 2003, which is before the earliest priority date of the challenged claims.

50. Levine teaches a location-based online multi-player game with the

same relevant features as the '582 patent, described in terms that are strikingly similar to the '582 patent's description. Much like the '582 patent, Levine describes "a distributed, platform-sensitive, location-based, contextual system, method and computer program product for bridging activities in real and virtual environments within the context of multi-user gaming" and other applications. (Levine, ¶0163.)[2] Levine's online game system "accounts for both the physical and virtual location and context of the participating devices and people" to serve "the purpose of coordinating activities in the real (i.e., physical) and virtual worlds." (Levine, ¶0158.)

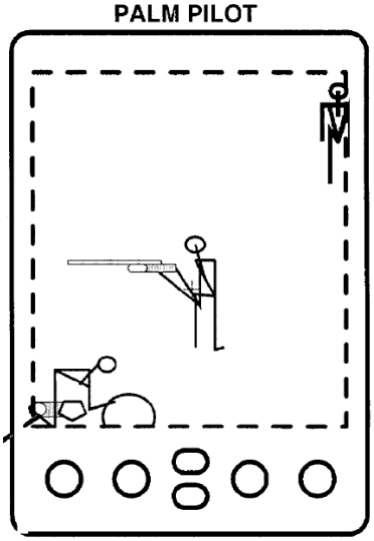
51. Like the '582 patent, Levine describes that a user may play its online game with a wireless telephone (a mobile phone) or various other type of devices. (Levine, ¶0187 ("client devices **112** would include, for example, a mobile phone **112*a***, a video game console (with Internet connection) **112*b***, a personal digital assistant **112*c***, a personal area network with retinal projection displays and/or ear piece **112*d***; a laptop **112*e***, and a desktop computer **112*f***").)

52. Like the '582 patent, Levine describes that each player may play a character in the game, which is represented by an "avatar." (Levine, ¶¶0224, 0244,

[2] All emphasis added to quoted material unless noted.

0324-0327.) Like the '582 patent, Levine also describes characters in the game that are controlled by the system as opposed to being controlled by a human player, such as "non-player character" (NPC) entities which are controlled with "artificial intelligence." (Levine, ¶¶0394 (describing "Active Objects (NPCs)—non-player controlled objects"), 0629 (describing "Non-Player Characters (NPCs) that may have an independent life of their own; that walk and talk, or run and hide, or perform other changes of state actively of their own accord" with "[s]ome sort of Artificial Intelligence (AI)"), 0186 (describing "elements of the application not directly controlled by users, such as artificial intelligence or aspects of a simulation that run on their own internal logic and react to other aspects of the simulation").)

53. Levine provides extensive description and discussion of its location-based online gaming system throughout its disclosure, including architectural and system-level components and features as well as example illustrations of games. Among the example illustrations are a location-based game where players interact with a "monster" and a location-based game with a "sniper" that is illustrated in Figures 45-47. (Levine, ¶¶0659-0673 ("monster" game), 0556-0573 & Figs. 45-47 (Figure 47 excerpted at right, illustrating sniper gameplay on Palm



Pilot device) ("sniper" game).)

54. I will provide more information about Levine in my discussion of the claim limitations below.

B. Ground 1: Claims 1, 2, 11, and 13 Are Obvious Over Levine

1. Independent Claim 1: "A non-transitory computer-readable medium having program logic provided thereon for providing a location-based game comprising:" (Claim 1[pre])

55. The preamble of claim 1 recites "[**a**] **non-transitory computer-readable medium having program logic provided thereon for providing a location-based game comprising**." Levine discloses a system for a multiplayer online game that renders obvious claim 1 as referenced in the summary of Levine above and discussed further below.

56. I have not been asked to opine on whether the preamble imposes a limitation on the claim. To the extent the preamble is a limitation, Levine discloses and renders obvious the preamble.

57. Levine discloses and renders obvious "**a location-based game**." Levine describes an online game system for playing multiplayer games:

> The present invention is directed to a system, method and computer program product for a computing grid for massively Multiplayer on-line games and simulations that substantially obviates one or more of

the problems and disadvantages of the related art.

(Levine, ¶0021.) Levine describes a system architecture for hosting games, such as a Game Server, a Grid, and a database that maintains game-related information:

> A Gateway Server (hereafter usually referred to as "Gateway"), a Hosting Environment (a "Game Server" in the case of a gaming application, an "Application Server" in more generic contexts, a "Collaborative Engineering Environment Server" in other contexts, or a "Context Server" if the application were to be thought of as a "context"), and a Daemon Controller (all discussed in detail below) are examples of processes, each of which may be multi-threaded, and each of which runs on a physical host. These processes, which collectively comprise a single application (e.g., a game) or multiple applications, may run on a single host, or may be distributed across multiple hosts.

(Levine, ¶0176.)

> The Grid is a collection of hosts that decouples semantic and syntactic context in a packet that is exchanged between clients (and that relates to the game itself) from information that is in some sense "essential" to the Grid itself. In other words, the Grid can mediate the state of the object(s) without knowing what the states actually means. The Grid thus becomes a host for the context of the application (i.e., game) while being agnostic about the context itself.

(Levine, ¶0179.)

> Thus, at the center of every persistent-state, massively multi-player game lies its database **104**. The database **104** manages the persistence of object state across the game world: from login to login, session to session, Avatar to Avatar, property to property, it keeps a record of all significant state changes.

(Levine, ¶0211.)

58. Levine further explicitly provides a "**location-based**" system for online games. As Levine describes, each game depends on the physical and virtual locations of the devices and people that play the game and coordinates activities between locations in the real world and locations in the virtual world:

> The system, method and computer program product of the present invention accounts for both the physical and virtual location and context of the participating devices and people. The system, method and computer program product also provide for both synchronous and asynchronous communications between people, computers, other devices and computers for the purpose of coordinating activities in the real (i.e., physical) and virtual worlds.

(Levine, ¶0158.)

> Another feature of the present invention is that users' locations can be geographically tracked, via a Global Positioning Satellite (GPS) system, cell-based triangulation, dead-reckoning (i.e., inertial tracking) or the like as described herein, in order to provide more realistic

> content, more realistic interactive experience to users, or data which is more contextually relevant to the user.
>
> The present invention is a distributed, platform-sensitive, ***location-based***, contextual system, method and computer program product for bridging activities in real and virtual environments within the context of multi-user gaming, entertainment, simulation, collaborative, and e-commerce applications. In aggregate, it is referred to as the "Grid."

(Levine, ¶¶0162-0163.)

> Latitude, longitude and other sets of location data are often integral to the applications executed within Grid system 100. Such location awareness allows software agents to traverse physical terrains and physical entities such as people, buildings and vehicles to be represented in virtual worlds.

(Levine, ¶0196.)

> Database 104 stores the various types of information that Grid system 100 would need to store in order to provide the bridging of activities in real and virtual environments in the context of multi-user gaming, entertainment and e-commerce applications. Such information, includes user registration information (name, address, billing information, etc.), device 112 registrations, device 112 capabilities (e.g., polygon rendering capability, media formats, operating systems, available peripherals, color versus black-and-white display, etc.), user permissions (e.g., who is allowed to access portions of the bridged

> environment and what actions they may perform on those parts) and user ownership of synthetic entities and environment objects, entity location information, game environments, game rules, themes and roles, etc., as will be apparent to one skilled in the relevant art(s) after reading the teachings herein.

(Levine, ¶0206.)

59. For purposes of analyzing a "**location-based game**" I consider the features and functions that a person of ordinary skill in the art would have understood and found obvious to be present in a game in Levine's system, in view of Levine's teachings. Levine's disclosure is not limited to any one or more specific games. Instead, Levine broadly teaches a variety of features, functions, and components to be used in implementing a multiplayer online location-based game system. Levine describes, for example, **(1)** design features generally applicable to the system's online games, **(2)** a "Gaming Example" with a "monster" character that players can "kill" (Levine, ¶¶0656-0666), **(3)** "Alternate Embodiments" of the "monster" game including functions such as running away from the "monster" (Levine, ¶¶0668-0673), **(4)** a "sniper" game that is provided for "illustration" and reflected in Figures 45-47 (Levine, ¶¶0556-0558, 0569-0573, Figs. 45-47), and **(5)** additional examples of features, characters, and objects that may be present in a game, such as a "Dragon or a Troll," a "dog" that "brushes against [a] flower," actions of "picking up a gold

coin, striking a sword blow, losing stamina," and others (*e.g.*, Levine, ¶¶0394, 0574, 0628, 0652). In view of these teachings, a person of ordinary skill in the art would have understood that each disclosed game and feature is a non-limiting illustration of how Levine's teachings may be applied. A person of ordinary skill in the art would have considered ways to apply Levine's teachings when implementing a game. For example, a person of ordinary skill in the art would have understood that features present in the "monster" game may be implemented in the "sniper" game and vice versa. This interchangeability of gameplay features would be particularly appreciable given the similarities between the "monster" and "sniper" games, including the location-based gameplay of characters approaching and retreating from each other and the roles of the characters being adversarial with "shooting" capability (for example, a "monster" versus other players that can "shoot" and "kill" the monster, and a "victim" versus a "sniper" having "a rifle scope" consistent with the capability to shoot the rifle). (*E.g.*, Levine, ¶¶0676 ("shooting a 'monster'"), 0666 (mobile user character can "kill the 'monster' character"), 0571-0573 ("sniper" and "victim" characters, where victim may be "in range" of the sniper because "the sniper may have a rifle scope"), Figs. 45-47 (showing sniper character pointing a rifle), ¶0252 ("A PROPERTY_VECTOR state could represent the direction in which a game character's gun is pointed.").)

60. For example, each of the "monster" and "sniper" games discloses a **location-based** game. In the "monster" game, a mobile user playing the game is physically located on Wall Street in New York City and in the game a "monster" is created at a corresponding nearby "location" in the game:

> In step **5808**, server **102** would cause the new "monster" character to be delivered to all other users playing the same instance of the interactive multi-user gaming application as the PC user. Such deliver[y] would be affected by translator **108**, under the control of server 102, via transportation network **103**. Further, the server would place the new "monster" character in a PC user-dictated location within the synthetic environment, say for example, the Wall Street area of New York City. . . .
>
> In step **5810**, a user on a laptop client device **112***e* ("laptop user") would now "see" the new "monster" character on their laptop. More specifically, the laptop user would see the "monster" character on the synthetic representation of Wall Street in New York City. Grid system **100** ensures that the "monster" character is properly rendered for each user utilizing a different type of client device **112**.
>
> In step **5812**, the laptop user sends a message to a user on a mobile phone client device **112***a* ("mobile user"). Such message, for example, would convey that "a new 'monster' character is two blocks from you." This message may be sent because the mobile user is represented in the synthetic environment as being on Wall Street in New York City

> because in the physical world, they are. . . .
>
> In step **5816**, the mobile user can interact with "monster" character (i.e., manipulate the "monster" character entity). Such interaction would involve, for example, pressing *9999 on their mobile phone client device **112***a* to kill the "monster" character. In step **5818**, the synthetic representation of the "monster" character would disappear from the PC user's, laptops user's and mobile user's client devices. Again, Grid system **100** would ensure that the "monster" character's death would be properly rendered (using the proper signal) for each player's different type of client device.

(Levine, ¶¶0661-0666.)

61. Levine further illustrates how the "monster" game is a location-based game because players may move locations in the physical world, such as by taking a taxi to "run away" from the "monster" for example, that result in corresponding changes of location within the game:

> In one embodiment, users of Multi-User Bridging system **100** may further bridge the synthetic environment with the physical environment. More specifically, in step **5816** of flow **5800**, the mobile user may have taken a taxi in order to "run away" from (i.e., interact with) the "monster" character. . . .
>
> In another embodiment of the present invention, as one skilled in the relevant art(s) will appreciate after reading the description herein, if the mobile user's taxi ride takes them outside of the Wall Street area of

> New York City, then the synthetic representation of the mobile user would disappear from the PC user's and laptops user's client devices.
>
> In another embodiment of the present invention, as one skilled in the relevant art(s) will appreciate after reading the description herein, a user may create an MP3 file that includes audio content (e.g., a recorded voice message) that is played on a registered client device owned by another player when that player enters a specific area of the synthetic or physical environment. For example, the PC user could specify that the "monster" character speaks each time another player enters a specific building located on Wall Street in New York City. That sound would be played, for example, on a player's mobile phone **112***a* when they walk into the physical building, or on a player's PC **112***f* speaker when a player's synthetic representation walks into the specified building.

(Levine, ¶¶0670-0672.)

62. The "monster" game is thus a "**location-based**" game. Gameplay depends on location—for example, as shown above, the mobile user is physically located on Wall Street in New York City, the game determines a location for the "monster" which is two blocks away from the mobile user, and the mobile user can "interact" with the "monster" located nearby and/or "run away" from the "monster" by changing locations in the physical world (for example, taking a taxi).

63. Levine's exemplary "sniper" game is also a "**location-based**" game.

For example, the "sniper" and other characters such as "bicyclist" or "courier" and "victim" interact with each other—including the ability to "see" each other and "collide" with each other—based on the location of each, as determined for example by the "POSITION" of each Avatar within its "Locale" of record. (Levine, ¶¶0569 ("In the example shown in FIG. 45, the area-of-interest of the 'sniper' Server Thing is the region centered about the POSITION of the embodiment-of-record of that Avatar on its Server-of-Record in its Locale."), 0556, 0557 ("**FIG. 46** shows a Game Server of Record **4601** that includes a Locale of Record **4602** with a sniper standing inside the Locale of Record **4602**. Box **4603** represents the sniper's region of presence, and box **4604** represents the sniper's region of interest."), 0571-0573, 0232-0236 ("Each object in every game has an entry in the Thing table. The Thing table controls the behavior of objects across the Grid, and maintains their common basic states: position, orientation, range, presence, region of interest type, whether they are active or passive in nature. . . . Position—where this object is located in the game world."), 0198-0204 (OAP device in each client device participating in the game determines and provides position information).)

64. Turning to the **non-transitory computer-readable medium having program logic provided thereon** for providing the location-based game, Levine broadly teaches that its disclosed invention may be implemented with hardware

and/or software implemented on one or more computer systems, such as a computer system running applications as illustrated by computer system **5900**:

> The present invention may be implemented using hardware, software or a combination thereof and may be implemented in one or more computer systems or other processing systems. An example of a computer system **5900** is shown in **FIG. 59**. The computer system **5900** represents any single or multi-processor computer. In conjunction, single-threaded and multi-threaded applications can be used. Unified or distributed memory systems can be used. Computer system **5900**, or portions thereof, may be used to implement the present invention. For example, the system **100** of the present invention may comprise software running on a computer system such as computer system **5900**.

(Levine, ¶0693.)

65. Levine further describes that the illustrative computer system **5900** includes **a non-transitory computer-readable medium** (disclosed by each of a hard drive and RAM) that allows **program logic** (logic in computer programs defining the game) to be loaded for execution. Levine describes that the system contains "main memory **5946**" that is preferably RAM and "secondary memory 5948" that can be a hard disk drive. Each of these components discloses the claimed non-transitory computer-readable medium. Levine describes:

> Computer system **5900** also includes a main memory **5946**, preferably

> random access memory (RAM), and can also include a secondary memory **5948**. The secondary memory **5948** can include, for example, a hard disk drive **5950** and/or a removable storage drive **5952**, representing a floppy disk drive, a magnetic tape drive, an optical disk drive, etc. The removable storage drive **5952** reads from and/or writes to a removable storage unit **5954** in a well known manner. Removable storage unit **5954** represents a floppy disk, magnetic tape, optical disk, etc., which is read by and written to by removable storage drive **5952**. As will be appreciated, the removable storage unit **5954** includes a computer usable storage medium having stored therein computer software and/or data.
>
> In alternative embodiments, secondary memory **5948** may include other similar means for allowing computer programs or other instructions to be loaded into computer system **5900**. Such means can include, for example, a removable storage unit **5962** and an interface **5960**. Examples can include a program cartridge and cartridge interface (such as that found in video game console devices), a removable memory chip (such as an EPROM, or PROM) and associated socket, and other removable storage units **5962** and interfaces **5960** which allow software and data to be transferred from the removable storage unit **5962** to computer system **5900**.

(Levine, ¶¶0698-0699.)

66. Levine further describes that computer programs stored in the memory, which Levine also describes as "control logic" and disclose the claimed "**program**

logic provided thereon for providing a location-based game," can be executed to perform the features of Levine's disclosed invention, which includes its online location-based game system as discussed previously and discussed further for the claim elements below.

> Computer programs (also called computer control logic) are stored in main memory **5946** and/or secondary memory **5948**. Computer programs can also be received via communications interface **5964**. Such computer programs, when executed, enable the computer system **5900** to perform the features of the present invention as discussed herein. In particular, the computer programs, when executed, enable the processor **5944** to perform features of the present invention. Accordingly, such computer programs represent controllers of the computer system **5900.**
>
> The present invention can be implemented as control logic in software, firmware, hardware or any combination thereof. In an embodiment where the invention is implemented using software, the software may be stored in a computer program product and loaded into computer system **5900** using removable storage drive **5952**, hard disk drive **5950**, or interface **5960**. Alternatively, the computer program product may be downloaded to computer system **5900** over communications path **5966**. The control logic (software), when executed by the one or more processors **5944**, causes the processor(s) **5944** to perform functions of the invention as described herein.

(Levine, ¶¶0702-0703.)

67. Accordingly, Levine discloses and renders obvious "[**a**] **non-transitory computer-readable medium having program logic provided thereon for providing a location-based game**" in the form of a non-transitory computer-readable medium (each of the hard drive and the RAM) having program logic provided thereon (the logic implemented by computer programming for a location-based game) for providing a location-based game (a location-based game as described by Levine).

(a) "a virtual playfield," (Claim 1[a])

68. Levine discloses "**a virtual playfield**" as part of each online game. For context, Levine's online game system "accounts for both the physical and **virtual** location and context of the participating devices and people" and operates "for the purpose of coordinating activities in the real (i.e., physical) and **virtual** worlds." (Levine, ¶0158.) As explained further below, the "virtual" world in a game encompasses a geographic region corresponding to one or more "Locales." The set of Locales for a game discloses "**a virtual playfield**."

69. Specifically, Levine describes that a game includes one or more "Locales" that together form the "world" of the game:

An actual game includes at least one Locale, and possibly many

> Locales, where all the Locales together form a seamless "game world", or simply "world".

(Levine, ¶0177.)

70. Levine describes that a Locale provides a 3D environment for interactions of "Server Things."

> A Locale is a convex region in three dimensional space, that provides a stage or environment that supports the interactions of one or more Server Things. A Locale represents a place to establish a specific presence as part of the larger game universe. Although a Locale does not have to be rectangular in boundary, in one embodiment, discussed below, it has to fit within a region with the maximum dimension of 65536*65536*65536, as shown in **FIG. 21**.
>
> The Locale is the atomic unit of geography in the game world, and is defined in terms of world coordinates. These values correspond to the POSITION state values transmitted in packets as part of object state (see also discussion of Network Protocol Stack below).

(Levine, ¶¶0371-0372.)

71. Levine's Figure 21 "illustrates an example of a Locale topology" and indicates how a Locale is three-dimensional and has a size "on the order of magnitude of a small town," illustrating how the "Locale" in the game represents a region of geographical space defining the virtual playfield in the game. Levine,

¶0052.)

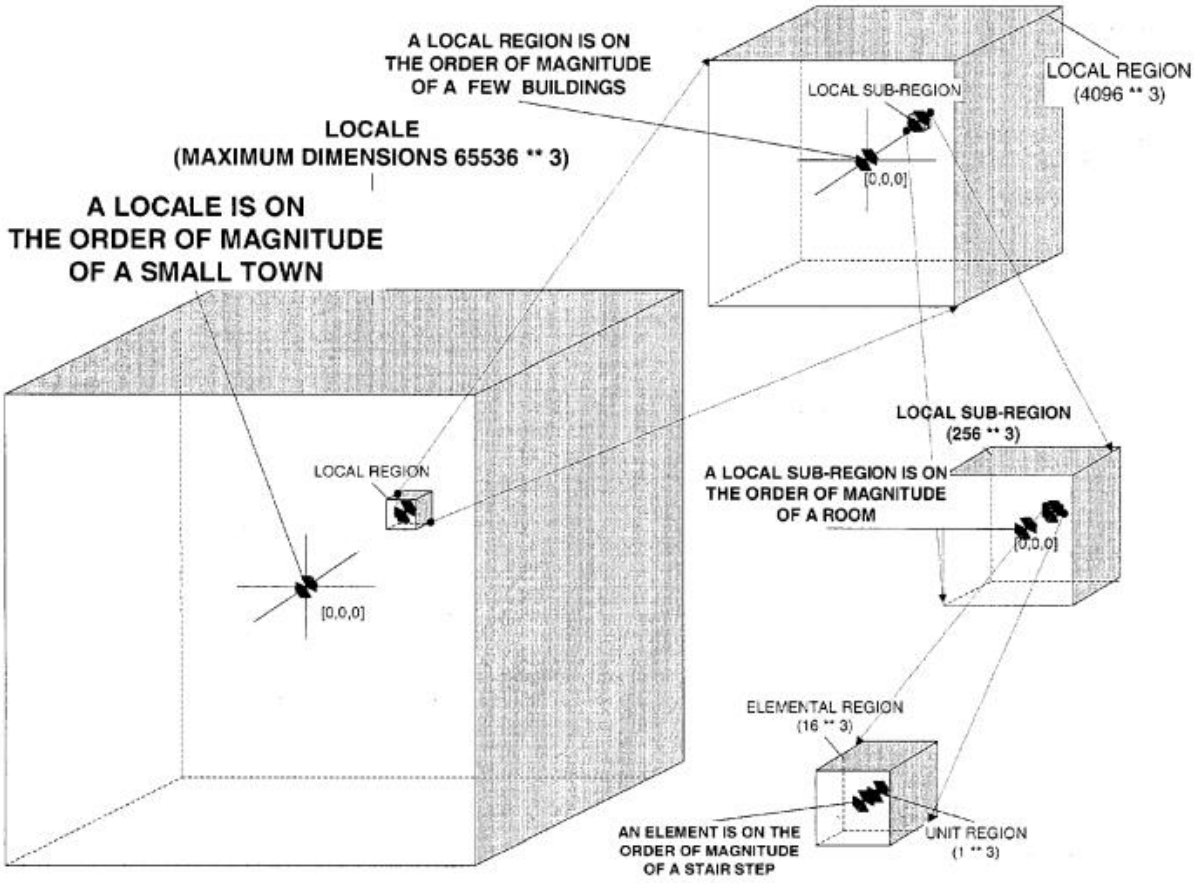


FIG. 21

(Levine, Fig. 21.)

72. Levine describes four types of Server Things that can interact within a Locale: (1) "Avatars," which are client-controlled characters "ultimately connected to a real human player," (2) "Active Objects (NPCs)," (3) "Passive Objects," and (4) "Sentinels." (Levine, ¶¶0391-0396.) A player's character in the game (avatar) is

initially assigned to a particular Locale but can move between Locales:

> When a client's Avatar is embodied, it is assigned (or bound) to whichever Locale its region of presence is positioned in, that is, the Locale within whose boundary hyperplanes it is completely contained. After discovery of the host location, the Gateway **401** directs (or proxies) client communications to this Game Server of Record. In turn, the Game Server of Record creates an Embodiment-of-Record (called a Server Thing) in the specified Locale and which represents the Avatar within its current context. This binding of the client to Server Thing is dynamic, and as the client roams throughout the Grid, its embodiment can move out of one Locale and into another, as shown in FIG. 24.

(Levine, ¶0379.)

73. Figure 24 "illustrates an example of a packet used for moving Embodiments of Record between Locales." (Levine, ¶0055.)

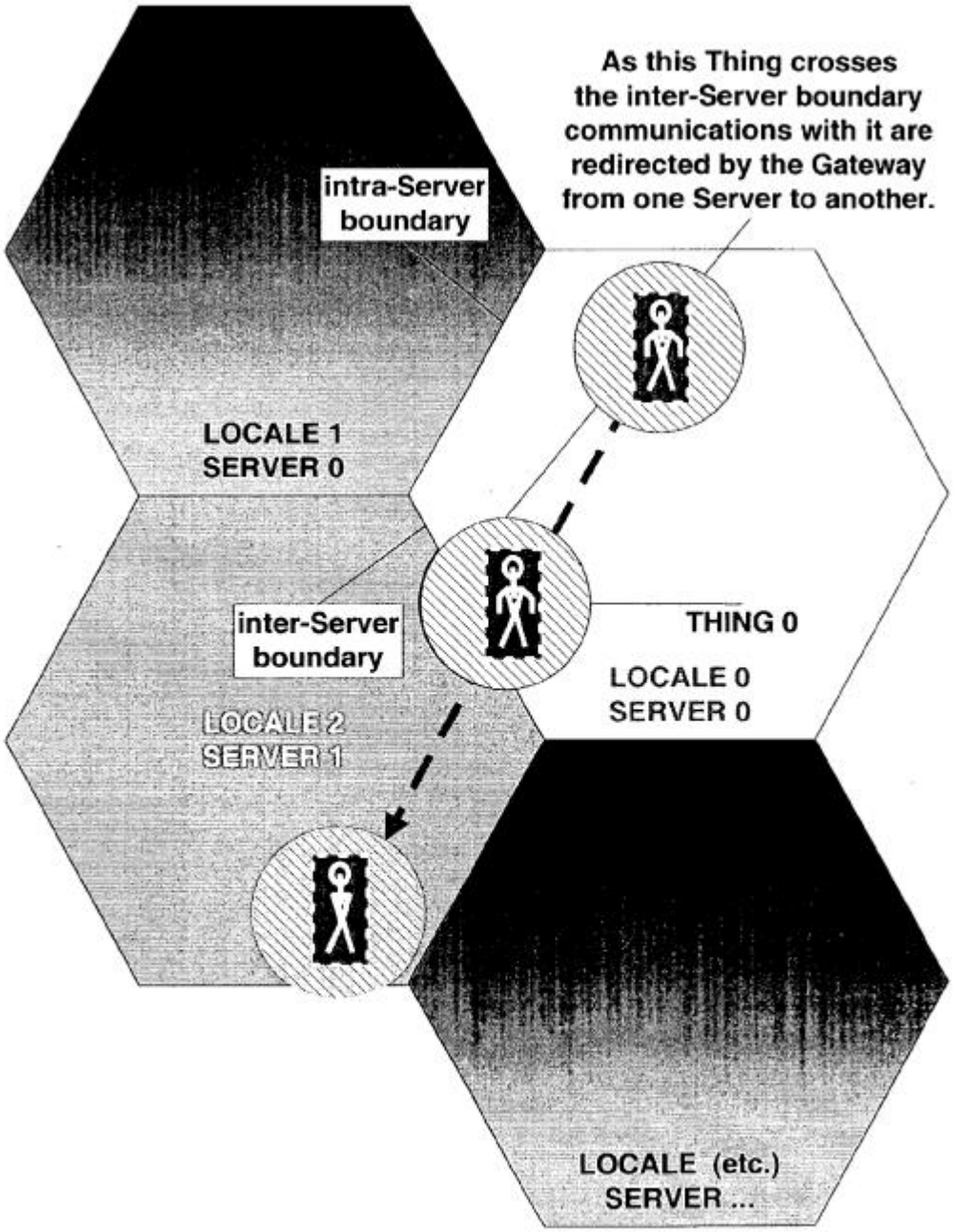


FIG. 24

(Levine, Fig. 24.)

74. Accordingly, when playing a game, the players' characters (avatars) may engage in interactions with other objects within the game's one or more Locales that define a playfield for the game, disclosing the claimed "**virtual playfield**."

75. Levine further illustrates how Locales can also correspond to real-world locations, so that the virtual playfield mirrors a real-world playfield in a certain geographic area. For example, in the "monster" game, the virtual playfield includes a geographic region corresponding to New York City and players may move around within the game's virtual playfield by moving around in the real world, such as moving from the Wall Street area to another area:

> In step **5808**, server **102** would cause the new "monster" character to be delivered to all other users playing the same instance of the interactive multi-user gaming application as the PC user. Such deliver[y] would be affected by translator **108**, under the control of server **102**, via transportation network **103**. Further, **the server would place the new "monster" character in a PC user-dictated location within the synthetic environment, say for example, the Wall Street area of New York City**. . . .
>
> In step **5810**, a user on a laptop client device **112*e*** ("laptop user") would now "see" the new "monster" character on their laptop. More specifically, **the laptop user would see the "monster" character on the synthetic representation of Wall Street in New York City**. Grid system **100** ensures that the "monster" character is properly rendered

> for each user utilizing a different type of client device **112**.
>
> In step **5812**, the laptop user sends a message to a user on a mobile phone client device **112*a*** ("mobile user"). Such message, for example, would convey that "a new 'monster' character is two blocks from you." This message may be sent because **the mobile user is represented in the synthetic environment as being on Wall Street in New York City because in the physical world, they are**.

(Levine, ¶¶0661-0664.)

76. Similarly, Levine also illustrates exemplary scenes of a virtual playfield in the "sniper" game, including visual depictions of characters in different areas of a virtual playfield and a screenshot of the game on a Palm Pilot device, such as shown in Figures 45, 46, and 47 reproduced below. As shown in the figures, the "virtual playfield" encompasses "Locale" regions that constitute the playfield in the game where characters (such as "sniper," "victim," and bicyclist) can perform activities and interact as part of playing the game.

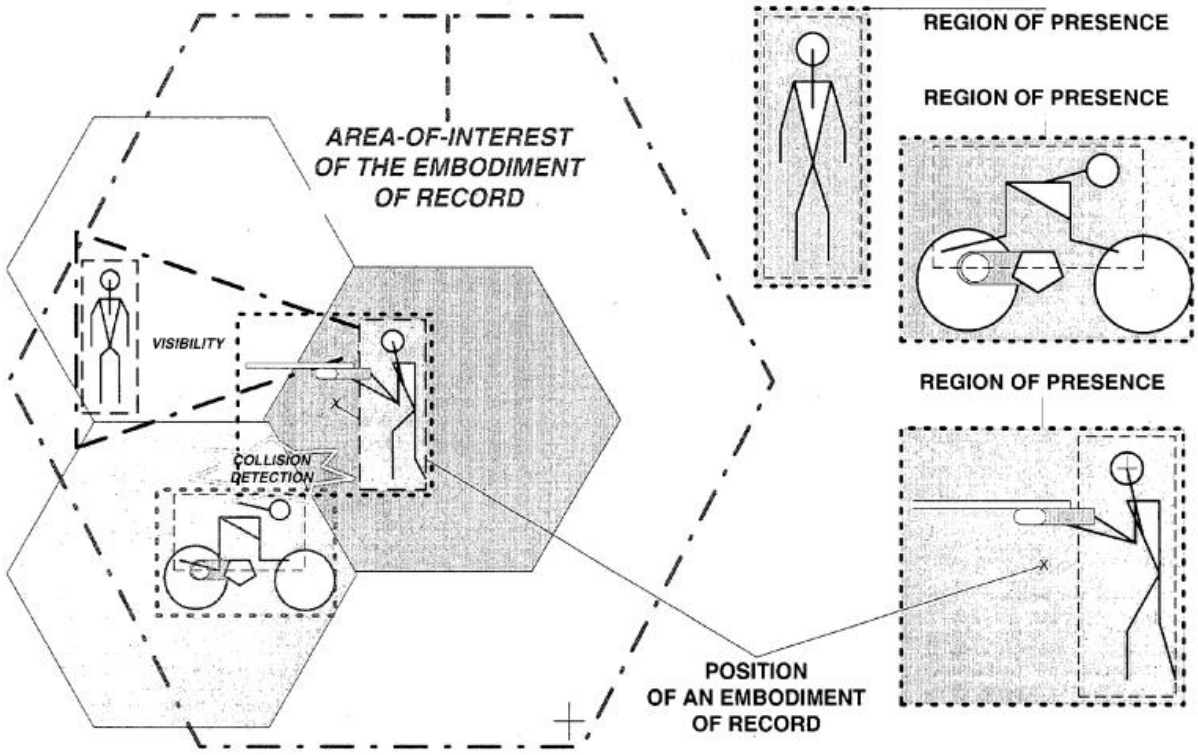


FIG. 45

(Levine, Fig. 45.)

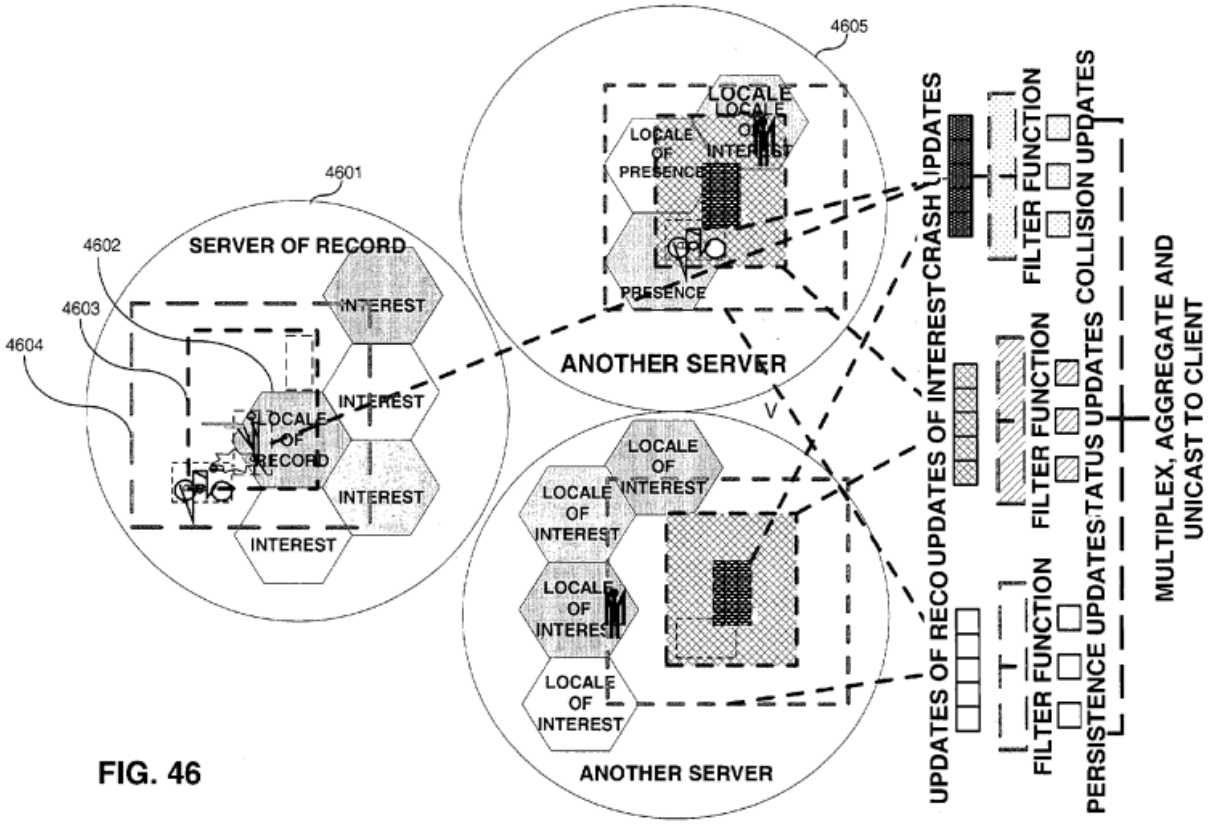


FIG. 46

(Levine, Fig. 46.)

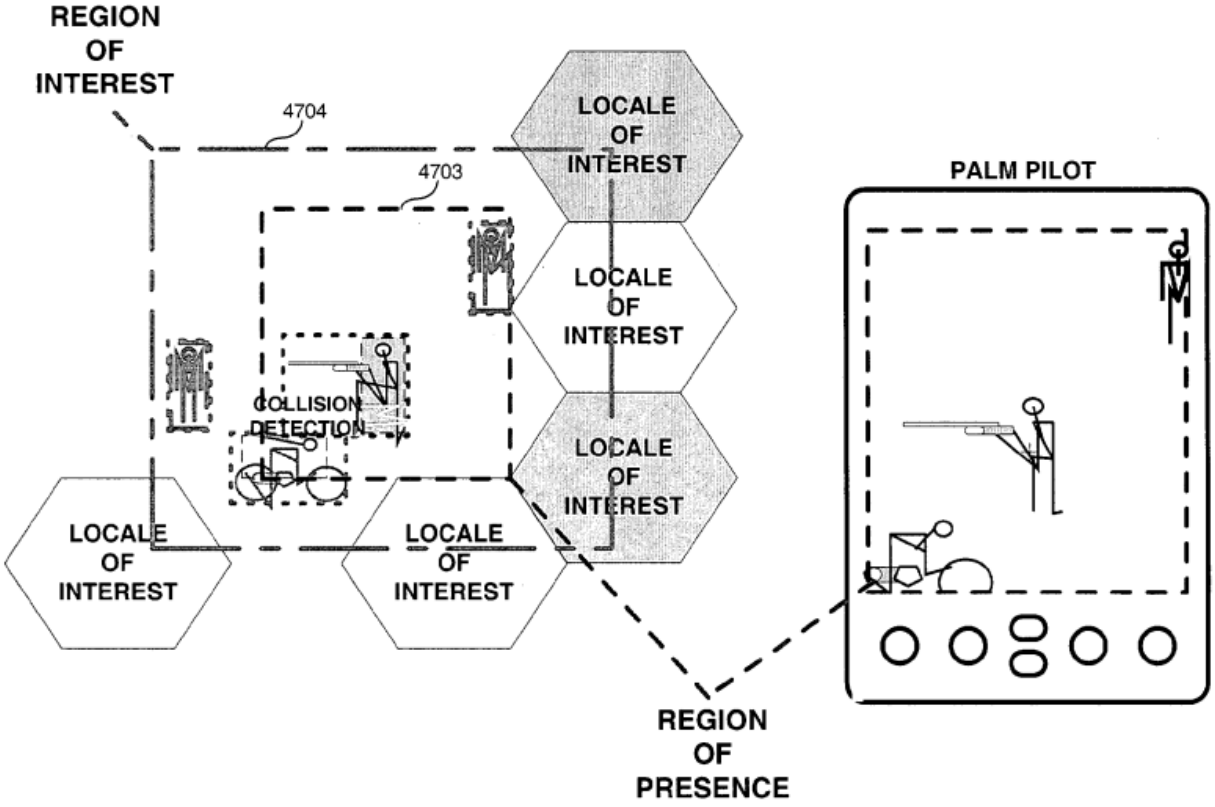


FIG. 47

(Levine, Fig. 47.)

(b) "a first character, wherein the location of said first character in said virtual playfield is displayed on a display and is determined utilizing a first control signal from a first locating device that is based, at least in part, on a physical location determined by said first locating device; and" (Claim 1[b])

77. Levine discloses and renders obvious "**a first character, wherein the location of said first character in said virtual playfield is displayed on a display and is determined utilizing a first control signal from a first locating device that**

is based, at least in part, on a physical location determined by said first locating device."

78. Due to the length of this element, I address it in multiple parts. Levine discloses "**a first character**" in the form of each character in a game (called an "avatar") that is controlled by a human user playing the game.

> Avatars **806**—defines a role for the player within a specific game: associates a specific Thing representing the player with its most recent Locale **802**.

(Levine, ¶0224.)

> Normally in the massively multi-player world, there are a multitude of objects. Avatar objects are Things connected to clients (real people pushing buttons and twitching joysticks somewhere out there on the Internet). Passive objects are Things that can be manipulated but aren't connected to any other form of control mechanism (gold coins that can be picked up and put into inventory, flags to capture, etc).

(Levine, ¶0628.)

79. For example, Levine describes that the "sniper" game includes characters/avatars such as a "sniper," a "victim," and bicyclist avatar that are controlled by players using client device. Each avatar discloses "**a first character**" in the game:

> In the example of **FIG. 45**, there would be a reference to the "sniper" Avatar on the list corresponding to the walking "victim" Avatar, and another reference to the "sniper" on the list corresponding to the bicycling "courier" Avatar. In order for the "sniper" to see the "victim", he or she must receive messages as the walking Avatar moves back and forth. This implies that the victim is a packet source for messages to the sniper, which becomes a packet sink for messages about the changes in state of the Server Thing representing the walking Avatar. For the "sniper" to collide with the courier, it must receive messages as the bicycling Avatar pedals here and there. This implies that the courier is a packet source for messages to the sniper, which becomes a packet sink for messages about changes in state of the Server Thing representing the bicycling Avatar. Thus, there is a Server ThingRef maintained on the internal list of the victim and the courier that is used to route messages from these Server Things (as sources) to the sniper Avatar (as sinks). Packets routed in this way and rebroadcast to the Gateway **401** handling the login session for the sniper Avatar, and are proxied back to the client controlling the sniper.

(Levine, ¶0571.)

80. Similarly, Levine describes that players can control characters in the "monster" game that can take actions such as "killing" the monster or running away from the "monster." (*See* Levine, ¶¶0661-0666, 0670-0672.) Each of the player-controlled characters in the "monster" game discloses "**a first character**" in the

game.

81. Levine further discloses and renders obvious that "**the location of said first character in said virtual playfield is displayed on a display**." For example, Levine describes and illustrates how the location of each character in the "sniper" game's virtual playfield is displayed on a display. As shown below, Levine's Figure 45 conceptually illustrates how different characters (including sniper, victim, and bicyclist) are located in nearby areas in the virtual playfield of the game. Figure 46 illustrates the location of characters in a "Locale" within the "**virtual playfield**" of the sniper game. (Levine, ¶0557 ("**FIG. 46** shows a Game Server of Record **4601** that includes a Locale of Record **4602** with a sniper standing inside the Locale of Record **4602**."). Figure 47 likewise shows "Locale" regions in the sniper game's "**virtual playfield**" and illustrates how **the location of each character in the virtual playfield is displayed on a display** of the player's client device (a Palm Pilot in this illustration):

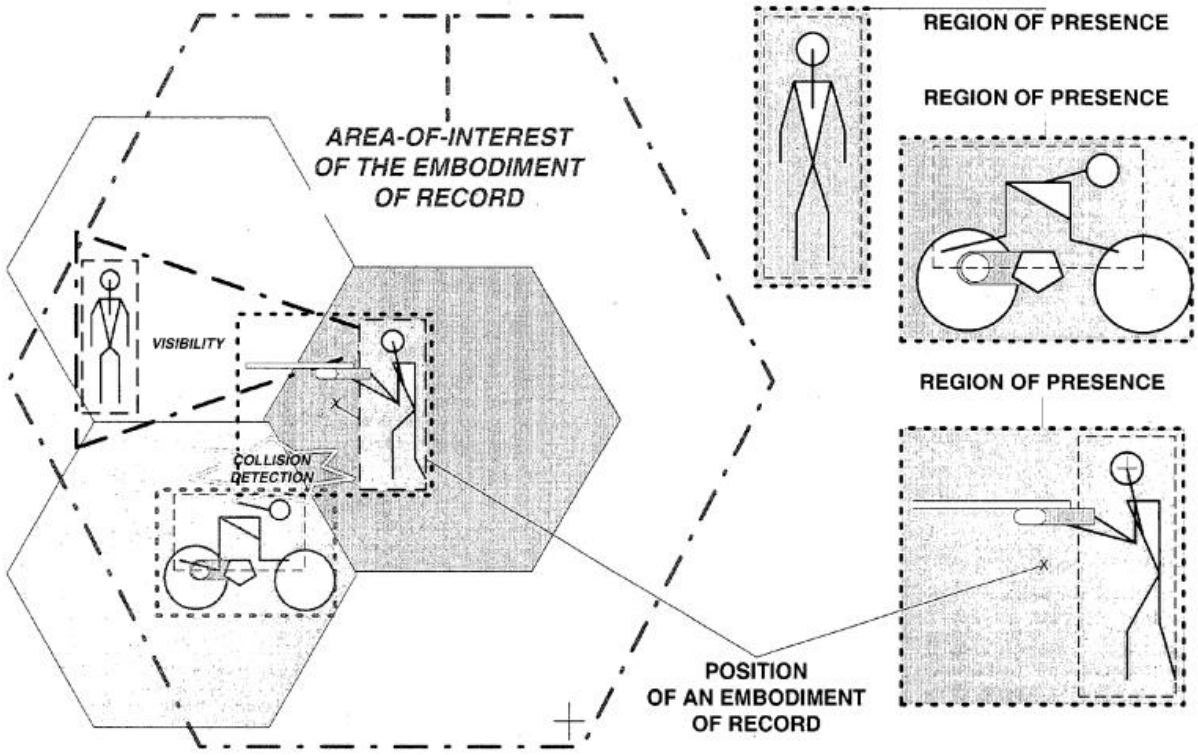


FIG. 45

(Levine, Fig. 45.)

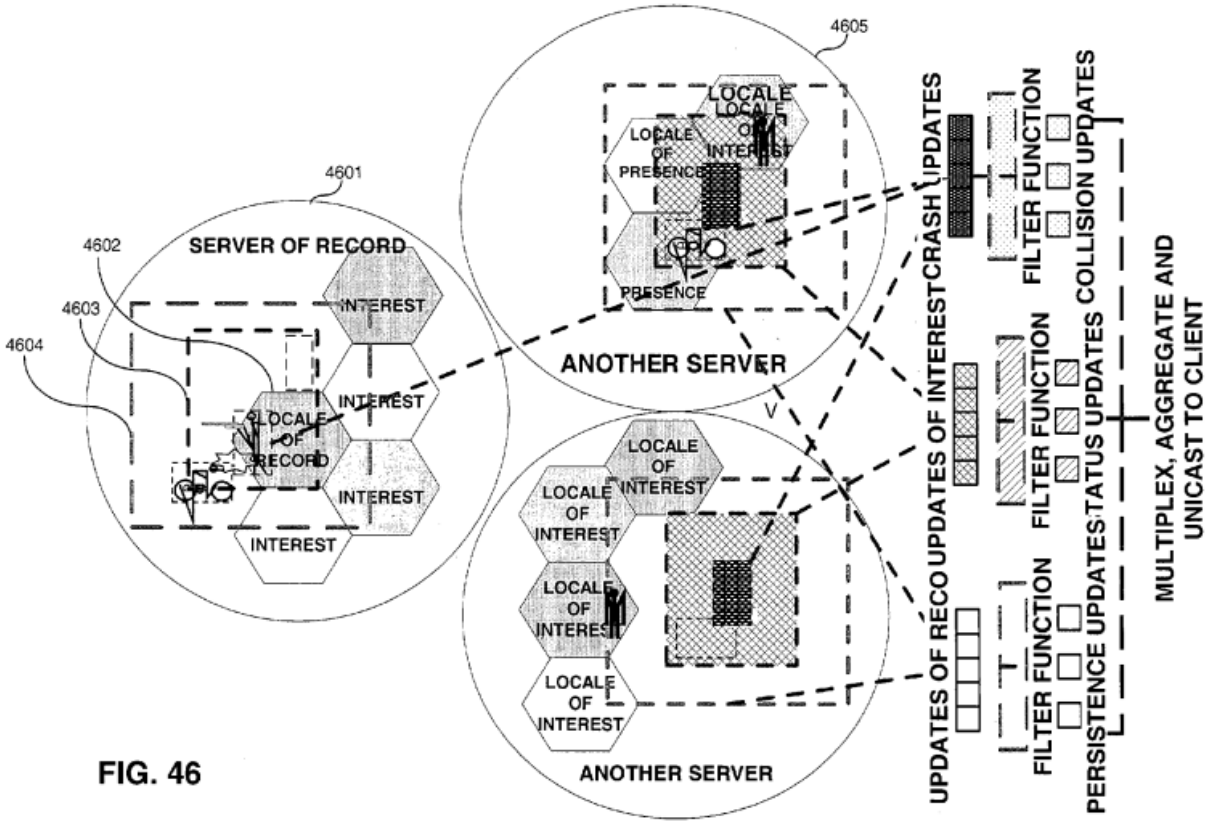


FIG. 46

(Levine, Fig. 46.)

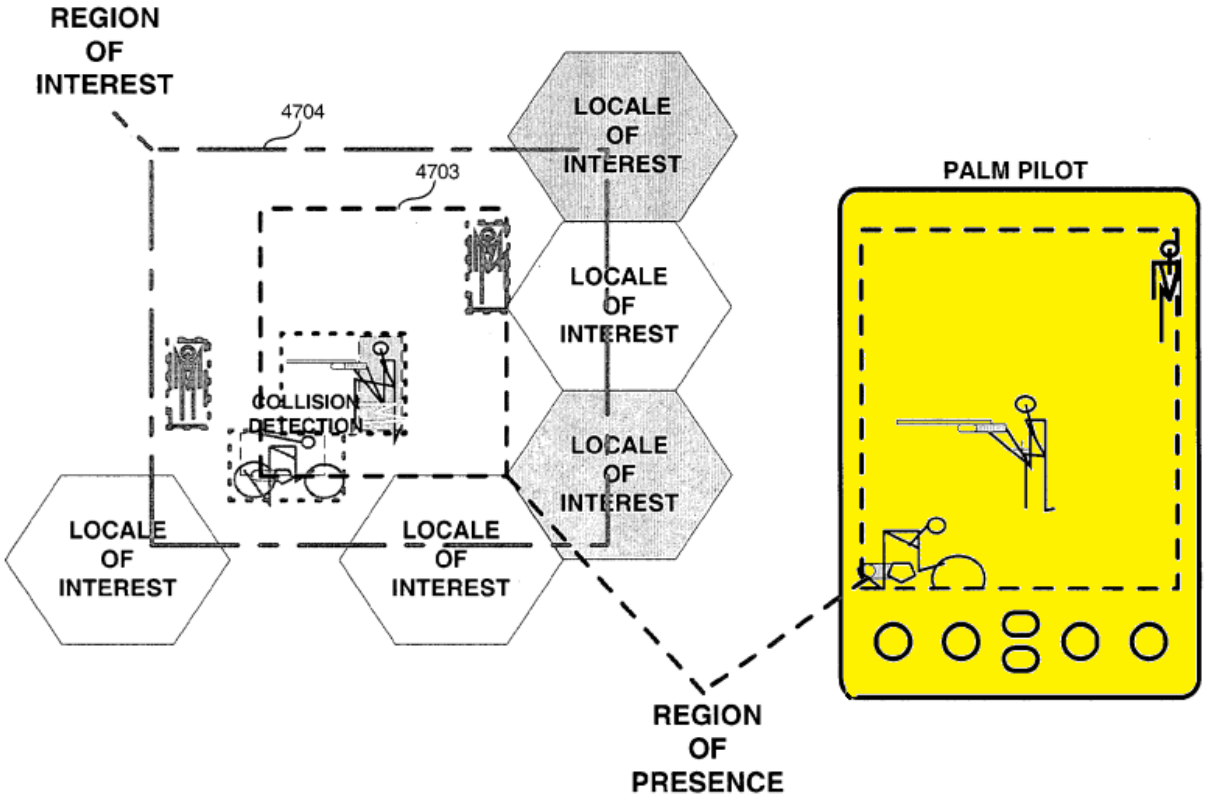


FIG. 47

(Levine, Fig. 47 (highlighting added).)

82. As shown in Figure 47 and highlighted above, the display on the client device (Palm Pilot) shows the location of each character in the game, such as showing the sniper located between the bicyclist and the victim in the exemplary screenshot. The left portion of Figure 47 illustrates the location of each character in the game with respect to Locale regions in the virtual playfield, including the sniper located near the bicyclist and the victim, and the right portion of Figure 47 illustrates how the location of each character is displayed on the client device. Levine thus

discloses in the "sniper" game "**the location of said first character in said virtual playfield is displayed on a display**."

83. Levine also renders obvious that a game in Levine's system would similarly display the location of each character on users' client devices. For example, the description of the "monster" game does not expressly specify that the location of each character is displayed on players' devices, but a person of ordinary skill in the art would have understood and found it obvious that the location of each character in the "monster" game would similarly be displayed. Levine describes that a visual representation of each player is presented to other players in the "monster" game. (*E.g.*, Levine, ¶0671 (when a mobile user leaves the area of Wall Street, "then the synthetic representation of the mobile user would disappear from the PC user's and laptops user's client devices").) It would have been obvious given the location-based gameplay of the monster game, such as where the player's character may "kill" or "run away" from the "monster" and effects such as audio content may be played when a player "enters a specific area," that the **location** of each character would be displayed so that the player could see the relative location of the character vis-à-vis the monster and other objects and characters with which the character interacts. (*E.g.*, Levine, ¶¶0666, 0670-672.)

84. Levine discloses "**a locating device**" in the form of an orientationally-

aware peripheral (OAP) device contained in each player's client device. Specifically, Levine teaches that each client device **112** may include within it an OAP for "tracking the locating and orientation of users within the system."

> In one embodiment, the system also includes an orientationally-aware peripheral device within the client devices for tracking the locating [sic] and orientation of users within the system of the present invention.

(Levine, ¶0155.)

> In an embodiment of the present invention, an orientationally-aware peripheral (OAP) device, described in detail below, may be included within Grid system **100** within each client device **112**.

(Levine, ¶0197.)

85. Levine further details how the OAP device is used to track the "**location**" of players in the system by incorporating an OAP device into each client device **112** used by players:

> Latitude, longitude and other sets of **location** data are often integral to the applications executed within Grid system **100**. Such location awareness allows software agents to traverse physical terrains and physical entities such as people, buildings and vehicles to be represented in virtual worlds. Therefore, in addition to existing systems such as GPS and the like, inertial tracking can be used to track the **location** and orientation of players within system **100**.

> In an embodiment of the present invention, an orientationally-aware peripheral (OAP) device, described in detail below, may be included within Grid system **100** within each client device **112**.
>
> Referring to **FIG. 3**, a block diagram representing the architecture of an orientationally-aware peripheral (OAP) device **300** according to an embodiment of the present invention is shown. OAP device **300** includes an inertial tracking subsystem **330** and a communication subsystem **320**. Inertial tracking subsystem **330** employs six accelerometers that will track the placement and orientation of the peripheral device in six degrees of freedom ("6-DOF"). Such a design eliminates the need for separate gyroscopic sensors to determine orientation information. The six accelerometers are divided into three groups of two sensors each (i.e., accelerometers pairs **302**, **304** and **306**) oriented along each of three perpendicular axes. Each pair of accelerometers is separated as far as is possible on the platform. By correctly integrating the acceleration of all six sensors, both position and angular orientation can easily be calculated.

(Levine, ¶¶0196-0198.)

86. As noted in the excerpted passage above, the OAP device provides inertial tracking, which "can be used to track the location and orientation of players" within the system. (Levine, ¶0196.) Levine further reiterates that "users' locations can be geographically tracked" by inertial tracking as provided by the OAP device:

> Another feature of the present invention is that users' locations can be

> geographically tracked, via a Global Positioning Satellite (GPS) system, cell-based triangulation, dead-reckoning (i.e., inertial tracking) or the like as described herein, in order to provide more realistic content, more realistic interactive experience to users, or data which is more contextually relevant to the user.

(Levine, ¶0162.)

87. Levine further notes that the OAP device calculates "position." (Levine, ¶0198 ("both position and angular orientation can easily be calculated").) Levine notes that "position" is recorded as "where this object is located in the game world."

> Each object in every game has an entry in the Thing table. The Thing table controls the behavior of objects across the Grid, and maintains their common basic states: position, orientation, range, presence, region of interest type, whether they are active or passive in nature. It includes definitions for the following properties: . . .
> d) Position—where this object is located in the game world. Also provided are Velocity and Acceleration for rectilinear motion.

(Levine, ¶¶0232-0236.)

88. Levine further discloses and renders obvious that "**the location of said first character in said virtual playfield . . . is determined utilizing a first control signal from a first locating device that is based, at least in part, on a physical**

location determined by said first locating device." Specifically, the position information that is determined and transmitted by the OAP (the "**first locating device**"), recorded as "Position" information in the system for the corresponding character object for the player (Levine, ¶¶0232-0236), and communicated to other client devices discloses and renders obvious the claimed "**first control signal**." As discussed previously, Levine describes that "inertial tracking can be used to track the location and orientation of players within system **100**" and teaches that the OAP device "within each client device **112**" contains an inertial tracking subsystem **330** using accelerometers from which "both position and angular orientation can easily be calculated." (Levine, ¶¶0196-0198.)

89. Levine further describes that the "output of the inertial tracker" is communicated to other client devices playing the same game:

> As mentioned above, OAP device **300** also includes communication subsystem **320**, where the output of the inertial tracker is received by a data translator **314** and communicated to other client devices **112** participating in the same instance of the multi-player, interactive game. One embodiment of the communication subsystem **320** would employ wireless communication protocols (such as Bluetooth, IEEE 802.11 or the like) to communicate with a nearby computer or base-station (and thus with translator **108**) via a transmitter **312**.

(Levine, ¶0204.) Figure 3 illustrates the OAP device including its inertial tracking subsystem and communication subsystem:

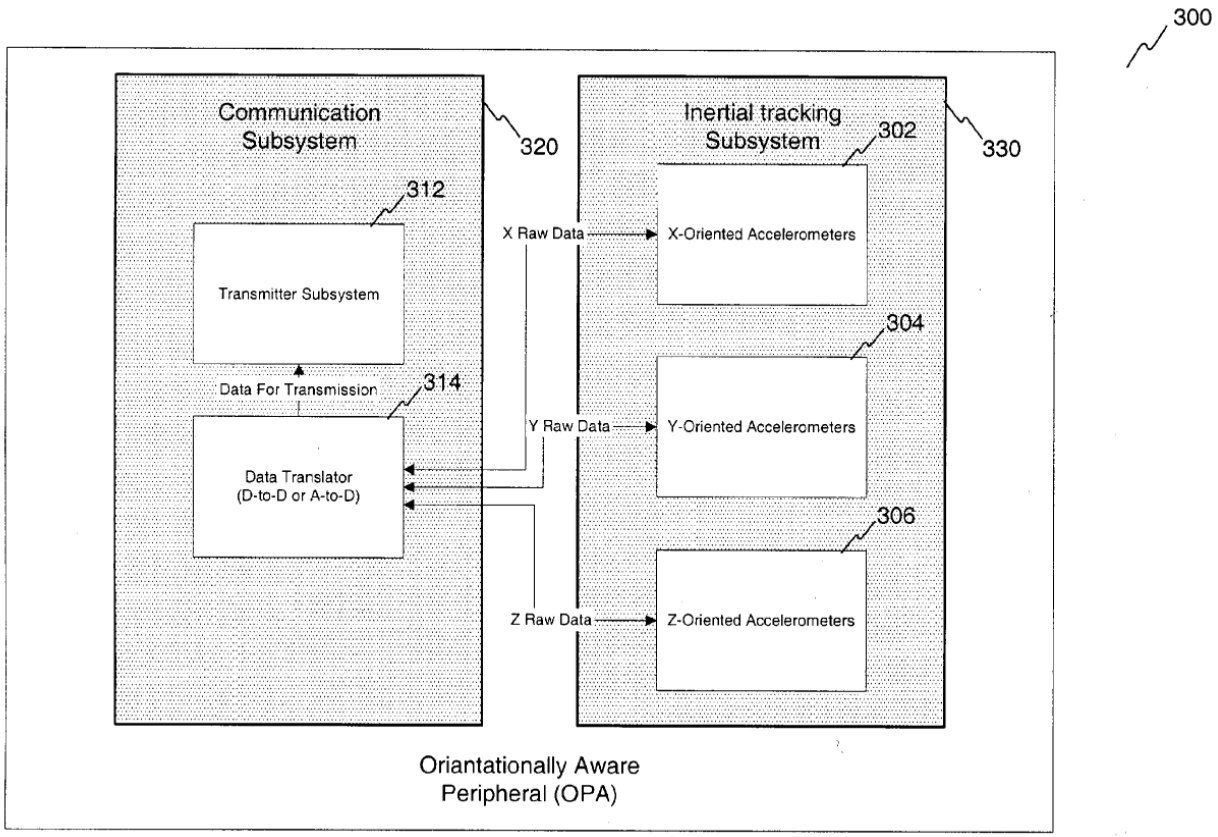


FIG. 3

(Levine, Fig. 3.)

90. The position information that is transmitted by the OAP, which is recorded in the system as "POSITION" information indicating the location of the character object within the game and communicated to other client devices, thus discloses and renders obvious the claimed "**control signal**" that is utilized to determine the location of each character in the virtual playfield. A person of ordinary

skill in the art would have understood that the information transmitted by the OAP device in each player's client device discloses and renders obvious a "**control signal**" that is used by the system to control the determination of the "POSITION" of the player's character in the game, which discloses the "location" of the character in the virtual playfield. Levine thus discloses and renders obvious that "**the location of said first character in said virtual playfield**" is determined based on the position information transmitted from the OAP in each client device, which is in turn "**based, at least in part, on a physical location determined by said first locating device**" (OAP device) as described previously. As an illustrative example based on Levine's disclosures, when a player is playing the "sniper" character in the "sniper" game, the player's client device (such as a Palm Pilot) can display on its display the location of each other character in the game (such as the bicyclist and "victim" characters). Each other character (such as bicyclist or victim) discloses the "first character" as claimed. The location of each character is based on the location information from the OAP device in the client device of the corresponding player, which is based on the physical location of the OAP device. Levine specifically describes how the POSITION of each avatar (player character), which is output from the OAP device of the player's client device, is recorded in the "sniper" game and used to determine the location of each character in the game: "In the example shown in **FIG. 45**, the

area-of-interest of the 'sniper' Server Thing is the region centered about the POSITION of the embodiment-of-record of that Avatar on its Server-of-Record in its Locale." (Levine, ¶0569.)

91. Similarly, in the "monster" game, a person of ordinary skill in the art would have understood and found it obvious that the position of each character that would be displayed on players' client devices, corresponding to their real-world location such as Wall Street in New York City, would similarly be determined based on the physical location determined by the OAP device resulting in a control signal determining the location of the corresponding character in the game. For example, after a player in the real world takes a taxi, "the mobile user's taxi ride takes them outside of the Wall Street area of New York City, then the synthetic representation of the mobile user would disappear from the PC user's and laptops user's client devices." (Levine, ¶0671.) This illustrates how the change in the physical location of the player results in a change of the corresponding location of the player's character in the virtual playfield. A person of ordinary skill in the art would have understood the change of location in the virtual playfield to be determined by the OAP device in the player's client device sending a control signal based on the physical location it determined.

(c) "a second character, wherein said second character is computer controlled via artificial intelligence and said artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character; and" (Claim 1[c])

92. Levine discloses and renders obvious "**a second character, wherein said second character is computer controlled via artificial intelligence and said artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character**."

93. Levine discloses "**a second character, wherein said second character is computer controlled via artificial intelligence**" in the form of Non-Player Character (NPC) objects, which are "character" objects (as the name indicates) that are controlled via "artificial intelligence" as Levine describes. At the system level, Levine describes that online games include "Active objects" which include NPCs and are controlled via "artificial intelligence" as opposed to being "directly controlled by users," as follows:

> Grid system **100** also includes a Daemon Controller **108** which acts as a privileged client for managing the activities of elements of the application not directly controlled by users, such as artificial intelligence or aspects of a simulation that run on their own internal logic and react to other aspects of the simulation.

(Levine, ¶0186.)

> Active Objects (NPCs)—non-player controlled objects that operate as multiple sources of packets to others and provide a single sink for packets from others. The originator of NPC packets is the daemon (discussed below), a computer controller login account for each Locale with special privileges. The daemon manipulates active objects within a specific Locale, and their embodiments-of-record provides a [sic] multiple sources of packets to other clients. An example of an active object might be a Dragon or a Troll.

(Levine, ¶0394.)

> Active Objects are objects, some of which are also known as Non-Player Characters (NPCs) that may have an independent life of their own; that walk and talk, or run and hide, or perform other changes of state actively of their own accord. These Non-Player Characters are not necessarily human characters. They may be animals, enchanted swords, or magic portals that take some positive role in directing game play. Some sort of Artificial Intelligence (AI) is attributed to this class of objects, and their object state changes appear to be directed by some sort of intelligent agent. Those changes of object state do not have to be physical ones. They may range from a proximity alarm that sounds a warning beacon if an Avatar approaches too closely to a morning glory that furls its petals at the setting of the sun. In other words, Active objects do something on their own or respond to external stimuli without having to be controlled by a real person sitting at the controls.

(Levine, ¶0629.)

94. Each NPC in a game that includes a "**first character**" as claimed thus discloses "**a second character, wherein said second character is computer controlled via artificial intelligence**." Further, a person of ordinary skill in the art would have understood and found it obvious that each game, including for example the "monster" and "sniper" games, implemented using Levine's online multi-player game system could include at least one such NPC. For example, in the "monster" game, Levine describes that the "monster" character is created with certain pre-defined characteristics including movement behavior that is not controlled by manual-input, and does not describe that the activities of the "monster" are controlled by manual-input from a player. (*E.g.*, Levine, ¶¶0659-0666 (creation of character to "define how the 'monster' character moves within the synthetic environment (e.g., x,y position to x′,y′ position at z rate)" and corresponding gameplay).) A person of ordinary skill in the art thus would have found it obvious to implement such a "monster" as an NPC controlled by artificial intelligence, in view of Levine's teachings of "active object" characters that are controlled in a manner "not directly controlled by users, such as artificial intelligence" (Levine, ¶0186) and may include non-player characters of a nature similar to a "monster" such as "Dragon" or "Troll" (Levine, ¶0394).

95. Levine also renders obvious that the "sniper" game would include NPC

active objects controlled by artificial intelligence. Levine describes that the "sniper" game is associated with one or more "Locales" among which players can move around, and Levine describes that a given "Locale" may have NPCs associated with it. (*E.g.*, Levine, ¶¶0557 ("FIG. 46 shows a Game Server of Record **4601** that includes a Locale of Record **4602** with a sniper standing inside the Locale of Record **4602**."), 0562 (discussing "when a player moves from one Locale to another" in the sniper game), 0394 (describing "Active Objects (NPCs)" and "active objects within a specific Locale"), 0637 (discussing "NPCs within a given Locale").) A person of ordinary skill in the art would have found it obvious to apply these teachings regarding Locales to embodiments of games that use Locales. I am informed and understand that combining embodiments in a prior art reference would not ordinarily require a leap of inventiveness. Levine thus renders obvious that one or more of the Locales encompassed within the "sniper" game would implement one or more NPCs controlled with artificial intelligence, as a matter of design choice to implement Levine's teaching that Locales may have associated NPCs.

96. Levine further renders obvious that "**said artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character**" as claimed. Specifically, Levine renders obvious that the location of each player's character in the game as indicated by a control signal,

as discussed for Claim 1[b], also is used to control, at least in part, the actions of NPCs controlled by artificial intelligence. Levine describes examples of how the activity of NPCs may be controlled, at least in part, based on the location of a player's character. For example, Levine describes NPCs that "talk," "run and hide," "sound[] a warning beacon," and generally "respond to external stimuli." (Levine, ¶¶0629-0630.) A person of ordinary skill in the art would have therefore understood and found it obvious that the "artificial intelligence" Levine describes as controlling the behavior and actions of an NPC would use a player's location information to control NPC behavior and actions (such as talking, running away/hiding, or sounding an alarm when a player approached). Levine describes these features as follows:

> Active Objects are objects, **some of which are also known as Non-Player Characters (NPCs)** that may have an independent life of their own; that **walk and talk**, **or run and hide**, or perform other changes of state actively of their own accord. These Non-Player Characters are not necessarily human characters. They may be animals, enchanted swords, or magic portals that take some positive role in directing game play. Some sort of **Artificial Intelligence (AI)** is attributed to this class of objects, and their object state changes appear to be directed by some sort of intelligent agent. Those changes of object state do not have to be physical ones. **They may range from a proximity alarm that**

> **sounds a warning beacon if an Avatar approaches too closely** to a morning glory that furls its petals at the setting of the sun. In other words, Active objects do something on their own or **respond to external stimuli** without having to be controlled by a real person sitting at the controls.

(Levine, ¶0629.)

97. As described in this passage, an NPC (claimed "**second character**" controlled by "**artificial intelligence**") may be controlled, at least in part, by the location of nearby player characters (each an avatar disclosing the claimed "**first character**"). For example, where an avatar (player character) approaches too closely to an NPC, that proximity **controls** the NPC to change its object state to a proximity alarm that sounds a warning. A person of ordinary skill in the art would have understood that the determined location of the player character (avatar) would be determined based on the control signal transmitted from the OAP in the player's client device, in view of the disclosures discussed previously for Claim 1[b]. Similarly, a person of ordinary skill in the art would have understood that the described functions of an AI-controlled NPC such as to "talk" with a player character, or "run and hide" from a player character, obviously would be **controlled** in part by the location of the player character as determined by the player's location as transmitted by the OAP in the player's client device. For example, it would have

been understood that an NPC character programmed with its artificial intelligence to "run and hide" under predefined conditions would be caused to "run and hide" when a player character approached the NPC within a certain proximity in the game, as determined based on the location of the character in the game that is in turn determined based on a control signal transmitted by the OAP device in the player's client device as described for Claim 1[b].

(d) "an impenetrable object, wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield, and said first character is impacted when said first character contacts said impenetrable object." (Claim 1[d])

98. Levine discloses and renders obvious "**an impenetrable object, wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield, and said first character is impacted when said first character contacts said impenetrable object**."

99. I first address the "**impenetrable object**" and "**impacted**" limitations and then address the "**location**" limitations.

100. As discussed below, Levine discloses and renders obvious "passive objects" which are each a "**virtual object**" in the game such as a "sword," an "axe,"

walls, "rubble," trees, and other objects that exist only in the game, are "**impenetrable**" in the game, and cause an impact (a "collision") on the character when the character contacts them.

101. The '582 patent describes "impenetrable" objects as objects in a game that may impact a character in the game, such as a wall that impedes movement or a car that runs into the frog in the classic video game FROGGER:

> A location-based game where a user's actual physical location on a physical playfield correlates to a video game character's location on a virtual video game playfield may require that the operational rules of current game be changed. Using PACMAN as an example, in the classic PACMAN, PACMAN is not operable to stray close to maze walls. In an actuality PACMAN game, however, a player may stray close to maze walls and even come into contact with maze walls. Hitting a maze wall may be similar to a user contacting, or passing through, a perimeter of the video game playfield. In this manner, functionality is provided for this scenario. For example, a user may be deducted a particular number of points if that user contacts a maze wall, a game's perimeter/boundary, or an object that a video game character cannot pass through and/or cannot use. **For the purposes of this application, such objects will be referred to as impenetrable objects**. One alternative to reducing points is to stun the character for a period of time (e.g., not allowing the video game character to move for a period of time), reduce the number of lives of that character (e.g.,

> reduce the number of character lives left by 1), or end the game (e.g., display "GAME OVER" to the user).

('582, 11:51-12:20.)

> Multiple types of impenetrable (or interactive) objects may be provided in a single game. For example, in FROGGER cars may be impenetrable objects that cause FROGGER to die (e.g., lose a life). Alternatively, the perimeter of the playfield may be an invisible impenetrable object such that when a user leaves a portion of the actual playfield that corresponds to a location of the virtual playfield outside of the perimeter, FROGGER is left behind at the perimeter.

('582, 15:49-56.)

102. Levine discloses and renders obvious the same concept of "impenetrable" objects contemplated by the '582 patent.

103. For context, Levine teaches that the "Grid" in its game system contains "objects" that represent "physical" things in the game:

> Central to the operation of the database **104** is the concept of the object. An object is a "physical" item that is part of a shared environment.

(Levine, ¶0286.)

104. Levine describes multiple different types of "object," including a character controlled by a player (an avatar), an "active object" such as a non-player character (NPC), or a "passive object" such as "an Enchanted Castle." (Levine,

¶0393-0395.) Levine describes various passive objects such as a sword, an axe, a wall, and other objects. (Levine, ¶¶0211 ("When a player picks up a sword, the database **104** must record this fact and store it . . ."), 0526 ("Every sword has its own GUID . . ."), 0633 ("If the Non-Player Character is low on health points, the daemon knows it. If it is carrying an axe, the Daemon Controller can swing it.").)

105. Levine further teaches that each object in its game system may occupy "space" in the game's virtual playfield, resulting in a "collision" when a character contacts the object. Levine describes:

> In terms of computation complexity, area-of-interest management is essentially an O (n^2) process, since each Server Thing in a region may potentially interact with every other Server Thing in that region. Every time some Avatar takes a step, they may come into range, **collide with**, or drop out of sight of some other object.

(Levine, ¶0574.)

> EVENT_HERE—this Thing is in close proximity to an existing secondary object: a collision is immanent.

(Levine, ¶0646.)

106. To determine whether two objects collide, Levine's Grid (virtual playfield) maintains the position and "presence" of each object, which is used to determine "collision detection" between objects:

> Each object in every game has an entry in the Thing table. The Thing table controls the behavior of objects across the Grid, and maintains their common basic states: position, orientation, range, presence, region of interest type, whether they are active or passive in nature. It includes definitions for the following properties: . . .
> Position—where this object is located in the game world. Also provided are Velocity and Acceleration for rectilinear motion. . . .
> **Presence—how far this objects "extends" in space for collision detection**.

(Levine, ¶¶0232-0239.)

> Each Server Thing (see discussion above) interacts with others in its proximity through its area-of-interest. For example, each object on the Game Server **405** can have a range of vision (of block data subtype RANGE) within which other objects are visible, and **a presence (of subtype PRESENCE) with which other objects can collide**.

(Levine, ¶0568.)

107. Levine describes numerous examples of passive objects in the game and with which a character may collide, such as a wall, trees, or rubble:

> For performance reasons, a particular client device **112** may perform certain use-logic calculations locally, but the results of these calculations will not be transmitted unmediated to other clients within system **100**. For example, **collision detection (i.e., a player collides into a wall within a shared environment)** may be performed locally,

> but the back-end servers **102** must perform heuristics to ensure that collision constraints are met before transmitting updated position-states to other clients **112**.

(Levine, ¶0681.)

> A group of civilians may form a molecular type of civilian called a crowd. **Other objects may be purely passive, such as trees or rubble**.

(Levine, ¶0386.)

108. A person of ordinary skill in the art would have understood and found it obvious that an object such as a sword, axe, wall, or rubble in the Grid would be understood to be an **impenetrable** object that the character could not penetrate in the game. As Levine describes, when the "presence" of two objects corresponds such that they **contact** each other, there is a "collision" between the two objects. A person of ordinary skill in the art would have understood and found it obvious that for realistic and satisfying gameplay when a player's character collides with a passive object, the object is **impenetrable** in the game such that the character cannot pass through or occupy the same space as the object.

109. Furthermore, Levine discloses that the character is **impacted** by contact with the wall because the contact forms a "collision," as shown in the passages cited above. The "collision" is an event that impacts the character.

110. In addition, it would have been obvious to implement the game such that a "collision" event may negatively impact the health of the character, providing an additional disclosure of **impact** on the character. Levine describes that characters in the game may have a "health" attribute (such as "health points"), like many adventure games in the prior art where the player's character has a variable "health" attribute. (Levine, ¶¶0255 ("Some networked games, especially first-person shooters, may get by with only a handful of states, such as health, damage, and strength. Other, more strategic games, will require an extensive list of special powers, items, and abilities (the palette of choices available to the game designer is illustrated in **FIG. 10**)."), 0633 ("If the Non-Player Character is low on health points, the daemon knows it.").)

111. Levine further describes that the objects in the game may include weapons such as swords and axes, and specifically describes "striking a sword blow" as an action between two players: "striking a sword blow, losing stamina, or exchanging goods or services do not necessarily affect the norm or distance metric between two players." (Levine, ¶0574.)

112. A person of ordinary skill in the art would have understood and found it obvious that where a player's character (the "first character") contacts an impenetrable object (such as a sword swung by another player or an NPC, or running

into a wall), the "collision" event would impact the character, such as by causing a loss of health points. A person of ordinary skill in the art would have understood that these are basic principles of adventure games that involve physical weapons and boundaries, where the game maintains the health status of the player's character, as reflected in Levine's teachings.

113. For these reasons, Levine discloses and renders obvious "**an impenetrable object, wherein . . . said first character is impacted when said first character contacts said impenetrable object**."

114. Levine further renders obvious "**wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield**." As described previously, Levine's games may correlate a real-world geographic area, such as the Wall Street area of New York City, with the "virtual playfield" of the game as defined by the Locales in the game, using location information from the OAP device in each player's client device. (*E.g.*, Levine, ¶¶0158 ("coordinating activities in the real (i.e., physical) and virtual worlds"), 0196-0204 (describing OAP device functionality and location information transmission), 0661-0664 ("the mobile user is represented in the synthetic environment as being on Wall Street in New York City because in the physical world, they are"), 671 ("if the mobile user's taxi ride

takes them outside of the Wall Street area of New York City, then the synthetic representation of the mobile user would disappear from the PC user's and laptops user's client devices.").)

115. However, the passive objects created and defined in the game, such as "rubble" or a sword or axe or gold coin, do not necessarily correspond to real-world objects (except perhaps in unusual circumstances where someone might manually create an object in the game to match a real-world object). (Levine, ¶¶0225 ("Things **807**—the basic description of an object in the game world. The Thing table distinguishes active objects from passive objects."), 0395 ("Passive Objects—non-controlled objects that operate as multiple sinks of packets to the Locale daemon and do not provide packets to others."), 0628 ("Passive objects are Things that can be manipulated but aren't connected to any other form of control mechanism (gold coins that can be picked up and put into inventory, flags to capture, etc[.]).").)

116. As such, since the virtual object does not exist in the real world, the player's client device including its OAP ("**first locating device**") can pass through a physical location that correlates to a virtual location of that object. For example, in a game set in Wall Street, the Position of a virtual object (for example, sword or axe or rubble) located on Wall Street in the game ("**virtual location**") would have a corresponding real-world **physical location** on Wall Street. The human player with

their device could walk along Wall Street through the location correlating to the virtual location of the object in the game without any impediment. Levine thus renders obvious "**wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield**."

2. Independent Claim 2

117. The preamble of claim 2 recites "[**a**] **non-transitory computer-readable medium having program logic provided thereon for providing a location-based game comprising**." To the extent the preamble is a limitation, Levine discloses and renders obvious the preamble for the same reasons discussed for the preamble of Claim 1.

(a) "a virtual playfield," (Claim 2[a])

118. Levine discloses "**a virtual playfield**" for the same reasons as discussed for Claim 1[a].

(b) "a first character, wherein the location of said first character in said virtual playfield is displayed on a display of a portable device and is determined utilizing a first control signal from a first locating device of said portable device that is based, at least in part, on a physical location determined by said first locating device" (Claim 2[b])

119. Claim 2[b] is the same as Claim 1[b] except that it adds a "portable

device" limitation as shown below.

Claim 1[b]	**Claim 2[b]**
a first character, wherein the location of said first character in said virtual playfield is displayed on a display and is determined utilizing a first control signal from a first locating device that is based, at least in part, on a physical location determined by said first locating device; and	a first character, wherein the location of said first character in said virtual playfield is displayed on a display <u>of a portable device</u> and is determined utilizing a first control signal from a first locating device <u>of said portable device</u> that is based, at least in part, on a physical location determined by said first locating device;

120. Levine discloses and renders obvious the two "portable device" limitations of Claim 2[b] and discloses and renders obvious the remainder of Claim 2[b] for the same reasons explained for Claim 1[b].

121. Levine teaches that each client device operated by each user playing the game may be a **portable device**, such as a mobile phone or personal digital assistant (PDA):

> Connected to the transportation network (e.g., global Internet **103**), outside of the LAN **101**, includes a plurality of external client devices

> **112** that allow users (i.e., players) to remotely access and use Grid system **100**. External client devices **112** would include, for example, a mobile phone **112*a***, a video game console (with Internet connection) **112*b***, a personal digital assistant **112*c***, a personal area network with retinal projection displays and/or ear piece **112*d***; a laptop **112*e***, and a desktop computer **112*f***.

(Levine, ¶0187; *see also* Levine, ¶¶0160 ("universal access to the shared environment is allowed via any device to which a client can be provided (e.g., mobile phones, video game consoles, personal computers, personal digital assistants (PDAs), retinal projection displays, ear pieces, etc.)"), 0161 ("Another feature of the present invention is that, aside from personal computers, workstations and terminals connected to the Internet, it allows mobile phones, wireless data devices, PDAs and the like, which are commonly owned by today's consumers, to represent opportunities to where users can participate in multi-person, interactive applications.").)

122. As such, where Levine discloses and renders obvious display of the first character as discussed for Claim 1[b], Levine further discloses and renders obvious that the display is "**of a portable device**" per Claim 2[b]. As discussed for Claim 1[b] above, Levine also expressly discloses a Palm Pilot—which is a PDA—as an example of a portable device in the "sniper" game, which includes a display as

shown in Figure 47. (Levine, Fig. 47 ("Palm Pilot" with display).)

123. Further, Levine teaches incorporating the "**locating device**" of Claim 1[b], the OAP device, into each client device playing the game, including mobile phones and PDAs. (Levine, ¶¶0197 ("In an embodiment of the present invention, an orientationally-aware peripheral (OAP) device, described in detail below, may be included within Grid system **100** within each client device **112**."), 0187 ("External client devices **112** would include, for example, a mobile phone **112*a***, a video game console (with Internet connection) **112*b***, a personal digital assistant **112*c***, a personal area network with retinal projection displays and/or ear piece **112*d***; a laptop **112*e***, and a desktop computer **112*f***.").)

124. For these reasons, Levine discloses and renders obvious Claim 2[b] for the same reasons as Claim 1[b] with the claimed "**display**" being provided on "**a portable device**" and the claimed "**locating device**" being contained within that "**portable device**."

(c) "a second character, wherein said second character is computer controlled via artificial intelligence and said artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character" (Claim 2[c])

125. Levine discloses and renders obvious "**a second character, wherein said second character is computer controlled via artificial intelligence and said**

artificial intelligence utilizes said first control signal from said first locating device for controlling, at least in part, said second character" for the same reasons explained previously for Claim 1[c].

(d) "a virtual object, wherein said virtual object is operable of being picked up by said first character; and" (Claim 2[d])

126. Levine discloses and renders obvious "**a virtual object, wherein said virtual object is operable of being picked up by said first character**."

127. Levine teaches that in its online games, a player's avatar in the game ("**first character**") can pick up a **virtual object** such as a sword, duck, or gold coin, which are then placed into a record of the avatar's inventory:

> Thus, at the center of every persistent-state, massively multi-player game lies its database **104**. The database **104** manages the persistence of object state across the game world: from login to login, session to session, Avatar to Avatar, property to property, it keeps a record of all significant state changes. **When a player picks up a sword, the database 104 must record this fact and store it**, otherwise the next time that player logs in they will wonder where they lost it.

(Levine, ¶0211.)

> utilities.grab (. . .)—invoke the grab function in the utilities module to **pick up an object and transfer it into your inventory**

(Levine, ¶0548.)

> Every time some Avatar takes a step, they may come into range, collide with, or drop out of sight of some other object. However, many state changes do not involve changes that affect the Server ThingRef list of current packets sinks for this Avatar. For example, **picking up a gold coin**, striking a sword blow, losing stamina, or exchanging goods or services do not necessarily affect the norm or distance metric between two players.

(Levine, ¶0574.)

> This C++ server method is called by the buy_a_duck function to generate an approval dialog with the seller of the 'duck', whose response will control whether or not the transfer actually takes place. If the approval for this action is received, the script will call another C++ server method, **grabByGUID**(. . .), **which will attempt to stuff the purchased 'duck' into the buyer's inventory list**.

(Levine, ¶0609.)

128. Each "picked up" item added to the player's avatar's inventory is a "**virtual object**" insofar as it exists only in the game and not in the real world.

129. Given these teachings that Levine's system includes programming for each avatar to pick up items and retain them in inventory, a person of ordinary skill in the art would have found it obvious that in each game implemented in Levine's

system, including the exemplary "monster" and "sniper" games, the player's character may pick up one or more virtual objects. For example, a person of ordinary skill in the art, considering Levine's teachings, would have understood and found it obvious that in the "monster" and "sniper" games, a character could pick up virtual items such as a weapon or shield to defend against the adversary in the game.

(e) "an impenetrable object, wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield, and said first character is impacted when said first character contacts said impenetrable object." (Claim 2[e])

130. Levine discloses and renders obvious "**an impenetrable object, wherein said first locating device is operable to travel through a physical location that correlates to a virtual location of said impenetrable object on said virtual playfield, and said first character is impacted when said first character contacts said impenetrable object**" for the same reasons as discussed for Claim 1[d] previously.

3. Dependent Claim 11: "The non-transitory computer-readable medium of claim 1, wherein said first locating device comprises an accelerometer."

131. Levine discloses claim 11. As discussed for Claim 1[b], Levine describes that the OAP device ("**first locating device**") contained in each client

device comprises an accelerometer:

> Referring to FIG. 3, a block diagram representing the architecture of an orientationally-aware peripheral (OAP) device **300** according to an embodiment of the present invention is shown. OAP device **300** includes an inertial tracking subsystem **330** and a communication subsystem **320**. Inertial tracking subsystem 330 employs six accelerometers that will track the placement and orientation of the peripheral device in six degrees of freedom ("6-DOF"). Such a design eliminates the need for separate gyroscopic sensors to determine orientation information. The six accelerometers are divided into three groups of two sensors each (i.e., accelerometers pairs **302**, **304** and **306**) oriented along each of three perpendicular axes. Each pair of accelerometers is separated as far as is possible on the platform. By correctly integrating the acceleration of all six sensors, both position and angular orientation can easily be calculated.

(Levine, ¶0198.)

4. Dependent Claim 13: "The non-transitory computer-readable medium of claim 2, wherein said first locating device comprises an accelerometer."

132. Levine discloses claim 13 for the same reasons discussed for Claim 1[b], Claim 2[b], and Claim 11.

V. NO SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

133. As explained in **Part III.B**, I understand that "secondary

considerations" may be used as indicia of nonobviousness, provided that any such consideration has a nexus to the invention claimed. I understand from Petitioner's counsel that Patent Owner in the related district court litigation has not yet identified any evidence related to secondary considerations with a nexus to the claimed invention. Nor am I aware of information, such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others, suggesting that the claims addressed in this Declaration are not obvious. To the extent Patent Owner later provides information it claims relates to secondary considerations, I reserve the right to supplement my analysis and opinions to comment on it.

VI. CONCLUSION

134. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in this proceeding. If required, I will appear for cross-examination at the appropriate time. I reserve the right to offer opinions relevant to the invalidity of the challenged claims at issue and/or offer testimony in support of this Declaration.

135. I hereby declare that all statements made herein of my own knowledge are true and that all statements are made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: April 5, 2025

Respectfully submitted,

Jeremy Cooperstock, Ph.D.
Sifnos, Greece

APPENDIX A

CURRICULUM VITAE

Jeremy R. Cooperstock

Version as of March 24, 2025

Contents

Biographical

Personal Data

Nationality	Canadian
Languages	English, French and Hebrew
Address	Department of Electrical and Computer Engineering, McGill University 3480 University Street, Montreal, QC, H3A 0E9, Canada
Telephone	(514) 398-5992
email	jer@cim.mcgill.ca

Education

Ph.D.	Electrical and Computer Engineering, University of Toronto, 1996. Thesis: "Reactive Environments and Augmented Media Spaces." (Nominated for NSERC Doctoral Dissertation Award) Advisors: Prof. K.C. Smith and Prof. W. Buxton
M.Sc.	Computer Science, University of Toronto, 1992. Thesis: "Neural Network Operated Vision-Guided Mobile Robot Arm for Docking and Reaching." Advisor: Prof. E. Milios.
B.A.Sc.	Electrical Engineering, Computer Engineering Option, University of British Columbia, 1990 (Honours)

Awards and Distinctions

2024	Best Poster Award, "Investigating Haptic Co-Creation with Reinforcement Learning", Eurohaptics [CP1]
2024-2029	Werner Graupe Distinguished Chair in Automation Engineering, McGill University ($15,000 plus research stipend of $30,000 per annum)
2022	Honorable Mention, "The Sound of Hallucinations: Toward a more convincing emulation of internalized voices" (top 5% of papers), Human Factors in Computing Systems (CHI) [C5]
2022	Finalist, Best Applications Paper Award, "Speaking Haptically: from Phonemes to Phrases with a Mobile Haptic Communication System", Transactions on Haptics [J4]
2019	Honorable Mention, "Detecting Perception of Smartphone Notifications using Skin Conductance Responses" (top 5% of papers), Human Factors in Computing Systems (CHI) [C34]
2019	San Diego Opera, Opera Hack award, Hamsafar! ($10,000, with 5 co-awardees)
2018	Best poster presentation award, "Enhanced Pressure-Based Multimodal Immersive Experiences", Augmented Human [CP12]

2015	Gerald W. Farnell Teaching Scholar, Faculty of Engineering ($12,500)
2014	US Ignite Best App in Education, Augmented Reality for Improved Training of First Responders
2013	Canadian National Institute for the Blind, Hochhausen Access Technology Research Award ($10,000)
2013	Best paper award, "Vibrotactile Rendering of Splashing Fluids", Transactions on Haptics [J17]
2013	Best use of sound award, "The Walking Straight Mobile Application: Helping the Visually Impaired Avoid Veering, International Conference on Auditory Displays [C62]
2012	Mozilla Foundation and NSF Gold Prize in the Mozilla Ignite Challenge (out of 305 submissions in the Brainstorming Round) ($5,000) for Real-Time Emergency Response
2012	Canadian Internet Registry Association .CA Impact Award (Applications category) for In-Situ Audio Services Project ($5,000)
2011	Best paper award, "What's around me? Spatialized audio augmented reality for blind users with a smartphone", Mobile and Ubiquitous Systems [C73]
2010	Best paper award, "Design of a Vibrotactile Display via a Rigid Surface", Haptics Symposium [C82]
2009, 2010	Nominee, NSERC Brockhouse Canada Prize
2009	Best paper award, "SoundPark: Exploring Ubiquitous Computing through a Mixed Reality Multi-player Game Experiment", 9e Conférence Internationale sur Les NOuvelles TEchnologies de la REpartition [C92]
2005	ACM/IEEE Supercomputing, Most Innovative Use of New Technology for Wide Screen Window on the World: Life Size HD Videoconferencing
2001	Audio Engineering Society Citation Award for pioneering the technology enabling collaborative multichannel performance over the broadband internet

Work Experience

Career Highlights

Haptic Information Delivery (2018-2021) My lab's haptics research has resulted in prominent visibility in the preeminent journal, IEEE Transactions on Haptics, and the two top-tier international conferences in the field, IEEE Haptics Symposium and IEEE World Haptics Conference, with a dozen publications in these forums between 2020 and 2021. Given my recognition in the field, I was invited to serve on the editorial boards of all of these bodies, in addition to the specialty section on haptics of the Frontiers Journal in Virtual Reality. Specific examples of significant contributions include the performance attained through use of our two-actuator apparatus and phonemic encoding for tactile communication of natural language [C31, J4, C9], which outperformed the previously cited best results on this task, achieved by Facebook Research Labs. A second contribution relates to the high recognition rates we attained for multi-dimensional tacton delivery (3 parameters, each at 3 levels), targeting clinical patient-monitoring scenarios. This work inspired studies of wearable vibrotactile devices for physiological monitoring of patients [C30, C19]. While our results were achieved initially using a set of three actuators [C44, C41, C32, C22], we subsequently demonstrated equivalent recognition performance via only a single vibrotactile actuator, with a novel parameter encoding scheme [C21]. We further demonstrated achievement of the highest information transfer rates reported in the literature for such a single-actuator device [C16].

Physiological Sensing (2017-2020) Our research for detection of smartphone notifications was recognized by an Honourable Mention (top 5% of papers) from the top-tier ACM Conference on Human Factors in Computing ([C34]), and led to a recent patent filing ([P1]). This work has the potential to serve as not only for more intelligent, context-sensitive notification delivery, but also, as a tool that can be exploited to combat the prevalent and adverse effects of Internet addiction, driven largely by "fear of missing out."

Real-Time Emergency Response (rtER) (2012-2013) provides an envisionment of the future of next-generation 911 (NG-911) technologies, supporting enhanced situational awareness for first responders through the use of citizen-supplied smartphone video streams and other relevant data [J15]. Our work was recognized by the *Gold Prize* from the Mozilla Ignite Fund, featured on the web site of the White House Office of Science and Technology, and prompted the launch of a funding program by the U.S. Department of Justice.

Autour (2009-2018) is an "eyes-free" app for the blind, which provides a rich, spatialized audio representation of one's environment [J22, C73, C64, C61]. The project further motivated a rigorous analysis of smartphone sensor reliability, resulting in what was the first comprehensive examination of practical limits on smartphone sensors, including the problems of gyro drift [C64].

Mobile Treatment Device for Amblyopia (2009-2012, in collaboration with ophthalmologist R. Hess) is a patented prototype Mobile Treatment Device for Amblyopia [P10] ("lazy eye"). Initial trials [J21], based on the popular Tetris game, provided highly promising early results [J29, J24], not only restoring the use of both eyes in a majority of patients but even resulting in binocular (3D) depth perception in some. Most significantly, the treatment has been found to work successfully

on adult populations, whereas the prevailing wisdom had been that treatment was only possible on children. The technology has now been acquired by Novartis, who are commercializing the system.

Natural Interactive Walking (2008-2017) investigated multimodal interaction with virtual ground surfaces, resulting in important findings of tactile discrimination ability [J23] and the role of vibrotactile stimulation in perception of compliance [J30]. Our "Ecotile" prototype (patent [P7]) was showcased at numerous venues including SIGGRAPH, and led to related research involving limb modeling [C75, C59, C53], foot-water interaction [J17], and variable-friction walking interfaces [C69, C60, J8].

Ultra-Videoconferencing (2002-2006) is our low-latency, high-fidelity network transport, used for distance music teaching with Maestro Pinchas Zuckerman, cross-continental jazz jams, and remote sign language interpretation. The Globe and Mail described Cooperstock's 2001 demonstration as "a watershed event for the elite club of the world's computer network engineers." Ultra-Videoconferencing garnered my research group a prestigious Citation Award from the Audio Engineering Society and the Award for Most Innovative Use of New Technology from ACM/IEEE Supercomputing (2005). This research directly constituted the basis for subsequent funding of $2.2M from Valorisation Recherche Quebec and over $4M from Canarie, and influenced the designs of similar telepresence videoconferencing systems from Cisco, HP, and Polycom. Our follow-up work on **Open Orchestra** (with HQP N. Bouillot, A. Olmos, T. Knight, M. Tomiyoshi), resulted in an immersive simulator for orchestral training, used by professional and semi-professional musicians [J20].

Academic Experience

May 2024–present	**McGill University, Montreal, QC** Werner Graupe Distinguished Chair in Automation Engineering
Oct 2023–present	**McGill University, Montreal, QC** Associate Member, Biomedical Engineering
Dec 2022–present	**McGill University, Montreal, QC** Member, McGill Institute for Aerospace Engineering
May 2022–present	**McGill University, Montreal, QC** Member, International Laboratory on Learning Systems
Jan 2018–present	**McGill University, Montreal, QC** Full Professor, Electrical and Computer Engineering. Director, Shared Reality Lab Associate Member, Faculty of Music, Department of Theory Founding Member, Centre for Interdisciplinary Research in Music, Media and Technology Member, Centre for Intelligent Machines
Feb 2022–present	**York University, Ontario** Affiliate Member, Vision: Science to Applications (VISTA)
Sep 2018–Jun 2019	**Technion–Israel Institute of Technology, Haifa, Israel** Visiting Professor, Industrial Engineering and Management
Sep 2018–Jun 2019	**IDC, Herzliya, Israel** Visiting Professor, Department of Computer Science
May 2003–Dec 2017	**McGill University, Montreal, QC** Associate Professor, Electrical and Computer Engineering
Aug 2011–Jul 2012	**University of Auckland, New Zealand** Invited Professor, Department of Computer Science
May–June 2009	**Bang & Olufsen, Denmark** Visiting Professor, World Opera Project
Jan 2009–present	**Bielefeld University, Germany** Virtual Member, Center of Excellence Cognitive Interaction Technology (CITEC)
Feb 2008	**Arizona State University** Visiting Scholar, School of Arts, Media and Engineering
Sep 2004–Aug 2005	**Université de Paris VI, Paris France** Invited Professor, Laboratoire des Instruments et Systemes d'Ile-de-France
Nov 1997–May 2003	**McGill University, Montreal, QC** Assistant Professor, Electrical and Computer Engineering.

Industrial and Consulting Experience

Sep 2019–Oct 2021	**RedPill Canada VR, Montreal** Director and Advisor
Apr–Jun 2019	**(Confidential project as consulting expert)** Providing expert report on topics concerning Human-Computer Interaction.
Aug–Nov 2014	**Menya Solutions and DRDC-Valcartier** Providing expert advice related to human-computer interfaces, visualization, and collaboration.
Aug 2012	**Tamaggo Inc.** Provide guidance and advice on digital imagery
May 2012	**York University** Review draft application to Canada Excellence Research Chairs program
May 2002 –Nov 2003	**Solicitor General of Canada** Media streaming configuration and user interface design.
May 2001	**National Research Council** Instructor of short course in Soft Computing, Institut des Materiaux Industriels.
Jan–Sep 1999	**Audio Engineering Society** Technical leader of demonstration of multichannel and multimedia audio distribution
Jan–Aug 1999	**Ontario Science Center** Scientific Director of Timescape Millenium Exhibit
Jul 1998	**Nortel** Instructor of short course in videoconferencing systems for the Nortel International SL-1 User's Association (ILUA), Long Beach
Sep 1996–Oct 1997	**Sony Computer Science Laboratory** Visiting Researcher, Sony Computer Science Laboratory, Tokyo, Japan. Developed speech-interface controlled VCR with visual tape database functionality. Wrote two patent applications, one filed.
Jun–Aug 1990	**Fibronics Research** Visiting Researcher, Fibronics Advanced Research Center, Haifa, Israel. Developed and tested an FDDI-to-token ring bridge.
May–Aug 1989	**IBM T.J. Watson Research Center** Research Intern, IBM T.J. Watson Research Center, Yorktown Heights, NY. Improved implementation of a VLIW architecture simulator.

Litigation and Expert Witness Experience

Parties I represented are marked by an asterisk.

Jan 2025–ongoing	**Earin AB v. Skullcandy, Inc.*** Case No. 1:24-cv-00275-RGA and related *Inter Partes* Review proceedings
Jan 2025–ongoing	**Mullen Industries LLC v. Meta Platforms, Inc.*** Case No. 1:24-cv-00354 (W.D. Tex.) and related *Inter Partes* Review proceedings of U.S. Patent Nos. 8,585,476, 9,662,582, 9,744,448, 10,179,277, 10,828,559, 10,974,151, 11,376,493, 11,904,243, 11,947,716, and 12,019,791
Jul–Oct 2024	**Haptix Solutions LLC v. Microsoft Corp.*** *Inter Partes* Review proceedings of U.S. Patent No. 8,253,686
Apr 2024–Jan 2025	**e-Vision Smart Optics* v. various parties** Litigation re U.S. Patent Nos. 8,708,483, 8,801,174, 8,905,541, 10,598,960, and 10,613,355
Jan–Apr 2024	**Immersion Corp. v. Valve Corp.*** Case No. 2-23-cv-00712 (W.D. Wash.) related to U.S. Patent Nos. 7,336,260, 8,749,507, 9,430,042, 9,116,546, 10,627,907, 10,665,067, and 11,175,738
Nov 2023–ongoing	**Sitnet LLC v. Meta Platforms, Inc.*** United States District Court, S.D. New York, Case No. 1:23-cv-6389 (AS) and related *Inter Partes* Review proceedings of U.S. Patent Nos. 8,249,932, 8,332,454, 9,877,345, and 11,470,682. Deposition testimony on expert report
Aug 2023–ongoing	**NEC Corporation* v. Peloton Interactive, Inc. et al.** United States District Court, District of Delaware, Case No. 1:2022cv00987 and related *Inter Partes* Review proceedings of U.S. Patent Nos. 9,769,427 and 8,752,101. Deposition testimony on expert reports (3 depositions)
Aug 2023–ongoing	**Resonant Systems, Inc. d/b/a RevelHMI v. Samsung Electronics Co., Ltd.* et al.** United States District Court, Eastern District of Texas, Case No. 2:22-cv-00423-JRG
May 2023–Dec 2024	**LoganTree LP v. Fossil Group, Inc.*** United States District Court, District of Delaware Case No. 1:21-cv-00385-JDW and related *Inter Partes* Review proceedings. Deposition testimony on expert reports (2 depositions)
Feb–May 2023	**Immersion Corp. v. Meta Platforms, Inc.*** United States District Court, Western District of Texas Case No. 6:22-cv-00541-ADA and related *Inter Partes* Review proceedings of U.S. Patent Nos. 8,469,806, 8,896,524, 9,727,217, 10,248,298, 10,269,222, and 10,664,143

Feb–May 2023	**Playvuu, Inc. v. Snap Inc.*** United States District Court, Central District of California Case No. 2:22-cv-06019. Involved in litigation matters related to U.S. Patent No. 10,931,911.
Sep 2022	**Apple* v. Taction Technologies, Inc.** Retained for *Reexamination Requests* of U.S. Patent Nos. 10,659,885 and 10,820,117 in the United States Patent and Trademark Office.
Aug 2022–Jun 2024	**Westwood One, LLC v. Local Radio Networks, LLC*** United States District Court, Northern District of Indiana, Case No. 1:21-cv-00088-HAB-SLC. Involved in litigation matters related to U.S. Patent Nos. 7,412,203 and 7,860,448
Jan–May 2022	**Peloton Interactive v. iFIT Inc. f/k/a ICON Health & Fitness*** United States District Court, District of Delaware, Civil Action No. 20-cv-1386-RGA. Prepared reports on patent invalidity and non-infringement.
Sep 2021–ongoing	**Brazos* v. Google** United States District Court, Western District of Texas Waco Division, Case Nos. 6:20-CV-00571-ADA through 6:20-CV-00585-ADA. Deposition testimony on expert reports (2 depositions)
Sep 2021–Aug 2022	**Allstate Insurance Co. v. Atos LLC*** Involved in *Inter Partes* Review, IPR2021-01118, of U.S. Patent No. 8,527,140, covering smartphone-based vehicle operation detection. Deposition testimony on expert report.
Jan 2021–Apr 2022	**GUI Global Products, Ltd. v. Apple*** United States District Court, Southern District of Texas, Case No. 4:20-cv-2652 and *Inter Partes* Review of U.S. Patent Nos. 10,259,020, 10,259,021, 10,562,077, and 10,589,320 in the United States Patent and Trademark Office. Deposition testimony on expert reports (2 depositions)
Dec 2020–Feb 2021	**Expert consultation re possible litigation in IT-related matter** Work done on behalf of Sheridan Ross P.C.
Nov 2020–Jun 2022	**Koss v. Apple*** United States District Court, Western District of Texas Civil Action No. 6:20-cv-00665. Involved in *Inter Partes* Review of U.S. Patent Nos. 10,206,025, 10,469,934, 10,506,325, 10,491,982, and 10,298,451 before the United States Patent and Trademark Office. Deposition testimony on expert reports (4 depositions).
Oct 2020–Oct 2021	**Triller v. ByteDance* and TikTok*** *Inter Partes* Review of U.S. Patent No. 9,691,429 before the United States Patent and Trademark Office. Deposition testimony on expert report.

Sep 2020–Jan 2023	**Content Square v. Quantum Metric* and Decibel Insight*** United States District Court, Massachusetts District Court, Case No. 1-20-cv-11184 and Delaware District Court, Case No. 20-cv-00832. Involved in invalidity arguments and petitions for *Inter Partes* Review. Deposition testimony on expert reports (5 depositions).
Sep 2020	**Wiesel v. Apple*** United States District Court, Eastern District of New York, Case No. 1:19-cv-7261. Engaged for source code review of products related to the Apple Watch (case presently stayed).
Aug–Oct 2020	**Finish Time* v. Garmin** United States District Court, District of Maine, Case No. 2:20-cv-00184. Involved in review of infringement arguments, discovery, related to fitness applications.
Dec 2019–Nov 2022	**Pinn v. Apple*** United States District Court, Central District of California, Case No. 8:19-cv1805, *Inter Partes* Review IPR2020-00999, Post Grant Review PGR2020-00066 and PGR2020-00073. Involved in preparation of expert witness declarations, code analysis involving multiple products related to earbuds and charging circuitry. Deposition testimony on expert reports, in-court trial testimony.
Oct 2019	**Qualcomm v. Apple*** *Inter Partes* Review, IPR2018-01279. Deposition testimony on expert witness declaration related to multimedia messaging.
Mar 2019–Feb 2022	**Cruz Hernandez* v. Air Canada and Lufthansa** Canadian Transportation Agency Case no. 20-01712, Petitioner before the Agency regarding passengers' rights to compensation under EC 261/2014
May 2018–May 2019	**Immersion Incorporated v. Samsung Inc.*** Civil Action No. 2:18-cv-00055 in the Eastern District of Texas and *Inter Partes* Review, IPR2018-01499. Consulted on technical details and involved in preparation of two expert witness declarations related to haptic feedback effects and force feedback in a multimodal system. (Patent Nos. 6,429,846, 7,969,288, 7,982,720, 8,031,181, 9,323,332 and 8,619,051)
May 2016–Nov 2017	**Cooperstock* v. Air Canada** Petitioner before the Canadian Transportation Agency. Brought successful complaint against Air Canada for the airline's making false or misleading statements to the public, Decision No. 105-C-A-2017 (otc-cta.gc.ca/eng/ruling/105-c-a-2017)
Jan–May 2014	**St. Lewis v. Rancourt*** Provided expert report on web server location, Ontario Superior Court File No. 11-51657

Mar–Sep 2013	**Cooperstock* v. United Airlines** Brought and argued successful appeal regarding anti-SLAPP legislation before the Quebec Court of Appeal, Decision 2013 QCCA 1670 (goo.gl/pgz301). Argued appeal in person (September 26, 2013)
Nov 2012–Aug 2017	**United Airlines v. Cooperstock*** Pro se litigant, Federal Court File No. T-2084-12. Deposition as litigant (August 2013) and testified at trial (December 2016).
Nov 2012–Jan 2017	**United Airlines v. Cooperstock*** Pro se litigant, Quebec Superior Court File No. 500-17-074743-124. Deposition as litigant (October 2014) and testified at trial (April 2016).
Sep 2012	**Lukács* v. Air Canada** Provided expert report on database query and execution times, Canadian Transportation Agency File No. M4120-3/11-06673, Decision No. 204-C-A-2013
May 2007–Jan 2008	**Market Maker c. Brim Solutions*** Provided expert witness report and in-court testimony (October 2007) on software-related intellectual property case. Quebec Superior Court File No. 500-17-036750-076.
Feb–Oct 2004	**Crawford Adjusters Canada** Provided analysis of artifacts in high definition video
Jul 2002–May 2016	**Court of Quebec, Small Claims Division** Brought 14 consumer rights complaints before the Court, 11 of which were successful

Research Dissemination

Notes on publication strategy: In my research field, papers in the ACM CHI (H5-index=87), UIST (H5-index=46), DIS (H5-index=33), and Mobile HCI (H5-index=28) conferences are considered to be top-tier, archival publications, competitive with the top HCI journals in terms of impact and visibility. Overall acceptance rates for these conferences are typically in the 20-25% range. As a measure of research impact, my publications have garnered ∼5800 citations to date (Google Scholar) with more one third since 2019, an h-index of 39, and i10-index of 115. HQP under my supervision (names in bold) are typically given first authorship on co-authored work.

Articles in Refereed Publications

[J1] **A. Talhan**, **Y. Yoo**, and J. R. Cooperstock. "Soft Pneumatic Haptic Wearable to Create the Illusion of Human Touch." In: *IEEE Transactions on Haptics* 17.2 (June 2024), pp. 177–190. DOI: 10.1109/TOH.2023.3305495. URL: https://ieeexplore.ieee.org/document/10219022.

[J2] **J. Regimbal**, **J. R. Blum**, **C. Kuo**, and J. R. Cooperstock. "IMAGE: An Open-Source, Extensible Framework for Deploying Accessible Audio and Haptic Renderings of Web Graphics." In: *ACM Transactions on Accessible Computing* (2024). DOI: 10.1145/3665223. URL: https://dl.acm.org/doi/10.1145/3665223.

[J3] **N. Duarte**, R. K. Arora, G. Bennett, M. Wang, M. P. Snyder, J. R. Cooperstock, and C. E. Wagner. "Deploying wearable sensors for pandemic mitigation: a counterfactual modelling study of Canada's second COVID-19 wave." In: *PLOS Digital Health* PDIG-D-22-00126R1 (Sept. 2022). DOI: 10.1371/journal.pdig.0000100. URL: https://journals.plos.org/digitalhealth/article?id=10.1371/journal.pdig.0000100.

[J4] **M. F. de Vargas**, **D. Marino**, **A. Weill–Duflos**, and J. R. Cooperstock. "Speaking Haptically: from Phonemes to Phrases with a Mobile Haptic Communication System." In: *Transactions on Haptics* 14.3 (July 2021), pp. 479–490. DOI: 10.1109/TOH.2021.3054812. URL: https://ieeexplore.ieee.org/document/9337220. Finalist, Best Applications Paper Award.

[J5] **P. Vyas**, **F. Al-Taha**, **J. R. Blum**, **A. Weill–Duflos**, and J. R. Cooperstock. "Ten Little Fingers, Ten Little Toes: Can Toes Match Fingers for Haptic Discrimination?" In: *Transactions on Haptics* 13.1 (2020). DOI: 10.1109/TOH.2020.2966969. URL: https://ieeexplore.ieee.org/document/8960637. Also presented at Haptics Symposium 2020.

[J6] **E. Sulmont**, E. Patitsas, and J. R. Cooperstock. "What Is Hard About Teaching Machine Learning to Non-Majors? Insights From Classifying Instructors' Learning Goals." In: *Transactions on Computing Education, Special Issue on Machine Learning Education* 19.4 (Aug. 2019). DOI: 10.1145/3336124. URL: http://dl.acm.org/authorize?N682238.

[J7] **J. Blum**, **P. Fortin**, **F. Al-Taha**, **P. Alirezaee**, **M. Demers**, **A. Weill–Duflos**, and J. R. Cooperstock. "Getting Your Hands Dirty Outside the Lab: A Practical Primer for Conducting Wearable Vibrotactile Haptics Research." In: *IEEE Transactions on Haptics, Special Issue on Wearable and Hand-held Haptics* 12.3 (July 2019), pp. 232–246. DOI: 10.1109/TOH.2019.2930608. URL: https://ieeexplore.ieee.org/document/8770138.

[J8] **G. Millet**, **M. Otis**, **D. Horodniczy**, and J. R. Cooperstock. "Design of Variable-Friction Devices for Shoe-Floor Contact." In: *Mechatronics* 46 (2017), pp. 115–125. DOI: 10.1016/j.mechatronics.2017.07.005. URL: https://www.sciencedirect.com/science/article/abs/pii/S0957415817301034.

[J9] **P. Fortin** and J. R. Cooperstock. "Laughter and Tickles: Toward Novel Approaches for Emotion and Behavior Elicitation." In: *IEEE Transactions on Affective Computing* 8.4 (2017). TAFFCSI-2016-07-0124.R1, pp. 508–521. DOI: 10.1109/TAFFC.2017.2757491. URL: http://ieeexplore.ieee.org/document/8052511/.

[J10] E. Aguilera, J. J. Lopez, and J. R. Cooperstock. "Spatial Audio for Audioconferencing in Mobile Devices: Investigating the Importance of Virtual Mobility and Private Communication and Optimizations." In: *Journal of the Audio Engineering Society* 64.5 (May 2016), pp. 332–341. DOI: 10.17743/jaes.2016.0009. URL: http://www.aes.org/e-lib/browse.cfm?elib=18138.

[J11] **D. El-Shimy** and J. R. Cooperstock. "User-Driven Techniques for the Design and Evaluation of New Musical Interfaces." In: *Computer Music Journal* 40.2 (2016), pp. 35–46. DOI: 10.1162/COMJ_a_00357. URL: http://www.mitpressjournals.org/doi/pdf/10.1162/COMJ_a_00357.

[J12] **F. Tordini**, A. Bregman, and J. R. Cooperstock. "Prioritizing foreground selection of natural chirp sounds by tempo and spectral centroid." In: *Multimodal User Interfaces, Special Issue on Auditory Display* 10.3 (Sept. 2016). Ed. by B. Katz and G. Marentakis, pp. 221–234. DOI: 10.1007/s12193-016-0223-x. URL: http://link.springer.com/article/10.1007%2Fs12193-016-0223-x.

[J13] R. F. Hess, **L. To**, J. Zhou, **G. Wang**, and J. Cooperstock. "3D Vision: the haves and havenots." In: *i-Perception* 6.3 (July 2015). DOI: 10.1177/2041669515593028. URL: http://ipe.sagepub.com/content/6/3/2041669515593028.full.pdf+html.

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Refereed Conference Publications

[C1] **D. Marino**, J. Dai, **P. Fortin**, **M. Henry**, and J. R. Cooperstock. "Co-Here: an expressive videconferencing module for implicit affective interaction." In: *Graphics Interface*. Halifax, NS: ACM, June 2024. URL: https://openreview.net/forum?id=L90yPA3fzE.

[C2] **E. Bouzekri**, P. Fortin, and J. R. Cooperstock. "ChatGPT, Tell Me More About Pilots' Opinion on Automation." In: *Cognitive and Computational Aspects of Situation Management (CogSIMA)*. Montreal, Canada: IEEE, May 2024. DOI: 10.1109/CogSIMA61085.2024.10553726. URL: https://ieeexplore.ieee.org/document/10553726.

[C3] **D. Marino**, **M. Henry**, **P. Fortin**, **R. Bhayana**, and J. R. Cooperstock. "I See What You're Hearing: Facilitating The Effect of Environment on Perceived Emotion While Teleconferencing." In: *Computer-Supported Cooperative Work and Social Computing*. Minneapolis, MN: ACM, Oct. 2023. DOI: 10.1145/3579495. URL: https://dl.acm.org/doi/10.1145/3579495.

[C4] **M. F. de Vargas**, **D. Marino**, **A. Weill–Duflos**, and J. R. Cooperstock. "Training to understand complex haptic phrases: a longitudinal investigation." In: *World Haptics Conference*. Delft, Netherlands: IEEE, July 2023. DOI: 10.1109/WHC56415.2023.10224492. URL: https://ieeexplore.ieee.org/document/10224492.

[C5] **H. Lee**, **R. Jiang**, **Y. Yoo**, **M. Henry**, and J. R. Cooperstock. "The Sound of Hallucinations: Toward a more convincing emulation of internalized voices." In: *Human Factors in Computing Systems (CHI)*. New Orleans, LA: ACM, Apr. 2022. DOI: 10.1145/3491102.3501871. URL: https://dl.acm.org/doi/10.1145/3491102.3501871. Honorable Mention.

[C6] **J. Regimbal**, **J. R. Blum**, and J. R. Cooperstock. "IMAGE: A Deployment Framework for Creating Multimodal Experiences of Web Graphics." In: *Web4All 2022 - Accessibility in a Hybrid World*. virtual event, Apr. 2022. DOI: 10.1145/3493612.3520460. URL: https://dl.acm.org/doi/pdf/10.1145/3493612.3520460.

[C7] **P. Fortin** and J. R. Cooperstock. "Understanding Smartphone Notifications' Activity Disruption via In Situ Wrist Motion Monitoring." In: *Human Factors in Computing Systems (CHI), Late-Breaking Work (LBW) track*. New Orleans, LA: ACM, Apr. 2022. DOI: 10.1145/3491101.3519695. URL: https://dl.acm.org/doi/10.1145/3491101.3519695. acceptance rate: 36.1%.

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[C9] **D. Marino**, **M. F. de Vargas**, **A. Weill–Duflos**, and J. R. Cooperstock. "Conversing Using WhatsHap: a Phoneme Based Vibrotactile Messaging Platform." In: *World Haptics Conference*. Virtual Conference: IEEE, July 2021. DOI: 10.1109/WHC49131.2021.9517186. URL: https://ieeexplore.ieee.org/document/9517186. Acceptance rate: 55.7%.

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[C11] **M. Demers**, **P. Fortin**, **A. Weill–Duflos**, **Y. Yoo**, and J. R. Cooperstock. "Active Sampling for Efficient Subjective Evaluation of Tactons at Scale." In: *World Haptics Conference*. Virtual Conference: IEEE, July 2021. DOI: 10.1109/WHC49131.2021.9517257. URL: https://ieeexplore.ieee.org/document/9517257. Acceptance rate: 55.7%.

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[C16] **Y. Yoo**, **J. Regimbal**, and J. R. Cooperstock. "Identification and Information Transfer of Multidimensional Tactons Presented by a Single Vibrotactile Actuator." In: *World Haptics Conference*. Virtual Conference: IEEE, July 2021. DOI: 10.1109/WHC49131.2021.9517169. URL: https://ieeexplore.ieee.org/document/9517169. Acceptance rate: 55.7%.

[C17] **A. Weill–Duflos**, **P. Fortin**, **F. Al-Taha**, and J. R. Cooperstock. "Haptic Augmentation of Audio and its Effects on Speech Perception." In: *International Workshop on Haptic and Audio Interaction Design*. Montreal, Canada, June 2020. URL: https://hal.archives-ouvertes.fr/hal-02901210.

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[C19] M. Gellert, N. Katzman, J. P. Klein, A. Frenkel, M. Klein, J. R. Cooperstock, J. J. Schlesinger, and Y. Bitan. "Comparing auditory and tactile cues to inform clinicians of patients' vital signs." In: *Annual Meeting of the Human Factors and Ergonomics Society*. Chicago, IL, USA, Oct. 2020. DOI: 10.1177/2327857920091015. URL: https://journals.sagepub.com/doi/abs/10.1177/2327857920091015.

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[C22] **P. Alirezaee**, **A. Weill–Duflos**, J. Schlesinger, and J. R. Cooperstock. "Exploring the Effectiveness of Haptic Alarm Displays for Critical Care Environments." In: *Haptics Symposium*. Washington DC, USA: IEEE, Mar. 2020. DOI: 10.1109/HAPTICS45997.2020.ras.HAP20.156.6c3cc0bf. URL: https://ieeexplore.ieee.org/document/9086328. Acceptance rate: 38%.

[C23] **P. Fortin**, **J. Blum**, **A. Weill–Duflos**, and J. R. Cooperstock. "Contact Force Estimation from Raw Photoplethysmogram Signal." In: *Sensors*. Oct. 2020. DOI: 10.1109/SENSORS47125.2020.9278658. URL: https://ieeexplore.ieee.org/document/9278658.

[C24] **P. Vyas**, **F. Al-Taha**, **J. R. Blum**, **A. Weill–Duflos**, and J. R. Cooperstock. "Ten Little Fingers, Ten Little Toes: Can Toes Match Fingers for Haptic Discrimination?" In: *Haptics Symposium (also appears in Transactions on Haptics)*. Washington DC, USA: IEEE, Mar. 2020. DOI: 10.1109/TOH.2020.2966969. URL: https://ieeexplore.ieee.org/document/8960637. Acceptance rate: 38%.

[C25] **P. Vyas**, **F. Al-Taha**, **J. R. Blum**, and J. R. Cooperstock. "HapToes: Vibrotactile Numeric Information Delivery via Tactile Toe Display." In: *Haptics Symposium*. Washington DC, USA: IEEE, Mar. 2020. DOI: 10.1109/HAPTICS45997.2020.ras.HAP20.34.8ad689d4. URL: https://ieeexplore.ieee.org/document/9086321. Acceptance rate: 38%.

[C26] **A. Weill–Duflos**, **F. Al-Taha**, **P. Fortin**, and J. R. Cooperstock. "BarryWhaptics: Towards Countering Social Biases Using Real-Time Haptic Enhancement of Voice." In: *World Haptics Conference*. Tokyo, Japan, June 2019. DOI: 10.1109/WHC.2019.8816153. URL: https://ieeexplore.ieee.org/document/8816153. Acceptance rate: 46%.

[C27] **E. Sulmont**, E. Patitsas, and J. R. Cooperstock. "Can You Teach Me To Machine Learn?" In: *Special Interest Group on Computer Science Education Technical Symposium*. Minneapolis, MN, Feb. 2019. DOI: 10.1145/3287324.3287392. URL: http://dl.acm.org/authorize?N682231.

[C28] **G. Yin**, M. Otis, **P. Fortin**, and J. R. Cooperstock. "Evaluating Multimodal Feedback for Accomplishing Assembly Tasks in a Virtual Environment." In: *Engineering Interactive Computing Systems*. Valencia, Spain: ACM SIGCHI, June 2019. DOI: 10.1145/3331163. URL: http://dl.acm.org/authorize?N682239.

[C29] **J. Blum** and J. R. Cooperstock. "Single-Actuator Vibrotactile Numeric Information Delivery in the Face of Distraction." In: *World Haptics Conference*. Tokyo, Japan, June 2019. DOI: 10.1109/WHC.2019.8816082. URL: https://ieeexplore.ieee.org/document/8816082. Acceptance rate: 46%.

[C30] N. Katzman, M. Gellert, J. J. Schlesinger, T. Oron-Gilad, J. R. Cooperstock, and Y. Bitan. "Evaluation of tactile cues for simulated patients' status under high and low workload." In: *International Meeting*. Seattle, WA, USA: Human Factors and Ergonomics Society (HFES), Oct. 2019. DOI: 10.1177/1071181319631285. URL: https://journals.sagepub.com/doi/10.1177/1071181319631285.

[C31] **M. F. de Vargas**, **A. Weill–Duflos**, and J. R. Cooperstock. "Haptic Speech Communication Using Stimuli Evocative of Phoneme Production." In: *World Haptics Conference*. Tokyo, Japan, June 2019. DOI: 10.1109/WHC.2019.8816145. URL: https://ieeexplore.ieee.org/document/8816145. Acceptance rate: 46%.

[C32] **P. Alirezaee**, J. Schlesinger, and J. R. Cooperstock. "Ergonomic Haptic Displays - Reducing Clinician Dependence on Patient Monitors and Auditory Alarms." In: *Human Factors and Ergonomics in Healthcare Symposium*. Chicago, IL, USA, Mar. 2019.

[C33] **P. Fortin**, **D. Huang**, and J. R. Cooperstock. "Exploring the Use of Fingerprint Sensor Gestures for Unlock Journaling: A Comparison with Slide-to-X." In: *Mobile HCI*. Taipei, Taiwan: ACM, Oct. 2019. DOI: 10.1145/3338286.3340135. URL: http://dl.acm.org/authorize?N684389.

[C34] **P. Fortin**, **E. Sulmont**, and J. R. Cooperstock. "Detecting Perception of Smartphone Notifications using Skin Conductance Responses." In: *Human Factors in Computing (CHI)*. Glasgow, Scotland: ACM, Apr. 2019. DOI: 10.1145/3290605.3300420. URL: http://dl.acm.org/authorize?N682230. 🏆 Honorable mention.

[C35] **J. Anlauff**, **T. Kim**, and J. R. Cooperstock. "Feel-a-Bump: Haptic Feedback for Foot-based Angular Menu Selection." In: *Haptics Symposium*. San Francisco, CA: IEEE, Mar. 2018. DOI: 10.1109/HAPTICS.2018.8357172. URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8357172. Acceptance rate: 44%.

[C36] **J. Blum**, J. R. Cooperstock, and J. Cauchard. "Pseudo-Ambience: Filling the Gap Between Notifications and Continuous Information Displays." In: *UbiTtention Workshop on Smart & Ambient Notification and Attention Management*. Singapore: ACM, Oct. 2018. DOI: 10.1145/3267305.3274111. URL: http://dl.acm.org/authorize?N682234.

[C37] **P. Fortin**, **E. Sulmont**, and J. R. Cooperstock. "SweatSponse: Closing the Loop on Notification Delivery Using Skin Conductance Responses." In: *User Interface Software and Technology (UIST)*. Berlin, Germany: ACM, Oct. 2018. DOI: 10.1145/3266037.3266084. URL: http://dl.acm.org/authorize?N682232.

[C38] **T. Kim**, **H. Ju**, and J. R. Cooperstock. "Pressure or Movement? Usability of Multi-Functional Foot-Based Interfaces." In: *Designing Interactive Systems (DIS)*. Hong Kong: ACM, June 2018. DOI: 10.1145/3196709.3196759. URL: http://dl.acm.org/authorize?N682246. Acceptance rate: 23%.

[C39] E. Cupellini, J. R. Cooperstock, and M. Olivetti. "The Sound Motion Controller: a distributed system for interactive music performance." In: *Conference of the European Society for the Cognitive Sciences of Music*. Ghent, Belgium, July 2017. URL: https://iris.uniroma1.it/bitstream/11573/1023094/2/Cupellini_Sound-motion_2017.pdf.

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[C136] **F. Rioux**, **F. Rudzicz**, and **M. Wozniewski**. "The Modellers' Apprentice – The Toolglass Metaphor in an Immersive Environment." In: *British HCI Group Annual Conference*. Leeds, UK, Sept. 2004.

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[C149] **A. Xu** and J. R. Cooperstock. "Real Time Streaming of Multi-Channel Audio Data over Internet." In: *108th Audio Engineering Society Convention*. Paris, France, 2000, 14 pgs. URL: https://srl.mcgill.ca/publications/2000-AES.pdf.

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[C154] **S. Arseneau** and J. R. Cooperstock. "Real-Time Image Segmentation for Action Recognition." In: *IEEE Pacific Rim Conference on Communications, Computers and Signal Processing (PACRIM'99)*. Victoria, BC, Canada, Aug. 1999, pp. 86–89. DOI: 10.1109/PACRIM.1999.799484. URL: https://srl.mcgill.ca/publications/1999-PACRIM.pdf.

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[C158] A. Chou, J. R. Cooperstock, R. El-Yaniv, M. Klugerman, and T. Leighton. "The Statistical Adversary Allows Optimal Money-Making Trading Strategies." In: *ACM-SIAM Symposium on Discrete Algorithms (SODA)*. San Francisco, CA, USA, Jan. 1995, pp. 467–476. URL: https://srl.mcgill.ca/publications/1995-SODA.pdf.

[C159] J. R. Cooperstock. "Making the User Interface Disappear: The Reactive Room." In: *IBM Center for Advanced Studies (CASCON)*. Toronto, ON, Canada, 1995, pp. 241–250. URL: http://portal.acm.org/citation.cfm?id=781915.781930.

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[C161] J. R. Cooperstock, K. Tanikoshi, G. Beirne, T. Narine, and W. Buxton. "Evolution of a Reactive Environment." In: *Human Factors in Computing Systems (CHI)*. Denver, CO, USA, May 1995, pp. 170–177. URL: https://dl.acm.org/citation.cfm?id=223926. Acceptance rate: 29%.

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Refereed Conference Publications (Posters)

[CP1] **J. Regimbal** and J. R. Cooperstock. "Investigating Haptic Co-Creation with Reinforcement Learning." In: *Eurohaptics*. Lille, France: IEEE, 2024. 🏆 Best Poster Award.

[CP2] **J. Regimbal**, **E. Wilson**, and J. R. Cooperstock. "See What You Feel: Visualizing Static Haptic Scenes." In: *Eurohaptics*. in press. Lille, France: IEEE, 2024.

[CP3] D. Hsueh, **Y. Liu**, **M.F. De Vargas**, **R. Bazin**, K. Moffatt, and J. R. Cooperstock. "AI-Digital Nurse Avatar (ADiNA)." In: *AGE-WELL AgeTech Innovation Week Conference*. Toronto, Ontario, Oct. 2023.

[CP4] **J. Lane-Smith**, D. Chow, S. Ajami, and J. R. Cooperstock. "The Hapstrument: A Bimanual Haptic Interface for Musical Expression." In: *New Interfaces for Musical Expression (NIME)*. Mexico City, Mexico, May 2023. DOI: 10.5281/zenodo.11189284. URL: https://nime.org/proceedings/2023/nime2023_77.pdf.

[CP5] **M. F. de Vargas**, **D. Marino**, **A. Weill–Duflos**, and J. R. Cooperstock. "Speaking Haptically: from Phonemes to Phrases with a Mobile Haptic Communication System." In: *World Haptics Conference*. Virtual Conference: IEEE, July 2021.

[CP6] J. Cooperstock and **J.R. Blum**. "Touch me like it matters: exploring location and encodings for explicit and implicit communication." In: *Haptics Symposium, Interactive Session associated with the Cross-Cutting Challenge on Using the Skin as a Medium of Communication*. Washington, DC, Mar. 2020.

[CP7] N. Katzman, M. Gellert, T. Oron-Gilad, J. R. Cooperstock, Y. Bitan, and J. J. Schlesinger. "Wearable haptic devices to monitor soldiers' physiology–discreet sensory input improves safety and monitoring in hostile low-light and high-noise conditions." In: *Military Health System Research Symposium*. Department of Defense, 2020. URL: https://mhsrs.health.mil/SitePages/Home.aspx.

[CP8] **P. Fortin**, **J. Blum**, and J. R. Cooperstock. "Towards Consistent Haptic Coupling with HaptiStrap: Doing Better than "Tight yet Comfortable"." In: *User Interface Software and Technology (UIST)*. New Orleans, USA: ACM, Oct. 2019. DOI: 10.1145/3332167.3357118. URL: https://dl.acm.org/doi/10.1145/3332167.3357118. Acceptance rate: 48.8%.

[CP9] **F. Al-Taha**, **P. Fortin**, **A. Weill–Duflos**, and J. R. Cooperstock. "Reversing Voice-Related Biases Through Haptic Feedback." In: *User Interface Software and Technology (UIST)*. Berlin, Germany: ACM, Oct. 2018. DOI: 10.1145/3266037.3266101. URL: http://dl.acm.org/authorize?N682233.

[CP10] **F. Tordini**, A. Bregman, and J. R. Cooperstock. "Effects of global brightness on salience and auditory foreground perception." In: *Speech in Noise Workshop*. Glasgow, Scotland, Jan. 2018. URL: https://spin2018.eu/?p=program&id=66.

[CP11] **J. Blum** and J. R. Cooperstock. "Exploring the Limits of Vibrotactile Numeric Information Delivery." In: *Ubicomp*. Singapore: ACM, Oct. 2018. DOI: 10.1145/3267305.3267658. URL: http://dl.acm.org/authorize?N682245.

[CP12] **T. Kim** and J. R. Cooperstock. "Enhanced Pressure-Based Multimodal Immersive Experiences." In: *Augmented Human*. Seoul, Korea: ACM, Feb. 2018. DOI: 10.1145/3174910.3174928. URL: http://dl.acm.org/authorize?N682247. Best poster presentation award, Acceptance rate: 34%.

[CP13] **P. Fortin**, **J. Blum**, and J. R. Cooperstock. "Raising the Heat: Electrical Muscle Stimulation for Simulated Heat Withdrawal Response." In: *User Interface Software and Technology (UIST)*. Quebec City, Canada: ACM, Oct. 2017. DOI: 10.1145/3131785.3131828. URL: http://dl.acm.org/authorize?N682248. Acceptance rate: 23%.

[CP14] **J. Anlauff**, J. Fung, and J. R. Cooperstock. "Modular Haptic Belt for Augmented Balance Feedback." In: *International Society for Posture and Gait Research*. Seville, Spain, June 2015.

[CP15] **D. El-Shimy** and J. R. Cooperstock. "EmbodiComp: Embodied Interaction for Mixing and Composition." In: *Sound and Music Computing Conference (ICMC — SMC)*. Athens, Greece, Sept. 2014. URL: http://hdl.handle.net/2027/spo.bbp2372.2014.052.

[CP16] **F. Tordini** and J. R. Cooperstock. "Auditory salience modeling via streaming: A behavioural view." In: *Milestones in Music Cognition: BKN 25*. Montreal, Canada, July 2014.

[CP17] **D. Glesser**, F. Bérard, and J. R. Cooperstock. "Overcoming Limitations of the Trackpad for 3D Docking Operations." In: *Human Factors in Computing Systems (CHI), Extended Abstracts*. Paris, France: ACM, Apr. 2013. URL: http://dl.acm.org/authorize?N06273. Acceptance rate: 20%.

[CP18] **C. Côté**, **S. Arseneau**, and J. R. Cooperstock. "Telepresence with no Strings Attached: An Architecture for a Shared Reality Environment." In: *Second International Symposium on Mixed Reality (ISMR)*. Yokohama, Japan, Mar. 2001. URL: https://srl.mcgill.ca/publications/2001-ISMR.pdf.

[CP19] **S. Arseneau** and J. R. Cooperstock. "Automated Camera Tracking in a Real-World Environment." In: Montreal, QC, Canada, 2000.

[CP20] J. R. Cooperstock. "Rethinking the Remote Control." In: *HCI International, Conference on Human-Computer Interaction*. San Francisco, CA, USA, Aug. 1997, p. 116.

Book Chapters

[B1] **T. Kim**, **J. Blum**, **P. Alirezaee**, **A. Arnold**, **P. Fortin**, and J. R. Cooperstock. "Usability of Foot-Based Interaction Techniques for Mobile Solutions." In: *Mobile Solutions and Their Usefulness in Everyday Life*. Springer International Publishing AG, Jan. 2019, pp. 309–329. DOI: 10.1007/978-3-319-93491-4_16. URL: https://link.springer.com/chapter/10.1007/978-3-319-93491-4_16.

[B2] **M. Wozniewski**, Z. Settel, and J. R. Cooperstock. "Sonic Interaction via Spatial Arrangement in Mixed Reality Environments." In: *Sonic Interaction Design*. Ed. by K. Franinovic and S. Serafin. MIT Press, 2013, pp. 329–340. URL: http://xplorebcpaz.ieee.org/xpl/login.jsp?tp=&arnumber=6504636.

[B3] M. Marchal, **G. Cirio**, **Y. Visell**, F. Fontana, S. Serafin, J. R. Cooperstock, and A. Lécuyer. "Multimodal Rendering of Walking over Virtual Grounds." In: *Human Walking in Virtual Environments*. Ed. by Y. Visell, A. Lécuyer, F. Steinicke, and J. Campos. Springer Verlag, 2013, pp. 263–295. URL: http://www.springer.com/engineering/robotics/book/978-1-4419-8431-9.

[B4] **Y. Visell** and J. R. Cooperstock. "Interacting with augmented floor surfaces." In: *Human Walking in Virtual Environments*. Ed. by Y. Visell, A. Lécuyer, F. Steinicke, and J. Campos. Springer Verlag, 2013, pp. 377–399. URL: http://www.springer.com/engineering/robotics/book/978-1-4419-8431-9.

[B5] **Y. Visell**, **R. Rajalingham**, and J. R. Cooperstock. "A review of nonvisual signatures of human walking with applications to person tracking in augmented environments." In: *Walking with the senses: Perceptual techniques for walking in virtual environments*. Ed. by Y. Visell and F. Fontana. Logos Verlag, 2012, pp. 33–68.

[B6] **Y. Visell**, **S. Smith**, and J. R. Cooperstock. "Distributed human-computer interaction with augmented floor surface." In: *Walking with the senses: Perceptual techniques for walking in virtual environments*. Ed. by Y. Visell and F. Fontana. Logos Verlag, 2012, pp. 15–32.

[B7] J. R. Cooperstock. "Human-Computer Interaction." In: *Wiley Encyclopedia of Computer Science and Engineering*. Ed. by B. W. Wah. Vol. 3. Wiley-Interscience, Mar. 2009, pp. 1529–1542. DOI: 10.1002/9780470050118.ecse524. URL: http://onlinelibrary.wiley.com/doi/10.1002/9780470050118.ecse524/abstract.

[B8] **F. Aubé** and **R. Shield**. "Modeling the Effect of Leadership on Crowd Flow Dynamics." In: *Cellular Automata*. Ed. by P. Sloot, B. Chopard, and A. Hoekstra. Vol. 3305. Lecture Notes in Computer Science. originally presented in International Conference on Cellular Automata for Research and Industry. Amsterdam: Springer Berlin / Heidelberg, Oct. 2004, pp. 601–611. DOI: 10.1007/978-3-540-30479-1_62. URL: http://dx.doi.org/10.1007/978-3-540-30479-1_62.

Other Refereed Publications

[O1] **N. Hieda** and J. R. Cooperstock. *SharedFace2*. International Conference and Exhibition of Virtual Technologies and Uses: Laval Virtual ReVolution (refereed interactive demonstration). Laval, France, Apr. 2015.

[O2] **Y. Visell**, **G. Millet**, and J. R. Cooperstock. *Haptic Display via a Vibrating, Rigid Surface*. Demonstration in IEEE Haptics Symposium. Waltham, MA, USA, Mar. 2010.

[O3] **A. Law**, **J. Ip**, **B. Peck**, **Y. Visell**, P. Kry, and J. R. Cooperstock. *A Multimodal Floor for Virtual Environments*. Demonstration in SIGGRAPH Emerging Technologies. Aug. 2009.

[O4] **M. Wozniewski**, Z. Settel, and J. R. Cooperstock. *Ménagerie Imaginaire*. Artwork Performance in New Interfaces for Musical Expression (NIME). New York, NY, USA, June 2007.

Non-refereed Contributions

[N1] J. Cooperstock. "Situating UbiComp Education within or distinct from HCI?" In: *Ubiquitous Computing Education: Why, What, and How:* ed. by A. Girouard, A. L. Kun, A. Roudaut, and O. Shaer. Vol. 9. 6. Dagstuhl, Germany: Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik, Mar. 2019. URL: http://drops.dagstuhl.de/opus/volltexte/2019/11460.

[N2] **E. Sheepy**, M. Orjuela-Laverde, and J. R. Cooperstock. "Encouraging active and collaborative learning in two engineering courses." In: *Supporting Active Learning and Technological Innovation in Studies of Education*. Montreal, Canada, June 2016.

[N3] J. R. Cooperstock and G. Lukács. *How to complain to airlines*. CBC Marketplace blog. Mar. 2014. URL: http://www.cbc.ca/marketplace/blog/plane-wrong-how-to-complain-to-airlines.

[N4] **F. Tordini** and J. R. Cooperstock. "Auditory salience modeling via streaming: A behavioural view." In: *Milestones in Music Cognition: BKN 25*. Montreal, Canada, July 2014.

[N5] J. R. Cooperstock. "Overcoming Complexity in the Teaching and Learning Environment." In: *Materials Science and Technology*. Ralph Lloyd Harris Memorial Symposium. Montreal, Oct. 2013.

[N6] J. R. Cooperstock. *From Rehearsal to Performance: Ensemble Learning in Open Orchestra and Distributed Rehearsal for World Opera*. Presentation in Music Anywhere, Anytime: International Symposium on Synchronous Distance Learning. Oct. 2011.

[N7] **Benovoy, M.**, J. Cooperstock, and M. Levine. *Real-Time Facial Recognition*. Phase II Project Report for Department of National Defence. 2010.

[N8] M. Levine, **Benovoy, M.**, and J. Cooperstock. *An Automatic Real-Time Facial Recognition System*. Phase I Project Report for Department of National Defence. 2009.

[N9] **N. Bouillot**, E. Cohen, J. R. Cooperstock, A. Floros, N. Fonseca, R. Foss, M. Goodman, J. Grant, K. Gross, S. Harris, B. Harshbarger, J. Heyraud, L. Jonsson, J. Narus, M. Page, T. Snook, A. Tanaka, J. Trieger, and U. Zanghieri. "AES White Paper AESTD1003V1: Best Practices in Network Audio." In: *Journal of the Audio Engineering Society* 57.9 (Sept. 2009), pp. 729–741. URL: http://www.aes.org/e-lib/browse.cfm?elib=14839.

[N10] V. N. Salimpoor, **M. Benovoy**, G. Longo, J. R. Cooperstock, and R. J. Zatorre. *Qualifying the Chills Response: Differences between Transient and Prolonged Chills in Response to Music*. Presentation in Auditory Perception, Cognition, and Action Meeting. Chicago, IL, USA, 2008.

[N11] J. Cooperstock. "Plus de largeur du bande, s'il vous plaît." In: *L'interdiscplinarité dans les sciences et technologies de la musique (invited)*. Montreal: Association francophone pour le savoir (ACFAS), May 2006.

[N12] J. Cooperstock. "Integrating Communication with Interaction: Computer Vision Challenges for Interactive and Intelligent Environments." In: *Workshop on Computer Vision for Interactive and Intelligent Environments (invited)*. Lexington, KY, USA, Nov. 2005. URL: http://srl.mcgill.ca/publications/2005-CV4IIE.pdf.

[N13] J. Cooperstock, J. Roston, and Woszczyk. "Broadband Networked Audio: Entering the Era of Multisensory Data Distribution." In: *18th International Congress on Acoustics (invited)*. Kyoto, Apr. 2004.

[N14] **Cayouette, F.**, **Sud, D.**, **Patel, K.**, **Sarikaya, D.**, and J. Cooperstock. "McGill Reddogs Final Report." In: *Robocup*. 2002.

[N15] J. Cooperstock. "Classroom of the Future: Enhancing Education through Augmented Reality." In: *HCI International, Conference on Human-Computer Interaction (invited)*. New Orleans, 2001.

[N16] **Sud, D.**, **Cayouette, F.**, **Gu, J.**, and J. Cooperstock. "McGill Reddogs Final Report." In: *Robocup*. 2001.

[N17] A. Saroyan, R. Harris, and J. R. Cooperstock. *Applying pedagogical principles to teaching and learning with technology*. Multi-cultural perspectives on the use of technology in education. Montreal, QC, Canada, 2000. URL: http://www.education.mcgill.ca/NAFTA.

Patents

[P1] **P. Fortin**, S. Kim, and J. R. Cooperstock. "Closed-loop XR Stimulus Presentation and Perception Feedback using Multi-Channel Physiological Signals." US12032740B2 (United States). July 2024.

[P2] **D. Marino**, **M. Henry**, **P. Fortin**, and J. R. Cooperstock. "System and method for displaying reaction animations." US application 18/463,799 (United States). 2023.

[P3] **H. Lee**, **C. Ducher**, **R. Wang**, **M. Henry**, and J. R. Cooperstock. "Voice Parameter Determination Method, System and Device." US application 18/310,213; Canada application 3,198,267 (United States). 2023.

[P4] **P. Fortin**, **J. Blum**, **Antoine Weill–Duflos**, and J. R. Cooperstock. "System and Method for Wearable Device Contact Force Estimation and Adjustment Feedback." application US 20230129166 A1 (United States). 2022.

[P5] J. R. Cooperstock, **A. Weill-Duflos**, **J. Regimbal**, **N. Radi**, **J. Blum**, **P. Alirezaee**, and **Y. Zhang**. "Methods and systems for controlling a haptic display." US 63/006,141, PCT/CA2021/050461, US 17/917,761 (United States). 2021.

[P6] J. R. Cooperstock and **J. Blum**. "Improving Haptic Feedback on Wearable Devices through Accelerometer Measurements." provisional application US 62/237,772; US 62/416,910 (United States). 2015.

[P7] J. R. Cooperstock, **Y. Visell**, **A. Law**, and K. Franinovic. "Floor-based Haptic Communication System." US 9,041,521 (United States). May 2015.

[P8] J. R. Cooperstock, **J. Blum**, **M. Bouchard**, **A. Olmos**, **S. Panëels**, and **D. El-Shimy**. "Spatialized audio augmented reality for blind users with a smartphone." provisional application US 61/727,828 (expired) (United States). 2012.

[P9] J. R. Cooperstock, **G. Millet**, and **M. Otis**. "Floor-Based Variable Friction Display." provisional application US 61/577,148 (expired) (United States). 2011.

[P10] J. R. Cooperstock, **L. To**, and R. Hess. "Binocular vision assessment and/or therapy." US 8,066,372 (United States). Nov. 2011.

[P11] **S. Spackman**, **S. Pelletier**, and J. R. Cooperstock. "High-resolution Video Synthesis." application 2,435,791 filed July 24, 2003 (expired) (Canada). 2003.

[P12] J. R. Cooperstock, **Y. Zhang**, and **S. Spackman**. "Adaptive Compression for the Storage, Transmission, and Arbitrary Quality Reconstruction of Spatial Data." US 60/339,816, provisional application filed Dec. 17, 2001 (expired) (United States). 2001.

[P13] J. R. Cooperstock and **S. Arseneau**. "A robust person tracking method and system." US 60/234,197 provisional application, filed Sept. 20, 2000 (expired) (United States). 2000.

[P14] J. R. Cooperstock. "Pixel Count-Sensitive PDA Tool Mechanism with Cut/Paste and/or Copy/Paste Function." P09-022797, filed in Japan by Sony Corp. (Japan). Feb. 1997.

Technology Transfer

License agreement signed in 2014 with amblyotech.com to commercialize amblyopia treatment (protected under US patent 8,066,372 "Binocular vision assessment and/or therapy"). The technology was subsequently acquired by Novartis in April 2020.

Research Demonstrations

[D1] 3D Printed Haptic Illusions and Demonstrations. IEEE World Haptics, Tokyo, Japan (conducted by Antoine Weill-Duflos and Pascal Fortin), July 2019.

[D2] Distributed Musical Practice and Performance, I Medici di McGill, Oscar Peterson Hall, Montreal, April 28, 2008.

[D3] Wide Screen Window on the World: Life Size HD Videoconferencing. Supercomputing 2005, Bandwidth Challenge, Seattle, November 16, 2005.

[D4] Streaming DSD Audio comes to the AES. Audio Engineering Society 117th Convention, San Francisco, October 31, 2004.

[D5] Cross-continental low-latency ultra-videoconferencing. McGill-Stanford jazz jam, June 13, 2002.

[D6] Remote master's class using SDI video and multichannel audio. McGill-National Research Council session with Pinchas Zukerman, March 25, 2002.

[D7] SDI video and multichannel audio. CANARIE's 7th Advanced Networks Workshop, Toronto, November 28, 2001.

[D8] Low-latency distributed violin duet in full-frame video. RISQ 2001 Conference, Montreal, November 5, 2001.

The Globe and Mail noted that *"Cooperstock's demonstration was a watershed event for the elite club of the world's computer network engineers. No one had ever before been able to demonstrate that, under the right conditions, it is possible for natural, normal human interaction to occur over the Internet."*

[D9] The Recording Studio that Spans a Continent. Audio Engineering Society 109th Convention, Los Angeles, September 23, 2000.

The Audio Engineering Society noted that this *"Landmark demonstration shows cost effective and high performance transmission systems for high quality 24-bit, 96kHz uncompressed mulitchannel audio are on horizon"*

[D10] Dolby Digital 5.1 audio with MPEG-2 video around the world. Internet Global Summit INET 2000 Conference, Yokohama, July 20, 2000.

CBC Radio noted that *"McGill University in Montreal has made Internet history by setting up the first intercontinental netcast of a live concert in surround sound and full-screen video."*

[D11] Dolby Digital 5.1 audio with MPEG-2 video. CANARIE's 5th Advanced Networks Workshop, Toronto, November 29, 1999.

[D12] First real-time Multichannel Audio Internet demo. Audio Engineering Society 107th Convention, New York, September 26, 1999.

The Learning Technologies Networked noted that *"The performance marked the first real time multichannel audio Internet transmission, a feat made possible by software developed at McGill University by a team under the leadership of Professor Jeremy Cooperstock."*

Invited Talks

Invited Talks to Industry, Students, and the Public

[T1] "HCI Research in the Shared Reality Lab", Professor Speaker Series, Electrical, Computer & Software Engineering Students' Society of McGill University, Montreal, November 8, 2024.

[T2] "AI Digital Nurse Avatar", Place Kensington Retirement Home, Montreal, September 12, 2024.

[T3] "HCI Research in the Shared Reality Lab", Marianopolis Engineering Society, Marianopolis College, Montreal, November 21, 2023.

[T4] "HCI Research inthe Shared Reality Lab", Professor Speaker Series, Electrical, Computer & Software Engineering Students' Society of McGill University, Montreal, November 15, 2023.

[T5] "Engineering of Technologies to Improve the Lives of People Living with Vision Loss", Bioengineering and Biomedical Engineering, McGill University, September 15, 2023.

[T6] "Using smartphones to answer 'What's around me?', 'Am I crossing the street safely?' and 'Where's the entrance?"', Accessible Coding Demonstrations for Youth with Visual Impairment, Science Odyssey 2021, May 1, 2021.

[T7] "From flight simulators to the passenger experience: what can we learn from pilot-training tools to improve airline customer service", AIST–NRC Collaboration Meeting on Improving Client-Agent Interaction, January 17, 2020.

[T8] "I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery", Department of Information Engineering and Computer Science, University of Trento, July 4, 2019.

[T9] "I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery", Department of Industrial Engineering and Management, Ben Gurion University, March 11, 2019.

[T10] "I Feel the Earth Move (Under My Feet): Haptic Interaction for Telepresence and Information Delivery", Information Systems, University of Haifa, November 7, 2018.

[T11] "What's around me? Audio augmented reality for blind users with a smartphone, Pint of Science, Montreal, May 15, 2018.

[T12] Presenter at Canadian National Institute for the Blind's TechnoVision+ Conference, Montreal, May 5, 2017.

[T13] "Innovations for Gaming, AR, Simulation & Training", Innovations for gaming, augmented reality, simulation and training, and other applications, Centre d'entreprises et d'innovation de Montreal (CEIM), April 8, 2016.

[T14] "Enhanced Human: Wearable computing that transforms how we perceive and interact with our world", Department of Computer Science, Technion–Israel Institute of Technology, February 11, 2016.

[T15] "Is Humanity Smart Enough for AI?", McGill Science Outreach Program, Freaky Friday public outreach lecture, October 23, 2015.

[T16] "Delivering a Compelling User Experience in a Computer-Mediated Environment", HCIN 5300, Interactive Entertainment Technologies, Carleton University, March 7, 2014.

[T17] "Multimedia as a Building Block: How audio, video and haptics integrate in a Shared Reality", Multimedia Systems, GLIS 633, School of Information Studies, McGill University, February 13, 2014.

[T18] "Are we there yet? Cognitive Science Challenges in Telepresence and Virtual Reality", Student Association of Cognitive Science, Cognitive Science Research Day, McGill University, November 13, 2013.

[T19] "Telepresence doesn't quite cut it: Multimodal Challenges in Virtual and Shared Reality", Institute of Telecommunications and Multimedia Applications, Universidad Politècnica de València, July 10, 2013.

[T20] "Telepresence doesn't quite cut it: Multimodal Challenges in Virtual and Shared Reality", Dawson College, First Choice Science speakers series, April 17, 2013.

[T21] "Dangerous AI or dangerous us?", Academia Week Artificial Intelligence event, Science Undergraduate Society, McGill University, January 24, 2013.

[T22] "They don't use Skype on the Holodeck", Department of Computer Science, University of British Columbia, July 4, 2012.

[T23] "But can the Holodeck do a good Shiraz?", School of Computer Science and IT, Royal Melbourne Institute of Technology, February 17, 2012.

[T24] "But can the Holodeck do a good Shiraz?", School of Information Technologies, University of Sydney, February 15, 2012.

[T25] "Distributed Music Performance and Latency Issues", School of Drama, Fine Art and Music, University of Newcastle (Australia), February 13, 2012.

[T26] "But can the Holodeck do a good Pinot noir?", Department of Computer Science, University of Otago, January 23, 2012.

[T27] "Shared Reality: Toward perceptually convincing computer-mediated environments", Department of Computer Science, University of Auckland, August 25, 2011.

[T28] "This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments", Vanier College, Science Week Presentation, March 24, 2011.

[T29] "This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments", Simula Lab, Oslo, May 15, 2009.

[T30] "This is your brain on Shared Reality: Toward perceptually convincing computed-mediated environments", Ambient Intelligence Group, CITEC, Bielefeld University, May 6, 2009.

[T31] "Distributed and Multimodal Interaction in Virtual and Augmented Reality Environments", McGill University, School of Physical and Occupational Therapy, November 25, 2008.

[T32] "Shared Reality: Effective Interaction for (Demanding) Distributed Tasks", University of Victoria, September 16, 2008.

[T33] "Bidirectional video communication for real-time applications", Institut für Telematik, University of Lübeck, Germany, May 15, 2008.

[T34] "Shared Reality: Effective Interaction for (Demanding) Distributed Tasks", Aalborg University, Esbjerg, Denmark, May 14, 2008.

[T35] "Distributed Multimodal Interaction", Bang & Olufsen, Struer, Denmark, May 13, 2008.

[T36] "Distributed Musical Practice and Performance", Biology and Music Lecture, I Medici di McGill, April 28, 2008.

[T37] "Shared Reality: Effective Interaction for (Demanding) Distributed Tasks", Arts, Media and Engineering, Arizona State University, February 29, 2008

[T38] "From Videoconferencing to Shared Reality" Department of Electrical and Computer Engineering, University of British Columbia, October 4, 2007.

[T39] "Engaging Technolog(ies) for Effective Interaction" Department of Computer Science, Hebrew University of Jerusalem, April 19, 2005.

[T40] "Engaging Technolog(ies) for Effective Interaction" Intelligence, Agents, Multimedia Group, University of Southampton, UK, March 7, 2005.

[T41] "From Videoconferencing to Shared Reality" l'Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris, November 25, 2004.

[T42] "From Videoconferencing to Shared Reality" Taiyuan University, Taiyuan, China, April 18, 2004.

[T43] "From Videoconferencing to Shared Reality" Tsighua University, Beijing, China, April 14, 2004.

[T44] "From Videoconferencing to Shared Reality" Beijing University, Beijing, China, April 14, 2004.

[T45] "From Videoconferencing to Shared Reality" Beihan University, Beijing, China, April 12, 2004.

[T46] "From Videoconferencing to Shared Reality" Advanced Telecommunications Research (ATR), Nara, Japan, April 9, 2004.

[T47] "From Videoconferencing to Shared Reality" Dept. of Industrial Engineering, Musashi Institute of Technology, April 5, 2004.

[T48] "High-fidelity telepresence" Graphics and Geometric Computing Seminar Series, Technion – Israel Institute of Technology, January 1, 2003.

[T49] "The Virtual Studio" Royal Conservatory of Music, Toronto, February 25, 2002.

[T50] "Building a Shared Reality" Department of Computer Science, University of Toronto, February 25, 2002.

[T51] "Distributed Concerts and Shared Reality: Just how much streamed data and computation do we need to support effective interaction?" Department of Computer Science, Clarkson University, November 1, 2001.

[T52] "Robotics and Design" Round Table Panel, Centre Design UQAM, February 9, 2000.

[T53] "The Shared Reality Environment" Department of Electrical and Computer Engineering, Ecole Polytechnique, Montreal, May 28, 1999.

Invited Talks in Scholarly Conferences and Workshops

[T54] "Intelligent Systems to Enhance Human Experience", International Laboratory of Learning Systems–DATAIA Workshop, Paris, May 25, 2023.

[T55] Speaker in "Ethics Research I am Excited About", Laidley Centre for Business Ethics, Montreal, April 28, 2023.

[T56] Speaker in "Next Gen Health Powered By The Open Grid And Edge AI", IEEE Future Networks Forum, Montreal, October 14, 2022.

[T57] "Touch and feel when it isn't real: Integrating haptics into the XR experience", InterDigital Scientific Seminar series, December 4, 2020.

[T58] "Taking Haptics Out of the Lab and Into the Wild", Introduction to Haptics for Next Generation XR. International Conference on Intelligent Robots and Systems Tutorial Session, October 29, 2020.

[T59] "Assistive Technology Research in the Shared Reality Lab", Conférence scientifique du CRIR-Institut Nazareth et Louis-Braille, September 25, 2019.

[T60] "Learning from sparse feedback: Adapting an environmental awareness app to visually impaired user preferences", ACM-SIGCHI sponsored summer school on Intelligent User Interfaces in the Era of IoT and Smart Environments, Haifa, Israel, October 3, 2018.

[T61] Speaker in "AR/VR panel", IEEE Multimedia Signal Processing Workshop, Montreal, September 23, 2016.

[T62] "Immersive multimedia and mobile interaction: Applications to new media, gaming, medicine, and beyond" Keynote speaker, Entertainment Technology Summit, Concordia University, Montreal, September 17, 2016.

[T63] "Leveraging video in public safety scenarios", Ninth Canadian Public Safety Interoperability Workshop (CITIG 9), Toronto, December 1, 2015.

[T64] "Future Cities (2040) – Mind: Human and Machine", Institute for the Public Life of Arts and Ideas, Symposium on Future Cities, March 13, 2015.

[T65] "UltraVideo and the Quest for Minimal Latency", International Workshop on High Quality Dynamic cross-continental Networked Artistic interaction, World Opera Association, Struer, Denmark, August 29, 2013.

[T66] "Assisting the blind and treating amblyopia: Two more things you can do with your smartphone", 15e Symposium scientifique sur l'incapacité visuelle et la réadaptation (presented with J. Blum). University of Montreal, February 12, 2013.

[T67] "Revolutions in human-device interaction: How new paradigms impact user experience", International Conference on Consumer Electronics, Consumer Electronics Society, Las Vegas, January 12, 2013.

[T68] "Around the World in 80 ms." Panel presentation in Workshop of the Audio Engineering Society Convention, San Francisco, November 5, 2010.

[T69] "UltraVideo and Virtual Presence: A Video Perspective." Presentation on Teaching in Distributed Performance, Tromsø, Norway, October 15, 2010.

[T70] "Future Interfaces for Audio." Panel presentation in Workshop of the Audio Engineering Society Convention, New York, October 10, 2009.

[T71] "World Opera Technologies and Tests", Danish Sound Technology Network, Aalborg University, June 8, 2009.

[T72] "The Montreal World Opera Experiments". Presentation at the World Opera Symposium, Struer, Denmark, May 12, 2009.

[T73] "Audio-Visual-Haptic-Tactile: Putting them all together for an engaging immersive experience". Panel presentation in Workshop of the Audio Engineering Society Convention, Munich, Germany, May 10, 2009.

[T74] "New Technologies for Audio over IP". Panel presentation in Workshop of the Audio Engineering Society Convention, Munich, Germany, May 10, 2009.

[T75] "A Platform to Create and Support Ocean Science Virtual Organizations (Oceans 2.0)" and "HSVO Health Services Virtual Organization", RISQ 2008 Colloquium, Montreal, November 14, 2008.

[T76] "The Future of VC: Music Teaching and High Fidelity Video", Elevate 2008: Reaching New Heights in Educational Video-conferencing, Banff, August 27–28, 2008.

[T77] "Creating an immersive video space", International Symposium on The World Opera: When the Opera stage becomes worldwide, Tromsø, Norway, May 9, 2008.

[T78] "Multimodal Streaming and Distributed Audio Interaction", High Quality Audio over Networks (ANET II) Summit, Banff Centre, April 12, 2008.

[T79] "Music and Games: How Fun Applications Stimulate Core Technologies", Canadian University Software Engineering Conference, January 19, 2008.

[T80] "From Teleoperation to Teleimmersion: Design Challenges for Distributed Interaction", Canadian University Software Engineering Conference, January 19, 2007.

[T81] "CANARIE sur UCLP et ROADM, deux technologies qui changent le monde des télécoms", Round Table panel, RISQ Annual Conference, Quebec City, October 16, 2006.

[T82] "La recherche sur en ultra-videoconference", Panel on "Vitrine technopédagogique sur la vidéoconférence", RISQ Annual Conference, Quebec City, October 16, 2006.

[T83] "Broadband transmission of multimodal content at the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT)", RISQ-CA*net4 Advanced Networking Day, Montreal, October 24, 2005.

[T84] "Low-Latency Ultra-Videoconferencing and Shared Reality" Interfaces Montreal, Rencontre du Génie numérique et des Affaires. Montreal, October 11, 2005.

[T85] "Shared Spaces" Asia-Pacific Advanced Networks (APAN) Conference, Taipei Aug. 22–27, 2005.

[T86] "Engaging Technolog(ies) for Effective Interaction" Keynote speaker, World Conference on Educational Multimedia, Hypermedia and Telecommunications, Montreal, June 29, 2005.

[T87] "Broadband Distance Education in 2007: Views from the Demand Side" Invited Panelist. World Conference on Educational Multimedia, Hypermedia and Telecommunications, Montreal, June 29, 2005.

[T88] "Ultra-Videoconferencing and Intelligent Classrooms" Keynote speaker, Canadian Higher Education and Information Technology Conference, Montreal, June 28, 2005.

[T89] "From Videoconferencing to Shared Reality" Bell University Laboratories' Annual Conference, Toronto, November 3, 2004.

[T90] "History of Internet Audio Experiments at McGill" High Quality Audio over Networks (ANET) Summit, Banff Centre, August 20–22, 2004.

[T91] "Advanced Video Applications: Developments in Extreme Video" Southeastern Universities Research Association Video Development Initiative (SURA/ViDe) 6th Annual Digital Video Workshop. Indianapolis, March 24, 2004.

[T92] "The Democratic Revolutions – Peer to Peer Meets Open Source: Design, Philosophy, Engineering" Intimate Technologies/Dangerous Zones. Banff New Media Institute, Banff Centre, April 27, 2002.

[T93] "The Development of Ultra VC Applications and Technology" Southeastern Universities Research Association Video Development Initative (SURA/ViDe) 4th Annual Digital Video Workshop. University of Alabama at Birmingham, April 25, 2002.

[T94] "High quality wide-screen SDI video and multichannel audio over CA*net3" CANARIE's 7th Advanced Networks Workshop, Toronto, November 28, 2001.

[T95] "Low-latency comes to videoconferencing: The Frères Jacques duet at a distance" RISQ 2001 Conference, Montreal, November 5, 2001.

[T96] Advanced Networking and the Arts: Innovations in Outreach, Collaboration, and Performance. Panel Discussion at Internet Global Summit INET 2001 Conference, Stockholm, June 6, 2001.

[T97] "The McGill–Calgary Advanced Learnware Network" CANARIE's 6th Advanced Networks Workshop, Montreal, November 29, 2000.

[T98] "Networks and Music Instruction" Panel Discussion with Pinchas Zukerman and Wieslaw Woszczyk, CANARIE's 6th Advanced Networks Workshop, Montreal, November 29, 2000.

[T99] "Tools for Distributed VR" Canadian Working Group on Virtualized Reality Systems, Montreal, November 28, 2000.

[T100] "Evolution of the Intelligent Classroom" Multicultural Perspectives on the use of Technology in Education. Montreal, October 2, 2000.

[T101] The Brave New World of Ubiquitous Bandwidth" Internet Global Summit INET 2000 Conference, Yokohama, July 20, 2000.

[T102] "Multichannel Audio over the Internet: The Next Phase" RISQ 2000 Conference, May 31, 2000.

[T103] "Multichannel Audio over the Internet" CANARIE's 5th Advanced Networks Workshop, Toronto, November 29, 1999.

[T104] "When Telemedicine feels like Regular Medicine" Communications and Information Technology Ontario (CITO) Healthcare for the Future: Telemedicine, February 18, 1999.

Media Exposure

[M1] Ami-Télé, Ça me regarde, February 8, 2018

[M2] Forbes, March 9, 2017

[M3] Discovery Channel, Daily Planet, Mar. 7, 2017

[M4] Télé-Québec, Electrons Libre, Jan. 17, 2017

[M5] ACB Radio, Mainstream, Nov. 18, 2016

[M6] CBC Radio, Tech Column, Aug. 8, 2016

[M7] CJAD Radio, Tech Talk, Aug. 6, 2016

[M8] Mobile Syrup, Aug. 4, 2016

[M9] CBC News, Aug. 4, 2016

[M10] Betakit, Aug. 3, 2016

[M11] Accessible Media Inc., Live from Studio 5, Aug. 2, 2016

[M12] La Presse, Jul. 31, 2016

[M13] CTV News, Jul. 29, 2016

[M14] Stevivor, Mar. 2015

[M15] Venture Beat, Mar. 3, 2015

[M16] Club Social (TV5), Feb. 4, 2011

[M17] Global TV (National), Jan. 29, 2009

[M18] Global TV (Montreal), Jan. 27, 2009

[M19] CBC Radio, As it Happens, Jan. 27, 2009

[M20] National Post, Jan. 27, 2009

[M21] Montreal Gazette, Jan. 27, 2009

[M22] Montreal Gazette, Feb. 20, 2009

[M23] Inside Higher Education, Sept. 3, 2008

[M24] CBC Radio (Daybreak), Sept. 3, 2008

[M25] CJAD radio, Sept. 2, 2008

[M26] Cabling Networing Systems, Jan. 2006

[M27] McGill Reporter, Nov. 24, 2005

[M28] CTV Quebec, Global News, Dec. 23, 2002

[M29] New York Times, Technology Section, Dec. 19, 2002

[M30] Discovery Channel, Daily Planet, Oct. 30, 2002

[M31] CFCF (CTV Quebec) Global News, June 19, 2002

[M32] National Post, June 15, 2002

[M33] CBC Television, The National, May 3, 2002

[M34] McGill Reporter, Learning the Strings, April 11, 2002

[M35] Ottawa Citizen, March 29, 2002

[M36] Montreal Gazette, March 27, 2002

[M37] Globe & Mail, Dec. 1, 2001

[M38] Canal Z, La Revanche des Nerdz, Nov. 13, 2001

[M39] Montreal Gazette, Nov. 10, 2001

[M40] CJAD Radio, The World Today, July 31, 2001

[M41] McGill Reporter, April 5, 2001

[M42] Globe & Mail Report on Business, Oct. 28, 2000

[M43] TQS Double Clic!, Oct. 7, 2000

[M44] McGill Reporter, Sept. 21, 2000

[M45] UPath.com, Vol 40, 2000

[M46] CBC (Montreal) Home Run, Aug. 22, 2000

[M47] Montreal Gazette, Aug. 22, 2000

[M48] CFCF (CTV Quebec) Pulse News, Aug. 21, 2000

[M49] CBC Radio The Arts Report, July 20, 2000

[M50] Elle Quebec, June 2000

[M51] Journal Le Monde des Affaires, May 2000

[M52] Canal Z, Technofolie, May 3, 2000

[M53] TQS Double Click, April 29, 2000

[M54] McGill Reporter, April 6, 2000

[M55] Briefing Digital, April 2000

[M56] Interface: La Revue de la Recherche, Vol. 21, No. 2, March-April 2000

[M57] American Society of Mechanical Engineers, Mechanical Advantage, Vol 9, No 3, March 2000

[M58] Canal Z, La Revanche des Nerdz, Feb. 2000

[M59] CFCF (CTV Quebec) Pulse News, Feb. 29, 2000

[M60] Canal Vox: CityMag, Jan. 15, 2000

[M61] Montreal Mirror, Jan. 6, 2000

[M62] Plan Mega: La revue du genie québecois, Ordre des ingenieurs du Québec. Vol 1, Jan. 2000

[M63] Radio Corporation of Singapore: Science and Technology Watch, Dec. 1999

[M64] Radio Canada (CBC French) Les Annees lumiere, Nov. 28, 1999

[M65] Financial Times Life/Technology, Nov. 25, 1999

[M66] CBC Radio: As it Happens, Nov. 22, 1999

[M67] Journal de Montreal, Nov. 19, 1999

[M68] Le Devoir, Nov. 18, 1999

[M69] TVA CyberClub, Nov. 13, 1999

[M70] La Presse, Sept. 26, 1999

[M71] CJAD Radio, April 11, 1999

[M72] Montreal Mirror, April 8, 1999

[M73] McGill Reporter, Jan. 14, 1999

[M74] High-Tech Shower International, Nov. 26, 1997

[M75] CBC Newsworld "Futureworld", Oct. 5, 1996

[M76] Discovery Channel, Sept. 18, 1996

[M77] Toronto Star, Sept. 15, 1996

[M78] University of Toronto Varsity, Sept. 3, 1996

[M79] TV Ontario "Studio Two", June 26, 1995

Research Supervision

Research Professionals

Name	**Period**	**Project title**	**Present Position**
Gvozdev, Mikhail	Feb 2025–	AI solutions architect, IMAGE project	
Yousef, Shahd	Sep 2024–	server-side developer, IMAGE project	
Singh, Jaydeep	Sep 2021–	web developer, IMAGE project	
Novack, Kaylee	Sep 2021–Apr 2022	medical doctor researcher on Avatar Therapy project	Medical Resident, Université de Montréal
Kuo, Cyan	Aug 2021 – Dec 2023	Usability Research Lead, IMAGE project	
Patil, Gandharv	Jun 2021 – Mar 2022	ML Research Lead, IMAGE project	PhD student, McGill
Grond, Florian	Apr 2021 – Mar 2023	Audio Research Lead, IMAGE project	Assistant Professor, Concordia University
Eichhorn, Alexander	Feb 2013 – Aug 2013	research associate under GRAND	CTO of Kidtsunami
Bouchard, Mathieu	Jan 2011 – Nov 2018	research assistant under MSG project	
Chen, Guangyi	Jan 2010 – Jul 2010	research associate under Canarie NEP	
Vincent, Coralie	Oct 2010 – Mar 2011	research assistant	Research Engineer, IRCAM, France
Dansereau, Don	Jun 2009 – Jan 2010	research associate under FRQNT grant	Senior Lecturer, University of Sydney

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Name	**Period**	**Project title**	**Present Position**
To, Long	Jan 2009 – Sep 2011	research associate under NSERC I2I	Software engineer, Abcam
Blum, Jeff	Oct 2008 – Aug 2013	research assistant under MSG project	
Olmos, Adriana	Sep 2008 – July 2012	user interface engineer under Canarie NEP	Interaction designer, Google/YouTube
Sun, Haijian	Sep 2008 – Oct 2010	computer engineer under Canarie NEP	ECM Consultant, JCDS Solutions Inc.
Soukhodolski, I.	Oct 2005 – Dec 2007	web services programmer under Canarie IIP	Owner, W4 Technology
Kiewe, Howard	Oct 2005 – Dec 2007	user interface developer under Canarie IIP	consultant
Spackman, S.	2000–2006	research associate on Canarie and VRQ projects	Google, Mountain View
Sarikaya, Deniz	2003–2004	research assistant on VRQ projects	deceased
Soucy, Gilbert	1999	research associate on CFI project	Imaging Specialist, 36pix Inc., Montreal

Post-doctoral Fellows

Name	Period	Project title	Present Position
Byeon, Yeong-Hyeon	Jan 2024 – Nov 2024	Bionic Ear Project	
Bouzekri, Élodie	Sep 2023 – Aug 2024	ADAIR Project	Assistant Professor, Université de Bretagne Occidentale
Fontana De Vargas, Mauricio	Jan 2023 – Nov 2023	Ai-Digital Nurse Avatar (ADiNA)	AI+VR Research Scientist, Meta, Toronto
Sullivan, John	Sep 2021 – Apr 2022	Multimodal Rendering for the IMAGE Project	post-doctoral fellow, Université Paris-Saclay
Jyoti, Vishav	Mar 2021 – Feb 2022	Mixed-Reality Platform for Simulation and Synthesis of Multi-Modal Hallucinations	Software Engineer, Youtube, India
Talhan, Aishwari	Jan 2021 – Dec 2022	Wearable Haptics	Research Scientist, SUNY Research Foundation, Albany, New York
Yoo, Yongjae	Mar 2020 – Jul 2022	Wearable Haptics and Haptics Lead, IMAGE project	Assistant Professor, Hanyang University ERICA, South Korea
Weill-Duflos, A.	Jan 2018 – Jan 2021	Wearable Haptics	Director of Research and Product Integration, Haply Robotics
Arnold, Andre	Oct 2017 – Dec 2017	Wearable Haptics	Product Manager – AI Nuvoola

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Name	**Period**	**Project title**	**Present Position**
Panëels, S.	Jan 2011 – Jan 2012	Natural Interactive Walking and In-Situ Audio Services	Researcher, Commissariat à l'énergie atomique et aux énergies alternatives (CEA)
Pelletier, S.	Nov 2009 – Jun 2011	Real-time Image-based Rendering (Canarie NEP, 2009-2010)	
		Parallax Barrier Display rendering software optimization (NSERC ENGAGE, 2011	Game Programmer, Behaviour Interactive
Otis, Martin	Jan 2010 – Dec 2010	Natural Interactive Walking (FRQNT Scholarship)	Assoc. Professor, U. Québec à Chicoutimi
Millet, G.	Nov 2009 – Mar 2012	Natural Interactive Walking	Patent Examiner, EPO, The Hague
Bouillot, Nicolas	Sep 2007 – Dec 2011	Mobile Audio Interaction (NSERC New Media Initiative, 2007-2009)	
		Open Orchestra (Canarie NEP-2 Project)	Co-Founder - Lab148
Darolti, Cristina	Jan – Dec 2009	Real-time Image-based Rendering (Canarie NEP)	Patent Examiner, EPO, The Hague
Wang, Guangyu	Sep 2007 – Mar 2011	Neurosurgical Visualization and Virtual Presence (NSERC Strategic and NCE)	Facebook, Mountain View
Wang, Yan	2002–2003	Channel and spatial view allocation for videoconferencing (VRQ)	V.P. Marketing, AMH Canada

Ph.D. Students

Name	Period	Thesis title	Present Position
Riazifar, Myles	Jan 2025–present	Advanced Airspace Usability	
Pinheiro de Oliveira, Henrique Jongh	Mar 2024–present	Orchestrating LLMs for blind and low-vision users, Cotutelle student with Universidade Federal do Rio Grande do Sul	
Kuo, Cyan	Jan 2024–present	Multimodal Perception in Sensory Substitution Frameworks	
Knappe, Sabrina*	Jan 2023–present	Advanced Airspace Usability	
Samuel, Segun*	Jan 2023–present	Spatial content representation strategies for blind and low-vision users	
Conan, Corentin*	Sep 2022–present	Advanced Airspace Usability	
Astles, Samantha*	Sep 2022–Jan 2024	Advanced Airspace Usability	
Shen, Lichao*	Oct 2021–Aug 2023	Social telepresence	
Regimbal, J.*§†C	Sep 2021–present	Audio-haptic authoring for information rich content delivery	
Fortin, P.*§	Sep 2016–Sep 2021	Methods and Interfaces for Closed-Loop Smartphone Communications	Asst. Professor, U. Québec à Chicoutimi
Blum, Jeff*†g	Sep 2013–present	Implicit Communication for Enriched Human Interaction	
Erfani-Joorabchi, M.*	Jan 2013–Jan 2015		iOS Software Engineer, Google

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Name	**Period**	**Thesis title**	**Present Position**
Anlauff, Jan*	Jan 2011–present	Sensor-Actor Wearables	
Tordini, F.	Jan 2011–Feb 2018	Auditory salience modeling for continuous processes sonification	Technology Transfer Manager, Innovation and Partnerships, McGill University
Ghourchian, N.*†	Jan 2010–Apr 2011	Affective Evaluation	transferred to another group
El-Shimy, D.†	Jan 2009–Nov 2014	Reactive Environment for Network Music Performance	Director of UX Research, WISE, London UK
Benovoy, M.†	Oct 2007–Aug 2010	Biosignals analysis	transferred to another group
Visell, Yon	Sep 2005–Mar 2011	Walking on virtual ground: physics, perception, and interface design	Assistant Professor (ECE), UC Santa Barbara
Qi, Zhi	Jan 2004–Dec 2008	Towards dynamic mosaic generation with robustness to parallax effects	Associate Professor (School of Electronic Science & Engineering), Southeast University, China
Pelletier, S.^{p}	Jan 2003–Oct 2009	Acceleration methods for image super-resolution	Game Programmer, Behaviour Interactive
Yin, Jianfeng	Sep 2000–Aug 2008	Toward an Alternative Approach to Multi-Camera Scene Reconstruction	Software engineer, Geomagical Labs
Sun, Wei	2002–2006	Multi-camera Object Segmentation in Dynamically Textured Scenes Using Disparity Contours	Apple Inc., Cupertino

Continued on next page

Name	**Period**	**Thesis title**	**Present Position**
Cayouette, F.†	2003–2006	human tracking (withdrew from program)	Generalist Programmer, Reflector Entertainment
Arseneau, S.	2000–2006	Representing Junctions through Asymmetric Tensor Diffusion	Chief Technology Officer, MVP, Austin

* McGill Engineering Doctoral Award recipient
† NSERC PGS D Scholarship recipient
†C NSERC CGS D Scholarship recipient
§ FRQNT Scholarship recipient
g Graphics Animation and New Media (GRAND) Scholarship recipient
p Precarn Scholarship

Additional Ph.D. Supervisory Service

I co-supervised a portion of the thesis work of the following students:

- Kilic, Şeyma Nur (Jan 2025-), visiting student from Istanbul University-Cerrahpasa
- Du, Xiaoxi (Sep 2023-Aug 2024), visiting student from Southeast University, Nanjing, China
- Mousavi, Mastoureh (Sep 2023-), visiting student from Azad University, Tehran, Iran
- Liu, Xian (Nov 2013-Dec 2015), visiting student from University of Electronic Science and Technology, China
- Xie, Meng (Sep 2012-Mar 2014), visiting student from Beijing University of Aeronautics and Astronautics, China
- Grond, Florian. (Jul-Dec 2010), visiting student from Bielefeld University, Germany
- Zambon, S. (Jul-Oct 2010), visiting student from Verona University, Italy
- Cirio, Gabriel (Jun-Aug 2010), visiting student from INRIA-IRISA, France
- Rizutti, Costantino (Sep-Oct 2008), visiting student from Università della Calabria, Italy
- Bossi, Eugenia (Oct 2008), visiting student from Università della Calabria, Italy
- Pellerin, Romain. (Jun-Sep 2008), visiting student from Conservatoire Nationale des Arts et Métiers, France
- Cupellini, Enrico (Jul-Aug 2007), visiting student from Università della Calabria, Italy
- Usher, John (2003-2004), Ph.D. student, Faculty of Music, McGill University
- Mohammadi, M. (Feb-Aug 2004). visiting student from Sharif University, Iran

I served as external reviewer or examiner of the following theses:

- Mauricio Fontana de Vargas, School of Information Studies, McGill University (2022)
- Richard Olayniyan, Department of Computer Science, McGill University (2021)
- Xavier de Tingu, Université Rennes, France (2020)
- Damien Brun, Le Mans Université, France (2020)
- Cheryl Savery, Queen's University (2014)
- Alexandre Plouznikoff, École Polytechnique de Montréal (2009)
- Xiaoyong Sun, School of Information Technology and Engineering, University of Ottawa (2007)
- Nicolas Bouillot, Conservatoire Nationale des Arts et Métiers, France (2006)
- Harold Okai-Tettey, Computer Science, Rhodes University, South Africa (2006)

I served on the supervisory and/or examination committees of the following students:

- Department of Electrical and Computer Engineering: Edouard Antoniou, Oliver Astley, Carmen Au, Marc Boulé, Wei Chu, Olivier St-Martin Cormier, Vincent Levesque, Muhua Li, Rui Ma, Dante De Nigris Moreno, Jun Ouyang, Jerome Pasquero, Andrew Phan, Ala Qumsieh, Harkirat Sahambi, Wei Sun, Yick Kei Wong, Dingrong Yi, Olivier St-Martin Cormier, Karl Fayad, Shalaleh Rismani, Lixiao Zhu, Amir Abbas (2023), Haji Abolhassani (2024)
- Department of Mechanical Engineering: Zahir Albadawi, Omar Wyman, Ehsan Yousefi
- Department of Biological and Biomedical Engineering: Alireza Heidari
- School of Physical and Occupational Therapy: Jackie Girgis
- School of Information Studies: Xiaofeng (Allan) Yong
- Faculty of Music: Jason Corey, Cory McKay, Caroline Medeiros, Sean Olive, Dale Stammen, Vanessa Yarmechuk, Mark Zadel
- Grad. School of Library and Information Studies: Charles-Antoine Julien
- Department of Educational Psychology and Counselling: Adam Finkelstein
- School of Computer Science: Paul Haroun, Wisam Al Abed

Masters Students

Name	Period	Thesis title	Present Position
Wang, Melody	Jan 2025–	TBD	
Jabbari, Kasra	Jan 2025–	TBD	
Pan, Edina	Sep 2024–	TBD	
Li, Yuancao	Sep 2024–	TBD	
Dhanania, Mansi$^{\diamond}$	Sep 2024–	TBD	
Buller, Abigail$^{\diamond\diamond\dagger C}$	Sep 2023–	Haptic displays for multi-patient vital sign monitoring	
Karve, Anay	Sep 2023–	ADvanced AIRspace Usability	
Naik, Khushi	Sep 2023–	Graphical displays for multi-patient vital sign monitoring	
Zou, Yichen	Sep 2023–	Bionic Ear	
Li, Heyang§	Jan 2023–	Emotion recognition and expression for ADiNA	
Fu, Jano	Jan 2023–	Dynamic multimodal chart representations for individuals who are blind	
Bazin, Romain	Sep 2022–Dec 2024	Leveraging Large Language Models for Automated Chart Summarization	
Quadros, Venissa Carol	Sep 2022–	Authoring of Audio-Tactile Content for Refreshable Tactile Displays	
Aubet, Antoine	Sep 2022–	Computationally efficient dynamic spatial audio rendering for distributed musical performance	
Liu, Yujing	Sep 2021–2024	Design and Implementation of Conversational Humanoid Avatars for Healthcare Applications	

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Name	**Period**	**Thesis title**	**Present Position**
Wilson, É.	Sep 2021–Sep 2024	Representations for the Blind of Depth Information in Photographs	Technical Product Coordinator, Haply Robotics
Duarte, Nathan$^{\diamond\diamond}$	Sep 2021–Aug 2023	Deploying wearable sensors for pandemic mitigation	Senior Associate, Boston Consulting Group
Henry, Max	Sep 2021–	Spatial-aware audio rendering for immersive telepresence	
Lewis-Lane, Jonathan	Sep 2021–Aug 2023	Haptic Interfaces for Musical Notation and Expression	Haptics Engineer, Apple Computer
Akut, Rohan	Jan 2021–Jul 2023	Enriching AI-based Image Descriptions for People who are Vision-Impaired	Machine Learning Engineer, iCAD Dental
Gannavarapu, S.	Sep 2020–Dec 2023	Haptic Perception and Multimodal Maps for the Visually Impaired	
Isran, Rayan	Sep 2020–Aug 2023	Investigating Audio-Haptic Rendering Methods To Deliver Chart Information to Blind and Low-Vision Individuals	Mechatronics Software Engineer, Bombardier Recreational Products
Kirby, Linnea	Sep 2020–	The Implications of Technology-Augmented Circus in Training, Performance, and Interdisciplinary Research	
Knappe, Sabrina	Sep 2020 – Dec 2022-	Towards a User Interface for Audio-Haptic Exploration of Internet Graphics by People who are Blind and Partially Sighted	Ph.D. student (see above)
Regimbal, J.	Sep 2020 – Aug 2021	Haptic effects authoring in artistic and utilitarian contexts	(fast-tracked to Ph.D. program)

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Name	Period	Thesis title	Present Position
Ducher, Clara	Sep 2019 – Sep 2021	GAN-based interaction paradigms for photorealistic avatar creation (McGill nominee for Northeastern Association of Graduate Schools Distinguished Thesis Award)	Research Software Engineer, European Centre for Medium-Range Weather Forecasts
Marino, David	Sep 2019 – Nov 2021	Implicitly Conveying Emotion While Teleconferencing	R&D Scientist, Hitachi Energy, Montreal
Lee, Hyejin	Sep 2019 – Apr 2022	Generating Convincing Simulation of Internalized Voices for Human-avatar Interaction	Full-stack developer, Société Générale, Montreal
Li, Yaxuan	Sep 2019 – May 2022	Towards Context-aware Automatic Multimodal Haptic Effect Generation for Home Theatre Environments	Ph.D. student, U. Michigan
Bouanane, Y.	Jan 2019 – Dec 2020	EchoDepth: Using a depth camera and sonification for blind navigation	Entrepreneur, sktch.io
Demers, Marc	Sep 2018 – Mar 2021	A Data-Driven Strategy for Evaluating Tacton Perceptual Similarity	Data Scientist, Maxen Technologies
Vyas, Preeti	Sep 2017 – Apr 2020	Foot-based Haptic Interfaces for Numeric Information Delivery and Dance Learning	Ph.D. student, UBC
Sulmont, E.	Sep 2017 – Dec 2018	Improved Learning of Machine Learning by Non-Majors	Curriculum Manager, DataCamp
Patil, Gandharv	Jan 2017 – Dec 2019	Min-Max Inverse Reinforcement Learning for learning bi-modal dialogue policies	Ph.D. student, McGill
Girgis, Roger	Sep 2016 – Apr 2019	Assessing the Use of Deep Learning in Assisting Visually Impaired People with Outdoor Exploration	Ph.D. student, MILA

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Name	**Period**	**Thesis title**	**Present Position**
Kim, Taeyong	Sep 2016 – Aug 2019	Exploration of foot based interaction for menu control and virtual reality applications	HRI Researcher, Hyundai Robotics
Alirezaee, P.	Sep 2016 – Dec 2019	Multimodal approaches to improved hospital alarms	Product Designer, Unity Technologies
Diaz, Manfred	Sep 2016 – Aug 2017	Interactive and Uncertainty-Aware Imitation Learning	Ph.D. student, MILA
Ahmer, Z.	Jan 2016 – Jan 2019	Automated musical accompaniment to children's stories	
Yin, G.	Sep 2015 – Oct 2018-	Augmented Reality Tools for Workplace Safety	Software Engineer, Kooltra
Fortin, P.	Sep 2015 – Aug 2016	Physiological Perception of Tickling Sensation	(fast-tracked to Ph.D. program)
Horodniczy, D.†	Sep 2014 – Dec 2016	Characterization and Application of a Variable-Friction Foot Device	Software Developer, Philips Innovative Imaging Technologies
Vuibert, Vanessa	Sep 2013 – Aug 2015	Efficient and Accurate Performance with Unconstrained Mid-air Interaction	Software Developer, Guavus
Hieda, Naoto	Sep 2012 – Aug 2015	Digital Video Projection for Interactive Entertainment	PhD student, Tallinn University, Estonia
Viswanathan, R.	Jan 2010 – Dec 2012	Testing the Two-Stream Hypothesis in an Immersive Virtual Environment	Senior Software Developer, Faurecia Irystec Inc
Knight, Trevor	Jan 2010 – Sep 2011	Music Visualization for Open Orchestra (CIRMMT Student Award)	Software Developer, Noteloop Systems
Li, Weizhong	Sep 2008 – May 2009	(recommended alternative supervision)	

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Name	**Period**	**Thesis title**	**Present Position**
Ip, Jessica	Sep 2008 – Mar 2011	Augmented Reality for Interactive Play in a Virtual and Physical Environment	iOS developer, Shopify, Toronto
Namit, Gaurav	May 2008 – Oct 2009	(withdrew in 2009 to pursue social entrepreneurship venture)	
El-Shimy, D.	Sep 2007 – Dec 2008	Gestural interaction for complex tasks	(fast-tracked to Ph.D. program)
Law, A.	Sep 2007 – Sep 2010	A Vibrotactile Floor for Enabling Interaction through Virtual Walking Spaces	Data Systems Engineer, AECOM, Vancouver
Benovoy, M.	Sep 2006 – Oct 2007	Biosignals analysis and its application in a performance setting	(fast-tracked to Ph.D. program)
Audet, Samuel†	2005-2007	Shadow Removal from Multi-Projector Displays via Three-Dimensional Modeling and Object Tracking	Deeplearning4j (Skymind), Tokyo, Japan
Wozniewski, M.	2003-2006	A framework for interactive three-dimensional sound and spatial audio processing in a virtual environment	research engineer, Societé des arts technologiques, Montreal
Rudzicz, Frank§	2004-2006	CLAVIUS: Understanding Language Understaing in Multimodal Interaction	Associate Professor, University of Toronto (status) and Dalhousie University
Rioux, Francois†	2003-2005	Software Framework for Parsing and Interpreting Gestures in a Multimodal Virtual Reality Context	Ph.D., Laval; Software Architect, Thales Canada
Chan, Siu-Chi	2002-2005	Hand and Fingertip Tracking for Gesture Recognition	Technical Staff, AMD Toronto
Hilario, Nadia§	2002-2005	Occlusion Detecion in Front Projection Environments	Software Developer, Spiria

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Name	**Period**	**Thesis title**	**Present Position**
Perez, Michael	2002-2005	Multimodal Human-Computer Interaction for a Public Kiosk System	User Interface Designer, Nuance
Sud, Daniel	2002-2005	Design of a Multi-Projector Display System	Senior Producer, Lucky Hammers
Boussemart, Y.	2002-2005	Design and Implementation of Framework for Immersive Environments in a Shared Context	Chief Technology Officer, Xerxes Global
Pelletier, S.	2001-2003	High-Resolution Video Synthesis from Mixed-Resolution Video Based on the Estimate-and-Correct Method	(see above)
Gu, Jinhua	2000-2002	A distributed software architecture for the Shared Reality Environment.	VP, Radian Asset Assurance Inc., NY
Yao, Jie	2000-2002	Human Arm Gesture Detection and Recognition in a Classroom Environment.	Ph.D. student, Concordia University
Zhang, Yuan	2000-2002	An efficient coding method for spatial data: the rotating, hierarchical, overlapping representation.	Ph.D. student, University of Delaware
Doutriaux, S.	1998-1999	(withdrew in 1999 to launch start-up company)	
Arseneau, S.	1998-2000	Robust Image Segmentation Towards an Action Recognition Algorithm.	(see above)
Xu, Aoxiang	1998-2000	A High-Performance Audiovisual Communication System.	QNX Software Systems, Ottawa

† NSERC PGS M Scholar recipient
†^{C} NSERC CGS M Scholar recipient
§ FRQNT Graduate Scholarship recipient
◇ McCall MacBain Scholar finalist
◇◇ McCall MacBain Scholarship recipient

Additional Masters Supervisory Service

I co-supervised a portion of the thesis work of the following students:

- Marcé, Clément (Jul-Aug 2024), visiting student from INSA (Toulouse)

- Albert, Nicolas (Jan-Jun 2024), visiting student from École Polytechnique Fédérale de Lausanne, Switzerland
- Peña Cortés, Dafne Vania (Nov 2023-present), School of Engineering and Sciences, Tecnológico de Monterrey, Mexico
- Dever, Ani (Sep 2017-Feb 2018), visiting student from Polytechnic University of Turin, Italy
- Gallo, Nicola (Sep 2015-Feb 2016), visiting student from Polytechnic University of Turin, Italy
- Roy, Louise (Jul-Dec 2015), visiting student from Ensimag, Grenoble, France
- Glesser, David (Feb-Jun 2012). visiting student from Ensimag, Grenoble, France
- Penin, O. (Jul-Aug 2011). visiting student from Paris-Sud 11, France
- Mabire, N. (Apr-Sep 2010). visiting student from Supélec, Metz, France
- Brulé, M. (Feb-Aug 2009). visiting student from Université de Louis Pasteur, Strasbourg, France
- Anlauff, J. (Dec 2008-Mar 2009). visiting student from Bielefeld University, Germany
- Delattre, G. (Apr-Aug 2007). visiting student from Université Paris VI, France

I served on the supervisory and/or examination committees of the following students:

- Zhonghao Zhao (M. Eng. project), Electrical and Computer Engineering, McGill University
- Anne-Marie Burns, Faculty of Music, McGill University
- Frank Riggi, Electrical and Computer Engineering, McGill University
- Eric Benzacar, Electrical and Computer Engineering, McGill University
- Oles Protsiym, Faculty of Music, McGill University

Funding

Individual Research Grants and Contracts

Date	Source	Amount	Title/Description
2024-2029	NSERC	$275,000	*Multimodal information communication to overcome environmental, sensory, and computer mediation limitations* Discovery grant
2024	HBHL/ HumanWare	$270,867	*Advancing IMAGE Support for the HumanWare/APH Monarch* Healthy Brains, Healthy Lives (CFREF) + McGill I+P with partner organization HumanWare
2024-2025	MEDTEQ/ NSERC	$268,115	*Improving Intelligibility of Speech in Noisy Environments* MEDTEQ Partenar-IA and NSERC Alliance funding
2023	Humanware	$33,600	*Prototype experience for IMAGE content on the Monarch* Research contract
2023-2024	MEDTEQ/ HBHL	$282,188	*Haptic devices for conveying non-textual visual information on the internet for individuals with vision loss.* MEDTEQ Partenar-IA (Ministère de l'Économie, de l'Innovation et de l'Énergie) and Healthy Brains, Healthy Lives (CFREF)
2022	HBHL	$50,000	*Extending Internet Multimodal Access to Graphical Exploration.* Healthy Brains, Healthy Lives (CFREF) Neuro Commercialization Ignite Grant
2022	Meta	$30,000	Unrestricted gift
2021	Mitacs	$13,333	*Analyse et recherche d'optimisation d'un processus d'adaptation de contenu issu de la numérisation 3D à un contenu photo-réaliste et interactif.* Mitacs Accelerate – Intern: Chen, Hongjun
2021-2022	ISED	$608,594	*Enabling Access to Graphical Image Content Published via the Internet for People Who Are Blind, Deaf-Blind or Visually Impaired.* Innovation, Science and Economic Development Canada (ISED), Accessible Technology Program (Total project budget of $765,787)
2019-2021	NSERC/ MEDTEQ	$374,366	*Mixed-Reality Platform for Simulation and Synthesis of Multi-Modal Hallucinations with Applications to Schizophrenia Treatment.* Collaborative Research and Development Grant with Industrial Partners, iMD Research and IA Précision Santé Mentale
2019	NSERC	$25,000	*360 degree imaging for navigation assistance for the visually impaired.* Engage Grants Program with Industrial Partner, ImmerVision.

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Date	Source	Amount	Title/Description
2019	Mitacs	$15,000	*Advanced sensor control implementations for energy optimization in commercial buildings using machine learning and data visualisation applied to building automation systems.* Mitacs Accelerate – Intern: Demers, Marc
2019	Mitacs	$6,000	*Facilitating Human Interaction with a Robotic Exercise Coach using Smart Objects.* Mitacs Globalink – Intern: Vyas, Preeti
2018	Mitacs	$6,000	*Mobile Remote Implicit Communication.* Mitacs Globalink: Intern: Blum, Jeff
2018	NSERC	$25,000	*Educational wine recommendations from initially sparse data.* Engage Grants Program with Industrial Partner, Wineout Inc.
2017-2018	McGill	$7500	*Physiological confirmation of stimulus reception.* Faculty of Engineering TechAccelR Grant
2017-2020	NSERC	$631,650	*Wearable Haptics.* Collaborative Research and Development Grant with InterDigital Corporation
2017-2018	CIRA	$44,500	*Intelligent Agent for the Visually Impaired: Vision-based scene description and contextual awareness for Autour.* Canadian Internet Registry Authority .CA Community Investment Program
2017-2022	NSERC	$ 222,000	*Multimodal Influences on Perception and Action in Computer-Mediated Environments.* Discovery grant.
2017-2018	MSP	$177,673	*Social Media Monitoring Architecture.* Research Contract with Ministère de la Sécurité publique
2015	CIRA	$53,878	*What's Around Me? Conveying Environmental Awareness to the Visually Impaired Community.* Canadian Internet Registry Authority .CA Community Investment Program
2014-2015	Mitacs	$15,000	*Effect of Mobile Technologies in Emergency Response.* Mitacs Accelerate – Intern: Erfani-Joorabchi, Minoo
2014	NSERC	$25,000	*Haptic user experience delivered through the shoes.* Engage Grants Program with Industrial Partner, InterDigital Canada
2013-2014	NSERC	$137,474	*3D immersive projection infrastructure with full-body motion capture and analysis.* Research Tools and Instruments Grants
2012-2013	Mozilla	$50,000	*Real-Time Emergency Response.* Mozilla Ignite Development Challenge (in partnership with the National Science Foundation)
2012-2017	NSERC	$210,000	*Improved Shared Reality for Multi-Party, Multimodal Simulation and Interaction.* Discovery grant.

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Date	Source	Amount	Title/Description
2012	Toyota	$30,000	*Haptic interaction with an augmented steering wheel.* Toyota Infotechnology Centre
2011	HP	$60,950	*Capturing attention via spatialized audio cues.* HP Labs Innovation Research Program (IRP)
2011	NSERC	$25,000	*Improved Parallax Barrier Autostereoscopic Display Software.* Engage Grants Program with Industrial Partner, Holoptick Technologies Inc.
2010-2011	Google	$50,000	*A Spatialized Audio Map System for Mobile Blind Users.* Google Faculty Research Awards.
2010-2011	Honda	$30,000	*Facial Expression Recognition for Machines.* Honda Research Institute.
2010	UVic	$8,000	*NEPTUNE Pleora streamer.* University of Victoria software license
2008-2012	MDEIE	$367,195	*Natural Interactive Walking.* Support for International Research and Innovation Initiatives, Ministère du Développement économique, de l'Innovation et de l'Exportation; for Canadian participation in EU FP-7 program with partners in France, Italy, and Denmark.
2007-2010	MDEIE	$15,000	*Un environment virtual pour la création de musique et de son à partir de systèmes chaotiques.* Support for International Research and Innovation Initiatives, Ministère du Développement économique, de l'Innovation et de l'Exportation.
2006-2009	NSERC	$317,785	*A pervasive multi-user augmented space for mobile immersive interaction with sound and music.* (additional funding for artist collaborator received from Canada Council for the Arts) New Media Initative STPGP 337999-06.
2006-2011	NSERC	$100,000	*Enhanced video for shared reality environments.* Discovery grant.
2004-2006	NSERC	$136,600	*Soundscape performance works via interactive environment for immersive audiovisual scene generation.* (additional funding for artist collaborator received from Canada Council for the Arts) New Media Initative NMIPJ 307934-04.
2002-2006	NSERC	$100,000	*Shared Reality Interaction over High Bandwidth Connectivity.* Discovery grant.
2000	LUB	$100,000	*Distributed Visualization Environment.* Laboratoire universitaire Bell Equipment Grant.

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Date	Source	Amount	Title/Description
1999-2000	Petro-Canada	$20,500	*Interactive Web Tools for Critique of Presentation Skills and Evaluation of Student Learning.* Young Innovator Award.
1999-2002	FCAR	$45,000	*Augmenting an Electronic Classroom for Improved Instructor-Student Interaction.* New Researchers Award.
1999	FCAR	$15,700	*Augmenting an Electronic Classroom for Improved Instructor-Student Interaction.* Equipment Grant.
1999	AES	$25,000	*Multichannel audio over Internet.* Audio Engineering Society.
1999	OSC	$15,000	*Timespace Exhibit.* Ontario Science Center contract.
1999	MFM	$10,000	*Intelligent Classroom tools.* McGill Faculty of Management.
1998-2002	NSERC	$76,000	*Reactive Hospital Environment.* Discovery research grant.
1998	FGSR	$20,000	McGill Graduate Studies and Research Development Fund

Team Research Grants and Contracts

(Percentages refer to my portion.)

Date	Source	Amount	Title/Description
2024	Societé inclusive	$35,000 (?%)	*Perceptions des utilisateurs ayant une déficience visuelle concernant l'utilisation des électroménagers et la nécessité d'améliorer la connaissance ou l'expérience utilisateur pour des innovations futures* Societé inclusive, Programme de recherche participative intersectorielle (with F. Poncet)
2023	Mitacs	$150,000 (70%)	**Avatar Care Provider for Seniors Residences* Mitacs Accelerate (with K. Moffatt)
2022-2025	CRIAQ	$1,318,171 (35%)	†NSERC Alliance with Consortium for Aerospace Research and Innovation of Québec (CRIAQ) *ADvanced Airspace Usability (ADAIR)* (with P. Doyon-Poulin (Poltechnique), Joon Chung (Ryerson), and 6 aerospace industrial partners)
2020-2021	CIRMMT	$1,500	*Agile Seed Funding for *Conveying paralinguistic cues and context while teleconferencing* (with students David Marino, Max Henry and Pascal Fortin)
2017-2018	SSHRC	$199,680 (10%)	†*Real time impact signalling and collective goods* Partnership Development Grant (with R. Janda and 6 co-investigators)
2016-2017	NAKFI	$100,000 (20%)	*Empathy Mirror* National Academies Keck *Futures Initiative* Art and Science, Engineering and Medicine Grant (with B. Korgel and 3 co-applicants)
2015-2018	FRQNT	$182,880 (25%)	†*Étude des modèles d'interactivité humain-robot en réalité mixte afin de réduire l'apparition des troubles musculo-squelettiques en utilisant une cellule de travail hybride* Recherche en équipes (with M. Otis and 6 co-applicants)
2014	Mozilla	$20,000 (90%)	**Augmented Reality Tools for Improved Training of First Responders* Mozilla Gigabit Community Fund (with R. Dearden)
2011	CIRMMT	$10,000 (90%)	**Acoustic Sculptures* CIRMMT Strategic Innovation Fund Award (with A. Olmos and 3 others)
2010-2011	NSERC	$49,815 (90%)	**Novel Portable Treatment Device for Lazy Eye* Idea to Innovation (I2I) Booster (Phase Ib) (with R. Hess)

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Date	Source	Amount	Title/Description
2009-2011	MSG	$200,000 (80%)	**Location-Based Spatialized Audio Interaction for the Blind and Visually Impaired* Programme Appui au passage à la société de l'information (Support for the transition to an information society program), Ministère des Services gouvernementaux (MSG) (with M. Wozniewski and Z. Settel)
2010-2014	CHRP	$327,000 (?%)	*Computational and statistical tools for image guided neurosurgery of brain tumors* NSERC Collaborative Health Research Projects (with L. Collins and 7 others)
2009-2010	CCSIP	$48,000 (4%)	**Digitally Merged Environments* California-Canada Strategic Initiatives Program (with S. Brown, UCSD and 20 co-applicants)
2009-2011	Canarie	$927,648 (40%)	†*Open Orchestra* Network-Enabled Platforms 2 (with J. Roston and W. Woszczyk)
2010-2014	NCE	$23,000,000 (2%)	†*GRAND: Graphics, Animation and New Media* Networks of Centres of Excellence (With K. Booth and 49 others)
2009	DND	$47,500	†*Video-Based Facial Recognition–Algorithm and Demonstration* Department of National Defence Contract (with M. Levine)
2008-2009	NSERC	$120,250 (90%)	**Novel Portable Treatment Device for Lazy Eye* Idea to Innovation (I2I) (with R. Hess)
2008-2010	Canarie	$1,397,758 (7%)	*NEPTUNE: A Platform to Create and Support Ocean Science Virtual Organizations* Network-Enabled Platforms (with B. Pirenne and J. Roston)
2008-2010	Canarie	$2,000,000 (18%)	*Health Services Virtual Organization* Network-Enabled Platforms (with R. Ellaway and 8 others)
2008-2010	NSERC	$196,000 (50%)	**3-D Visualization and gestural interaction with multimodal neurological data* Strategic Projects (with 5 others)
2006-2009	FRQNT	$146,550 (50%)	**Unités agenceables: Reseau d'Environnements Immersifs pour Collaboration à Distance* Recherche en équipes (with X.-W. Sha)
2005-2006	Canarie	$825,000 (50%)	*Undersea Window–High Definition Video Online* Intelligent Infrastructure Program. (with J. Roston)
2005-2006	SAT	$1,276,000 (1%)	*TOT2: Nouveau Territoires de la Création-Diffusion en Réseau* Heritage Canada New Media Research. (M. Savoie, PI)
2004-2006	Canarie	$568,971 (33%)	*Shared Spaces – High Definition Ultra-Videoconferencing* Advanced Applications Program. (with J. Roston)
2003-2004	SAT	$792,082 (1%)	*TOT1: Nouveau Territoires de la Création-Diffusion en Réseau* Heritage Canada New Media Research. (M. Savoie, PI)

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Date	Source	Amount	Title/Description
2002-2005	IRIS	$573,000 (25%)	**Parallel Distributed Camera Arrays for Intelligent Environments* (with J. Clark, S. Fels, R. Vertegaal)
2002-2005	VRQ	$2,180,000 (20%)	*Real-time Communication Of High-res. Multi-sensory Content via Broadband Networks.* Valorisation-Recherche Quebec (with W. Woszczyk and others)
2001-2002	Canarie	$391,000 (30%)	*Remote Video Sign-Language Interpreting.* Advanced Networking Apps. Services & Technologies. (with J. Roston and others)
2000-2002	Canarie	$808,000 (35%)	*McGill Advanced Learnware Project.* Advanced Networking Applications Services and Technologies. (with B. Pennycook)
2000-2003	LUB	$150,000 (50%)	**Distributed Shared Visualization Environment.* Laboratoire universitaire Bell. (with B. Ozell)
2000-2001	Royal Bank	$2,000 (80%)	**Improving Teaching through an Interactive Critiquing System.* Teaching Improvement Fund Award. (with R. Harris and J. Blatter)
1999-2002	CFI	$400,000 (50%)	†*The Shared Reality Environment.* New Opportunities Award. (with J. Clark)
1999-2000	Royal Bank	$10,000 (80%)	**Interactive Web Tools for Critique of Presentation Skills and Evaluation of Student Learning.* TIF (with R. Harris)

*Indicates grants on which I am project leader. †Grant on which I am co-investigator.

Centre Research Grants

Date	Source	Amount	Title/Description
2022-2026	ILLS	$400,000	FRQNT International Laboratory on Learning Systems, funded jointly by CNRS (France) and FRQNT (Quebec), Pablo Piantanida, PI, $100,000 per annum
2021-2028	FRQSC/ FRQNT	$2,712,295	Regroupement Stratégique: *Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie.* (with I. Cossette and 52 others) $276,000 per annum for 2 years and $432,059 per annum for the remainder
2019-2025	FRQNT	$2,160,000	Regroupement Stratégique pour *Systémes cyberphysiques et intelligence machine matérialisée (REPARTI).* (with C. Gosselin and 49 others) $480,000 per annum.
2015	CFI	$4,366,723	Innovation Fund: *Live Expression "in situ": Musical and Audiovisual Performance and Reception* (with M. Wanderley and 9 others)
2014-2021	FRQSC/ FRQNT	$1,800,000	Regroupement Stratégique: *Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie.* (with M. Wanderley and 23 others)
2013-2019	FRQNT	$2,160,000	Regroupement Stratégique pour *l'Étude des Environnements PARTagés Intelligents répartis (REPARTI).* (with D. Laurendeau and 34 others) $359,943 per annum.
2008-2014	FRQSC/ FRQNT	$1,800,000	Regroupement Stratégique: *Centre Interdisciplinaire de Recherche en Musique, Médias et Technologie.* (with S. McAdams and 23 others)
2007-2009	NSERC	$57,630	Major Resources Support: *Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT).* (with S. McAdams and 8 others)
2006-2013	FRQNT	$1,530,000	Regroupement Stratégique pour *l'Étude des Environnements PARTagés Intelligents répartis (REPARTI).* (with D. Laurendeau and 23 others) $100,000 per annum allocated to CIM.
2002-2005	FCAR	$720,000	Regroupement Stratégique: *Réseau Québecois de Recherche en Réalité Artificiellle Distribuée (QUERRAnet).* (with F. Ferrie, R. Bergevin, P. Cohen, and others)
2001	CFI	$6,500,000	Major Facilities Award: *Centre for Integrated Research in Music Media and Technology.* (with W. Woszczyk and 11 others)
2000-2002	FCAR	$113,500	Centre de Recherches. (with F. Ferrie and 17 others)

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Date	Source	Amount	Title/Description
2000	NSERC	$275,000	*Information Systems in Support of Intelligent Machine Research.* (with F. Ferrie and 17 others)

Teaching

Courses Taught

Course title and number	Description	Semester
ECSE-618 *Haptics*	Graduate course on haptic information design, co-taught with other instructors across Canada, under the informal designation of HAPTICS 501	Winter 2021–present
ECSE-421 *Embedded Systems*	Undergraduate course dealing with both the theory and practice of design for embedded systems	2018–present
ECSE-526 *Artificial Intelligence*	Graduate level course in artificial intelligence with emphasis on machine learning and autonomous agents	1998–present
*ECSE-683 *Topics in Vision and Robotics*	Graduate level laboratory course for RoboCup projects	Fall 2000 Fall 2002
*ECSE-424/542 *Human-Computer Interaction*†	Undergraduate (424) and graduate (542) course in human-computer interaction with emphasis on new interface paradigms	2000–present
ECSE-487 *Computer Architecture Laboratory*	Undergraduate laboratory course	1999–2018
ECSE-427 *Operating Systems*	Undergraduate course (core for Computer Engineering students)	1998
CSC-270 *Introduction to Modelling and Optimization*	Computer Science undergraduate course, University of Toronto	1993–1994
CEE 1714Y *Digital Systems and Computers*	Continuing Engineering Education course for the Association of Professional Engineers of Ontario	1993–1994
CSC-228 *File Structures and Data Management*	Computer Science undergraduate course, University of Toronto	1992–1995

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Course title and number	**Description**	**Semester**
COSC-3411 *File Structures and Data Management*	Computer Science undergraduate course, York University	1992

*Indicates new course that I created.
†In 2011, a project from this class placed third in the Usability Professionals Association International Student Design Competition. Note that graduate students have also enrolled in this course under the designation of ECSE-681, *Colloquium in Electrical Engineering* or ECSE-689, *Recent Advances in Electrical Engineering*.

Undergraduate Supervision

ECE Honors Undergraduate Projects (2 semesters)

Name	Year	Research topic
Bu, Bruce	2020	360^o Imaging for Navigation Assistance for the Visually Impaired
Akgul, Ahmet	2017-2018	Haptic Wearables
Bashar, Sharhad	2016-2017	Image-based environment description
Wu, Pei Yuan (Richard)	2016	Mixed-Reality Human-Machine Interaction
Gordon, Adam	2011-12	Virtual Presence
Warraich, Shahjahan	2010-11	Natural Interactive Walking
Lin, Nan	2008	Location sensing for mobile apps
Wang, Letao	2007	Interactive Agent
Charlebois, Pierre-Olivier	2004–2005	Sound Objects in a Soundscape
Myer, Sam	2003	Automated Music Transcription
El-Refaei, Sameh	1998–1999	Shared Reality simulator

ECE Undergraduate Design Projects (2 semesters)

Name	Year	Research topic
Archambault, Roxanne	2024-2025	Holoportation: CSA VR Astronaut Training
Dejanov, Aleksej	2024-2025	Holoportation: CSA VR Astronaut Training
Nguyen, Anh Tu	2024-2025	Holoportation: CSA VR Astronaut Training
Turianskyj, Alex	2024-2025	Holoportation: CSA VR Astronaut Training
Lu, Yu-An	2024-2025	AI Digital Nurse Avatar (ADiNA)
Chowdhury, Nazia	2024-2025	AI Digital Nurse Avatar (ADiNA)
Hall, Allison	2024-2025	AI Digital Nurse Avatar (ADiNA)
Gouchee, Annie	2024-2025	AI Digital Nurse Avatar (ADiNA)
Ajji, Maya	2024	AI Digital Nurse Avatar (ADiNA)
Rahman, Nafis	2024	AI Digital Nurse Avatar (ADiNA)
Wang, Jingyi	2024	AI Digital Nurse Avatar (ADiNA)
Zhang, Rong Wei	2024	AI Digital Nurse Avatar (ADiNA)
Srivastava, Atreyi	2024	AI Digital Nurse Avatar (ADiNA)
Ktaily, Nour	2024	AI Digital Nurse Avatar (ADiNA)
Bansal, Pratham	2024	AI Digital Nurse Avatar (ADiNA)
Cattani, Alex	2024	AI Digital Nurse Avatar (ADiNA)
Wang, Bohan	2024	Cybersight
Feng, Shuzhao	2024	Cybersight
Tian, Steven	2024	Cybersight
Wang, Yiqiao	2024	Cybersight
Bebee, Lukas	2023-2024	Force-feedback experiences for IMAGE

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Name	**Year**	**Research topic**
Alexander Tsahageas	2023-2024	Force-feedback experiences for IMAGE
Emma Kawczynski	2023-2024	Force-feedback experiences for IMAGE
Massimo Rosati	2023-2024	Force-feedback experiences for IMAGE
Gurhan, Eren	2023-2024	Vision-guided Navigation Assistance
Yan, Ke	2023-2024	Vision-guided Navigation Assistance
Calitoiu, Mihail	2023-2024	Vision-guided Navigation Assistance
Park, John	2023-2024	Vision-guided Navigation Assistance
Hu, David	2023	Vision-guided Navigation Assistance
Gasmi Ilyes	2023	Vision-guided Navigation Assistance
Habelrih Edward	2023	Vision-guided Navigation Assistance
Arabian Ari	2023	Vision-guided Navigation Assistance
Fathi, Saab	2023	Avatar therapy for psychosis
Ham, Sia	2023	Avatar therapy for psychosis
Choi, Myunghoon	2023	Avatar therapy for psychosis
Kruchinski Almeida, Martin	2023	Avatar therapy for psychosis
Kabir, Anika	2023	Chatting with historical figures
Huynh, Vy-Kha	2023	Chatting with historical figures
Solaberrieta, Emilia	2023	Chatting with historical figures
Cui, Bowen	2022-2023	Immersive multimodal CAVE experience
El Haddad, Georges	2022-2023	Immersive multimodal CAVE experience
Fazal, Gohar Saqib	2022-2023	Immersive multimodal CAVE experience
Mahajan, Madhav	2022-2023	Immersive multimodal CAVE experience
Pan, Edwin	2022-2023	Touching faces in VR
Gosman, Mircea	2022-2023	Touching faces in VR
Justin, Legrand	2022	Vision-guided Navigation Assistance
Sen, Wang	2022	Vision-guided Navigation Assistance
Chamberland, Noah	2022	Vision-guided Navigation Assistance
Natchev Keanu	2022	Novel digital representation of sign language
Arabian Matthias	2022	Novel digital representation of sign language
Destiné, Maxens	2022	Novel digital representation of sign language
Jarvis, Thomas	2022	Natural Dialog Generation for Mental Health
Kong, Norman	2022	Natural Dialog Generation for Mental Health
MacNaughton, Ben	2021-2022	plots data parsing for IMAGE project
Williams, Aidan	2021-2022	plots data parsing for IMAGE project
Nunez, Matteo	2021-2022	Foot-fluid interaction simulation in mobile VR
Comeau, Francis	2021-2022	Foot-fluid interaction simulation in mobile VR
Gure, Kaan	2021-2022	Foot-fluid interaction simulation in mobile VR
Calin, Haluk	2021-2022	ML-based Navigation Assistance
Cano, Victor	2021-2022	ML-based Navigation Assistance
Das Sharma, Kaustav	2021-2022	ML-based Navigation Assistance
Dufault, Louca	2021-2022	ML-based Navigation Assistance
Simard, Felix	2021	detecting benevolent sexism in text
Watson, Tyler	2021	detecting benevolent sexism in text

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Name	**Year**	**Research topic**
Porporino, Anthony	2021	detecting benevolent sexism in tex
Bourbeau, Charles	2021	detecting benevolent sexism in text
Ko, Neroli	2020-2021	haptic dance shoes
Zwack, Noah	2020-2021	haptic dance shoes
Zhang, Weijing	2020-2021	haptic dance shoes
Szwimer, Benjamin	2020-2021	visually impaired access to web graphics
Zoltak, Matthew	2020-2021	visually impaired access to web graphics
Itovitch, Ethan	2020-2021	visually impaired access to web graphics
Weiss, Ben	2020-2021	mixed-reality for schizophrenia treatment
Bieber, Nicolas	2020-2021	mixed-reality for schizophrenia treatment
Khan, Marwan	2020-2021	360^o imaging for navigation assistance
Johansen, Anthony	2020-2021	360^o imaging for navigation assistance
Gurkan, Mert	2020-2021	360^o imaging for navigation assistance
Warsi, Osman	2020-2021	360^o imaging for navigation assistance
Lague, Ethan	2019-2020	AR firefighter situational awareness tools
Masciotra, Alex	2019-2020	AR firefighter situational awareness tools
Philippon, Thomas	2019-2020	AR firefighter situational awareness tools
Bouchard, Tristan	2019-2020	AR firefighter situational awareness tools
Smith, Babette	2019-2020	AR and 360: camera-mediated future
Smith, Lilith	2019-2020	AR and 360: camera-mediated future
Chen, Jennie	2019-2020	Foot-fluid interaction simulation in mobile VR
Servera, Ryan	2019-2020	Foot-fluid interaction simulation in mobile VR
Wong, Tyrone	2019-2020	Foot-fluid interaction simulation in mobile VR
Bluethner, Lucas	2019-2020	Foot-fluid interaction simulation in mobile VR
Volodina, Yuliya	2019	360^o camera scene understanding
Ritch, David	2019	360^o camera scene understanding
Lam, Guillaume	2019	360^o camera scene understanding
Nasseem, Veronica	2019	360^o camera scene understanding
Amjad, Adeeb Ibne	2019	360^o camera supported intersection-crossing
Amarouche, Hakim	2019	360^o camera supported intersection-crossing
Tang, James	2019	360^o camera supported intersection-crossing
Commodari, Stefano	2019	360^o camera supported intersection-crossing
Regimbal, Juliette	2019	Haptic Wearables
Radi, Nusaiba	2019	Haptic Wearables
Berman, Isaac	2018	Vision-based crossing assistance
Mashaal, Stuart	2018	Vision-based crossing assistance
Liu, Shi Yu	2018	Vision-based crossing assistance
Legrand, Augustin	2018	Force Feedback for VR and AR
Fournier, Clément	2018	Force Feedback for VR and AR
Nith, Romain	2018	Force Feedback for VR and AR
Malik, Numan	2017-2018	Variable-Friction Surface Mechanism
Eshaq, Yousef	2017-2018	Variable-Friction Surface Mechanism
Alalawi, Beshr	2017-2018	Variable-Friction Surface Mechanism

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Name	**Year**	**Research topic**
Ahmed, Ridwan	2017-2018	Variable-Friction Surface Mechanism
Nichyporuk, Brennan	2017-2018	AI/vision-based Q&A Dialogue
Benseler, Nick	2017-2018	AI/vision-based Q&A Dialogue
Karatzas, Thomas	2017-2018	Wine recommendation engine
Zhilin, Oleg	2017-2018	Wine recommendation engine
Simard-Morissette, Olivier	2017-2018	Wine recommendation engine
Mirfallah Liarestani, N.	2017	Autour
Kim, Yong Beom	2017	Autour
Gibeault-Girard, Gabriel	2017	AR firefighter display
Velastegui, Nicolas	2017	AR firefighter display
V Cama, Carmen Aimee	2017	AR firefighter display
Dermont, Daniel	2016-2017	Haptic shoes
Makriogiorgos, A.	2016-2017	Haptic shoes
Rohlicek, Greg	2015-2016	Mobile telepresence
Carter, Stephen	2015-2016	Mobile telepresence
Zhang, Zhaowei	2015-2016	Haptic shoes
Huynh, Alex	2015-2016	Haptic shoes
Guzman, Juan	2015-2016	Video analytics
Ali, Hassan	2015-2016	Video analytics
Macario, Daniel	2015-2016	Automated event detection
Arané, Yarden	2015-2016	Automated event detection
Leighton, Brett	2015-2016	Automated event detection
Aird, Nicholas	2015-2016	AR firefighter display
Chen, Yuechuan	2015-2016	AR firefighter display
Lei, Simon	2015-2016	AR firefighter display
Mendonca, Justin	2015-2016	Firefighter IPS
Asfour, Justin	2015-2016	Firefighter IPS
Ward, Thomas	2015-2016	Firefighter IPS
Laramée, Alexandre	2015-2016	Firefighter IPS
Sahib, Shivan	2015-2016	Biosignal wearables
Nath, Saptaparna	2015-2016	Biosignal wearables
Bramson, Shawn	2013–2014	Mobile Telepresence
Larose, Andrew	2013–2014	Mobile Telepresence
Dirik, Alize	2013–2014	Mobile Telepresence
Mansour, Rita	2013–2014	Walking Straight
Elkerdi, Ghalia	2013–2014	Walking Straight
Redel, Josh	2012	Augmented Meeting Collaboration
Savchenko, Eugene	2010	3D interaction

ECE Undergraduate Design Projects (1 semester)

Name	Year
Himmelman, Tristan	2009
Ephraim, Theo	2009
Peck, Benjamin†	2008
Mankarios, Daniel	2007
Konstantinidis, Alex	2007
Pufahl, David	2005
Zhu, Ming-Zhang	2005
Chan, Keng Chi	2005
Phan, Andrew	2004
Saifee, Ali-Akber	2004
Shield, Robert	2004
Aubé, Francois	2004
Rudzicz, Frank	2003
Sarikaya, Deniz	2002
Vallianatos, K.	2002
Hassaine, Sofiane	2002
Wyse, Marisa	2001
Bancroft, David	2001
Glass, Emily	2001
Asselin, Ramy	2001
Sud, Daniel	2001
Gapakov, Timofei	2001
Rosenblatt, Avi	2001
Pekofsky, Gregory	2001
Kitisa, Anousack	2000
Vial, Thibaut	2000
Bernier, Martin	2000
Agha, Khurram Z.	2000
Bhattacharya S.	2000
Lavery, William	2000
Yeung, Jason	2000
Liao, Yuan Mei	1999
Yee, Amy	1999
Pereira, David	1999
Ciambella, Gary	1999
Kassouf, Nadim	1999
Lee, Garvin	1999
Li, (Shao-Gi) Chris	1999
El-Sharif, Osama	1999
Nasereddin, Hazem	1999
Virdi, Gurpratap	1999
Shah, Ali	1999
Djihanian, Sylvie	1999
Moussaoui, Khaled	1999
Dib Youssef	1999
Tam, H.	1999
Gagnon, Gabriel	1999
Tjhin, P.	1999
Luong, Mai	1999
Lau, Sau	1999
Tsai, Wanti	1999
Lerner, Sorin*	1999
Hochstein, Lorin*	1999
Pollack, Jonathan	1998
Nguyen, Bau	1998

*Co-supervised with James Clark
†Co-supervised with Paul Kry

Computer Science Undergraduate Projects (1 semesters)

Lakhwani, Sanjeev	Sep–Dec 2024	Musical Telepresence
Kandlikar-Bloch, Mira	Jun–Aug 2024	AI Digital Nurse Avatar
Gostovic, Lilith	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Newman, James	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Song, Juyeon Olivia	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Chowdhury, Shadman	Jan– Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Liang, Tina	Jan– Apr 2024	Integrating Attention Detection with Human-Avatar Interaction
Nejad, Namdar	2022	Improving Accessible Representations of Web Graphics
Li, Dailun	2022	Training and Testing an Open-Source French TTS Model

Bioengineering Undergraduate Research Projects (1 semesters)

Wang, Angela	Sep–Dec 2024	Characterizing comfort of wearable band tightness

Mechanical Engineering Undergraduate Design Projects (2 semesters)

Sadaqa, Abdel-Rahman	2020-2021	Haptic illusions
Waite, Emilie	2020-2021	Haptic illusions
Shi, Rock	2020-2021	Haptic illusions
Fitz-Gerald, Thomas	2020-2021	Haptic illusions
Pollet, Nathan	2020-2021	Multimodal haptic armrest
Uzan, Emanuel	2020-2021	Multimodal haptic armrest
Ruivo Patricia	2020-2021	Multimodal haptic armrest
Abravanel Tal	2020-2021	Multimodal haptic armrest
Fowo, Clovis	2017-2018	Haptic interface for the feet
Robert, Gabrielle	2015-2016	Variable friction shoe
King, Michael	2013-2014	Variable Friction Foot-Ground Contact

Undergraduate Internships

Name	Year	Research project
Raza, Abbas	2024	(NYU Abu Dhabi research grant intern) Comparing speech and text interactions with automation in the cockpit
Castrillon Acosta, Isabel	2024	(Mitacs Globalink) Transforming speech into vibrations
Adnaan, Mohammad	2024	(Mitacs Globalink) Autonomous Navigation Assistance for the Visually Impaired
Mandampully, Samyuktha	2024	(Mitacs Globalink) Internet Multimodal Access to Graphical Exploration (IMAGE)
Lu, Calla	Jan–Apr 2024	Visualizing Chronic Pain with Artificial Intelligence
Sarellano, Andrés	Sep– Dec 2023	(Tec de Monterrey Undergraduate Research Trainee) Social Telepresence
Moreno Piedra, Balthazar	Sep– Dec 2023	(Tec de Monterrey Undergraduate Research Trainee) Social Telepresence
Tomiuk, Emma	2023	(ARIA Intern) Musical Telepresence
Gunatilaka, Movinya	2023	(Mitacs Globalink) Musical Telepresence
Lavoie, Gabrille	2023	(research trainee) Internet Multimodal Access to Graphical Exploration (IMAGE)
Bessonov, Vladimir	2023	(research trainee)
Phan Antoine	2023	(SURE student) Internet Multimodal Access to Graphical Exploration (IMAGE)
MacInnes, Gabrielle	2023	(SURE student) Internet Multimodal Access to Graphical Exploration (IMAGE)
Abderrahim, Ons	2023	(Mitacs Globalink) Autour
Glavas, Theodore	2023	(NSERC USRA) ChatGPT-based health assistants
Li, Hanzi	2022	(CS Intern) Internet Multimodal Access to Graphical Exploration (IMAGE)
Gutiérrez, Diego Macias	2023	(Mitacs Globalink) Haptic dance shoes
Cortes, Dafne Peña	2023	(Tec de Monterrey Undergraduate Research Trainee) Internet Multimodal Access to Graphical Exploration (IMAGE)
Shen, Xing	2022	(ECE Intern) Vision-Guided Navigation Assistance
Dutta, Riana	2022	(NSERC USRA) Internet Multimodal Access to Graphical Exploration (IMAGE)
Pan, Edwin	2022	(SURE Student) Touching Face in VR
Chen, Hongye	2022	(ECE Intern) Internet Multimodal Access to Graphical Exploration (IMAGE)

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Name	**Year**	**Research project**
Behal, Rahul	2021-2022	ML-based Navigation Assistance for the Visually Impaired
Rao Appala, Siddharth	2021	(Mitacs Globalink) Making internet graphics accessible through rich audio and touch
Contreras, Luis F. H.	2021	(Mitacs Globalink) Haptic device for sensory re-education application
Bhayana, Rachit	2021	(NSERC USRA) Conveying Paralinguistic and Non-Verbal Cues in Teleconferencing
Reszetnik, Grace	2021	(NSERC USRA) Avatar therapy for psychosis
Jiang, Cecilia	2021	(NSERC USRA) Avatar therapy for psychosis
Radi, Rakshitha	2021	(ECE Intern) Assistive Technology Project
Marshall, Kenji	2020-21	(ECE Intern) Avatar therapy for psychosis
Pollet, Nathan	2020	(SURE Student) 360^o camera imaging
Bu, Bruce	2019	(SURE Student) Haptic Wearables
Chen, Jennie	2019	(SURE Student) Haptic Wearables
Zhang, Yukai	2019	(SURE Student) Haptic Wearables
Ratnakirti, Navneet	2019	(SURE Student) Sweatsponse
Al Taha, Feras	2018-2019	(NSERC USRA) Haptic Wearables
Nunez, Matteo	2018	(SURE Student) Haptic Wearables
Huang, Yixiang	2018	(SURE Student) Non-Intrusive Mobile Experience Sampling
Li, Zihang	2018	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array
Kaoubi, Hadir	2018	(Mitacs Globalink) Autour: "What's around me?"
Ma, Jiantong	2018	Haptic Zoom
Tran, Jessica	2017	Social Media Monitoring
Xing, Emily	2017	Attention Switching Protocols in Family Conversations
Hao, Ju	2017	(Mitacs Globalink research intern) Haptic shoes
Lisus, Daniil	2017	(NSERC USRA) Natural Interactive Walking
Tran, Andrew	2016-2017	Multimodal CAVE integration
Sun, Nan Jin (Kelly)	2016-2017	Multimodal CAVE integration
Liu, Yufei (Kevin)	2016	Flexible graphical display of foot-ground interactions
Kashyap, Sumeha	2016	(Summer Intern from Indian Institute of Technology Guwahati) Walking Straight Project

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Name	**Year**	**Research project**
Hamed-Baghi, Bobak	2016	(SURE Student) Game Interaction for Haptic Shoes
Dubé, Felix	2016	(SURE Student) Haptic Shoes
Yang, Yanzhe	2015	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array
Morency-Trudel, Juan	2015	(NSERC USRA) Spatialized audio for environmental awareness for the visually impaired
Liu, Bei Chen	2015	(SURE Student) Haptic in-sole design and implementation
Liu, Shuxuan (Dennis)	2015	Multimodal CAVE integration
Chaudhary, Yetesh	2014	Communication in Emergency and Crisis Response
Pavlasek, Jana	2014	(NSERC USRA) Natural Interactive Walking
Jiang, Mike	2014	(IAESTE student trainee) Graphics Rendering for Multimodal CAVE
Yin, Guofan	2014	(Mitacs Globalink) Enhanced Remote Viewing Capabilities from a Camera Array
Murgai, Prateek	2014	Acoustic Signal Processing
Sharma, Alok	2013-14	(BITS India Student) rt Emergency Response
Gupta, Sakshi	2013	(SURE Student from Indian Institute of Information Technology, Jabalpur) In-Situ Audio Services
Brais, Robert	2013	(NSERC USRA) Natural Interactive Walking
Gourdy, Oriane	2013	(Grenoble INP Student) 3DUI Interaction
Jain, Nehil	2011-12	(BITS India Student) In-Situ Audio Services
Sutcliffe, Andrew	2011	Haptically Augmented Steering Wheel
Greencorn, Dan	2011	Food Analysis Simulation
Redel, Josh	2011	Open Orchestra
Varenne, Dylan	2011	(Polytech Nice-Sophia), In-Situ Audio Services
Tomiyoshi, Marcio	2011	(ELAP Scholarship Student) Open Orchestra
Beniak, Stephane	2010	(NSERC USRA) Natural Interactive Walking
Salenikovich, Stepan	2010	Natural Interactive Walking
Chaw, Gary	2010	Natural Interactive Walking
Redel, Josh	2010	Health Services Virtual Organization
Smith, Severin	2009-11	Natural Interactive Walking

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Name	**Year**	**Research project**
Rajalingham, Rishi	2009	(NSERC USRA) Natural Interactive Walking
Rener, Farid	2009	(SURE Student) Natural Interactive Walking
Bae, Sung	2009	Optical Tracking for Audio Graffiti
Jathal, Kunal	2007	Haptic and auditory perception in human walking
Lin, Nan*	2006	(NSERC USRA) Interactive navigational control of robotic wheelchair
Reiter, Philippe	2005	(VP USRA Student) Distributed Video Rendering
Ariane Chan-You	2003	Region-of-Interest Control in Videoconferencing
Ariane Chan-You	2002	Videoconferencing Data Reduction
Gupta, Greeshma	2000	(NSERC Student) Automated slide converter
Cote, Christian	2000	(NSERC Student) Video transformations
Ayatizadeh, Negah	2000	Network communication daemons
Swartz, Tanya	2000	Speech-based TV-tuner interface
Cohen, Ouri	2000	Classroom 2000 access control
Yeong, Jason Aw	1999	(Work Study) Previously Asked Questions system
Agha, Khurram Zubair	1999	(Work Study) URL access tracking
Lim, Weoi Peng	1999	(Work Study) Graffiti board
Agha, Haroon Ali	1999	(Work Study) Classroom 2000 minipres. system
Klinger, Zamir	2000	(NSERC Student) Automated Door Attendant
Hooshangi, Sara	2000	(NSERC Student) Intelligent Classroom
Liao, Yuan Mei	1999	Electronic Classroom control interfaces
Luo, Jiexin	1999	PowerPoint C2000 interface and image libraries
Zhao, Changpeng	1998-99	Seamless PowerPoint upload for Classroom 2000
Lakdawalla, Azeem	1998-99	Real-time conjugate-gradient based head-tracking

*Co-supervised with Joelle Pineau

Service

University Service

Department Committees

2024-2025	Department Search Committee
2024-2025	Professional Advancement and Recognitions Committee
2020-2022	ECE Unit Lab Access Committee
2017-2018	Undergraduate Recruitment Committee, Chair
2017-2020	Search Committee (Software Engineering, Artificial Intelligence)
2017-2018	Tenure Committee
2015-2025	Safety Committee (Chair in 2015-2017)
2014-2016	Grant Application Support Committee
2012-2024	Graduate Committee
2008-2012	Undergraduate Recruitment Committee
2005-2011	Scholarships/Graduate Student Financing Committee
2002	Ad hoc Committee on Computing Infrastructure for ECE/SOCS
2000-2008	College Liaison Comittee
2001-2004	Information Technologies & Undergraduate Lab
2000-2002	Curriculum Committee
2000	Software Engineering subcommittee
2000-2007	Undergraduate Student Advisor

Other University Service

2024	Chair's representative, Biomedical Engineering PhD Committee meeting
2024	Faculty Mentor, McGill Biomechanics Club
2022-2024	Research Axis Co-lead and Member of CIRMMT Executive Committee
2014-2016	Elected Member of Council, McGill Association of University Teachers
2009-2013	Research Axis Co-lead and Member of CIRMMT Executive Committee
2007-2013	Co-chair, Multimodal Immersive Systems research axis, CIRMMT
2006-2008	Member, CIRMMT Board of Directors
2006	Advisory Committee for Dean of Music
2004	Tomlinson University Science Teaching Project adjudication
2003-2004	Royal Bank Teaching and Learning Innovation Fund adjudication
2003	Groupe de travail sur les normes et standards de la formation en ligne. Conférence des recteurs et des principaux des universités du Québec (CREPUQ), McGill University Representative
2002-2003	SC-IST Workgroup on Research Computing
2000-2003	SC-IST Workgroup on Classroom Design
1999-2004	Engineering Committee on Teaching and Learning
1999	SC-IST McGill Machine Project
1998	Workgroup on Educational Technology

Fundraising Activities

2002	RoboCup demonstration at McCord museum for Dean's Circle
2002	Corporate fundraising for McGill RoboCup team
2001-2002	Intelligent Classroom promotion with the Engineering Class of '50; helped raise $274,000
2001	Trottier Building research promotion

Other Activities

2007-2010	Promotion of Academic Integrity
2001-2002	Design of new Intelligent Classroom systems for ENGMC 304
1999-2002	Maintenance of the Intelligent Classrooms, training other faculty in use of the technology
1999	Curriculum development of three new courses in software engineering

Professional Activities

Service to the Community

2023-2024	Local Events Organizer, 2024 IEEE Cognitive and Computational Aspects of Situation Management (CogSIMA)
2023	Sponsorship and Exhibits Co-Chair, 2024 IEEE Haptics Symposium
2019	Government of Canada, Network of Canadian Experts on Virtual Reality
2018	Consulted by Ordre des ingénieurs du Québec regarding the OIQ's position on AI
2018	Invited Member, Fonds de recherche, Chantier sur l'intersectorialité et la créativité
2018	Co-chair, ACM SIGCHI Demonstrations
2017	External member of academic selection committee, École de technologie supérieure
2016	Organizing Committee, IEEE International Workshop on Multimedia Signal Processing, Special Session on Multimodal Interaction with Digital Information in Smart Cities
2016,2019	Selection Committee, Bill Buxton HCI Thesis Award
2016	Digital Media Program Review, York University
2016	Critique of TCPS CORE Tutorial on Research Ethics (Secretariat agreed to remove problematic question associated with the Zimbardo study)
2010-2015	Theme Leader, Enabling Technologies, Graphics Animation and New Media (GRAND) Networks of Centres of Excellence
2010-ongoing	Voting Member, IEEE Communication Society Multimedia Communications Technical Committee (IEEE MMTC)
2009	Organizer and Chair, AES Workshop on Network Technologies for Audio over IP
2008	Tenure Portfolio evaluation, York University
2005-2006	Organizer, AES Tutorial and Workshop on Human Factors in Audio
2004	Founder, AES Technical Committee for Human Factors in Audio Systems
2003	Organizer, Workshop on LAN Delivery of Audio for AES
2002-2003	Comité Scientifique de Robofolies, Centre Science de Montreal
2001	Local Events Organizer, Autonomous Agents Conference, Montreal
2001-2009	Chair, AES Technical Committee for Network Audio Systems
2000-2004	Scientific Organizer, RoboCup Junior, Montreal
2000-2001	Organizing Committee, Robofesta International Robot Games Festival, Japan
1999-2000	Member and Webmaster, Canadian Virtualized Reality Working Group
1998	Co-organizer, AAAI Symposium on Intelligent Environments

Editorial Service

2025-ongoing	Associate Editor-in-Chief, IEEE Transactions on Haptics
2021-2024	Associate Editor, IEEE Transactions on Haptics
2021	Senior Program Committee, International Conference on Multimodal Interaction
2021	Guest Editor, IEEE Transactions on Haptics (WHC track)
2020-ongoing	Associate Editor, Frontiers in Virtual Reality
2019, 2025	Associate Editor, World Haptics Conference
2019	Guest Editor, Multimodal Technologies and Interaction, Special Issue on Multimodal Medical Alarms
2018-2022	Associate Editor, Program Committee member, Haptics Symposium
2013	Guest Editor, Journal of the Audio Engineering Society, Special Issue on Audio Networking
2008-2022	Associate Editor, Journal of the Audio Engineering Society

Journal Referee

2025	Springer Nature Discover Computing
2022	IEEE Multimedia
2021	ACM Transactions on Human-Computer Interaction
2020-21	ACM Transactions on Applied Perception
2020	ACM Interactive, Mobile, Wearable and Ubiquitous Technologies
2019	Frontiers in Neurobotics
2018	Peer J–Journal of Life & Environmental Sciences
2017	Sensor Review
2015	Ambient Intelligence and Smart Environments
2010-20	IEEE Transactions on Haptics
2012	International Journal on Acoustics
2011	BMC Medical Informatics and Decision Making
2011	IEEE Software
2010	IEEE Transactions on Affective Computing
2010	IEEE Transactions on Robotics
2010	IEEE Signal Processing Magazine
2009	IEEE Transactions on Robotics
2008	EURASIP Advances in Signal Processing
2008	EURASIP Image and Video Processing
2008-ongoing	Audio Engineering Society
2007	IEEE Transactions on Systems, Man, and Cybernetics
2006	International Journal of Human-Computer Interaction
2006	Springer Virtual Reality
2005	Elsevier: Computers and Education
2005	Elsevier: Image and Vision Computing
2004, 2019	IEEE Pervasive Computing
2000, 2003	Wiley Journal of Robotic Systems
1999	ACM Transactions on Computer-Human Interaction
1999	IEEE Transactions on Robotics and Automation
1998	IEEE Personal Communications

Conference Review

2024	IEEE Conference on Cognitive and Computational Aspects of Situation Management (CogSIMA)
2023	ACM/IEEE Human-Robot Interaction
2020	IEEE Virtual Reality
2018, 2020, 2024	ACM SIGCHI User Interface Systems and Techniques
2018	Workshop on Assistive Computer Vision and Robotics
2018	Eurohaptics
2017	International Conference on Auditory Display
2017	Mobile HCI
2017-19	IEEE World Haptics
2016	IEEE International Workshop on Multimedia Signal Processing
2015	ACM Multimedia
2015	INTERACT
2014	ACM SIGGRAPH
2012, 2013	Workshop on Context Based Affect Recognition
2012, 2013	International Society for Presence Research
2012	IEEE Canadian Conference on Electrical and Computer Engineering
2011	AES Conference on Audio Networking
2011	Intelligent Robots and Systems
2011	VRIC Wkshop on Haptics for Telepresence, Teleoperation & Collab. Environments
2009	IEEE Haptics Symposium
2009	International Computer Music Conference
2009	Stereoscopic Displays and Applications
2008-19	ACM SIGCHI Human Factors in Computing
2008	Immersive Medical Telepresence
2006	International Conference on Digital Audio Effects
2006, 2007	IEEE Workshop on Projector-Camera Systems (part of CVPR)
2005-2009	Canadian Conference on Computer and Robot Vision
2004, 2009-14, 2016	Graphics Interface
2003, 2006	Audio Engineering Society
2003	New Interfaces for Musical Expression
2002	RoboCup International Symposium
2002, 2015	IEEE International Conference on Robotics and Automation
2001	ACM UbiComp
2001	IEEE International Conference on Computer Vision

Grant Review

2017	NSERC Strategic Project Grants
2017	Member of Expert Committee, CFI Innovation Fund
2016	L'Agence Nationale de la Recherche (France)
2011	NSERC Collaborative Research and Training Experience Program (CREATE)
2009, 2011	Mathematics of Information Technology and Complex Systems (MITACS)
2009	NSERC Strategic Networks (Site Visit Chair)
2008, 2015, 2017	Peer review, NSERC Collaborative Research and Development Grants
2007-2008	NSERC Industrial Research Chair (Site Visit)
2007-2020	Research Grants Council, Hong Kong
2005	NSERC Steacie Memorial Fellowship
2002, 2005-2008	Panel member, NSERC/Canada Council, New Media Initiative
2001-2017	Peer review, NSERC Discovery Grants
2001, 2008	Peer review, CFI (Canada Foundation for Innovation)

Participation in Academic Fora

2019	San Diego Opera – Opera Hack, July 27-28
2019	Dagstuhl Seminar on Ubiquitous Computing Education, June 2-7
2010	Participant, NSF/CCC Workshop on Ultra-Large Scale Interaction

Service to Society

Organizations for People with Disabilities

2024	foster parent for Mira Foundation service dog in training

Consumer Rights' Advocacy

2013	brought successful appeal (2013 QCCA 1670) before Quebec Court of Appeal regarding anti-SLAPP legislation
2013	initiated petition to improve rights of Canadian airline passengers
2010	advocating for reliable public transportation in Montreal
1997-2019	created and maintained passenger rights website