

DECLARATION OF LYNN BERTHUSEN

I, Lynn Berthusen, being of sound mind, declare the following to be true to the best of my knowledge, information and recollection.

1. I am an IT specialist at Fish & Richardson PC.
2. I personally visited <https://reprap.org/forum/read.php?1,20208,page=1> and printed both pages indexed by this web site on December 31, 2024.
3. Attached hereto as Exhibit A is a true and correct copy of what I printed on December 31, 2024, which matches what was displayed on my browser when I personally visited the above web site. Exhibit A attached herein is identical to Exhibit EX-1010.
4. I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

By: /s/ Lynn Berthusen

Lynn Berthusen

Date: 1/27/2025

Exhibit A

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[Home](#) > [General](#) > [Topic](#)


Genetic Algorithms


 [Advanced](#)

Posted by [vbgraphix](#)

[Forum List](#) [Message List](#) [New Topic](#)

 vbgraphix	Registered: 15 years ago Posts: 8
Genetic Algorithms	
January 11, 2009 04:35AM	
<p>I'm wondering what applications Genetic Algorithms could have in improving RepRap.</p> <p>It shouldn't be too hard to use software-based optimizers that can improve our circuits, designs, etc.</p> <p>Thoughts?</p>	
Reply Quote	

 nophead	Admin Registered: 17 years ago Posts: 7,881
Re: Genetic Algorithms	
January 11, 2009 05:38AM	
<p>I doubt software could improve the design any better than 1000's of people making Repraps and tweaking the design as they go. That is really gathering momentum this year. It is like genetic evolution in so much as the best design aspects survive and the things that don't work get dropped but the mutations are not random, they are hopefully intelligent design.</p>	
<p>[www.hydraraptor.blogspot.com]</p>	
Reply Quote	

 Forrest Higgs	Admin Registered: 17 years ago Posts: 1,915
Re: Genetic Algorithms	
January 11, 2009 08:45AM	
<p>I've written genetic algorithms in my day job in years past. The question isn't one of whether they could improve outcomes. They definitely could. The question is more one of who wants to invest the man-hours to apply the method to these particular applications. It's not something I have time for.</p>	

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

 [Reply](#)  [Quote](#)

 **nophead**

Re: Genetic Algorithms
January 11, 2009 08:50AM

Admin
Registered: 17 years ago
Posts: 7,881

Plus somebody would have to be a slave to the genetic software, building and testing the variants, unless the software had a brilliant physics simulator in it. As most of the random mutations would be no hope dead ends it would be a lot of work, most of it pointless.

[\[www.hydraraptor.blogspot.com\]](http://www.hydraraptor.blogspot.com)

 [Reply](#)  [Quote](#)

 **Forrest Higgs**

Re: Genetic Algorithms
January 11, 2009 08:54AM

Admin
Registered: 17 years ago
Posts: 1,915

>
>unless the software had a brilliant physics simulator in it.
>
Yeah, I should have mentioned that bit. Unless you have an evaluation function, you can't have genetic algorithms. I don't think that we have any that can be reduced to pseudocode.

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Thomas A. Edison

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 **Batist**

Re: Genetic Algorithms
January 11, 2009 09:24AM

Registered: 16 years ago
Posts: 32

There are some brilliant physics simulators available...
For example [www.bulletphysics.com] (C++ & Java)
Or [www.ode.org] (C++)

However, it doesn't solve the evaluation function problem...

[www.coded.be]

 [Reply](#)  [Quote](#)

 **nophead**

Re: Genetic Algorithms
January 11, 2009 09:34AM

Admin

Registered: 17 years ago
Posts: 7,881

They might be brilliant but I would be very surprised if you could input a 3D model including its materials and simulate the extruder building an object, predicting all the defects like stringing and warping and working out how long it would take for things to wear out. Sounds like science fiction to me.

[www.hydraraptor.blogspot.com]

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 **Forrest Higgs**

Re: Genetic Algorithms
January 11, 2009 09:38AM

Admin

Registered: 17 years ago
Posts: 1,915

There have been some very science fictiony things done with genetic algorithms. I've done one or two. 🤖 I fear, though, that the app proposed here is simply too fuzzily defined to yield useful results.

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Thomas A. Edison

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 **Samuel**

Re: Genetic Algorithms
January 12, 2009 06:45PM

Registered: 17 years ago
Posts: 82

I'd be interested in hearing about your experiences with GA, Forrest. Unfortunately, it probably isn't related enough to reprop to post here. Got any better ideas?

On a more topic related note: Yes, the extruder physics stuff would be hard to do with GA, but the suggestion about circuit boards would be more approachable.

Maybe you could use it to come up with a better slicing/filling algorithm for the software, or use GA to design better corner brackets that use less material, but are just as strong. That should be possible to simulate without a fancy filament warping function.

Do you think any of those physics sims could tell us how far apart our fill threads can be without sagging too much? Saving on material and build time is certainly a worthy goal, even without achieving higher accuracy in model shape.

 [Reply](#)  [Quote](#)

 **[VDX](#)**

[Re: Genetic Algorithms](#)
January 13, 2009 03:25AM

Admin
Registered: 17 years ago
Posts: 13,988

Hi Forrest,

actual working GA-samples would be interesting for me too.

20 years ago i made some 'traveling salesmen'-optimisation with a neural-network-chain for CNC-drilling PCB's on my Atari-ST and hoped to develop a 'self-trained' perfect 3D-CNC-controller, but then my diploma examinations went hot and i somehow lost contact ...

Viktor

 [Reply](#)  [Quote](#)

 **[Forrest Higgs](#)**

[Re: Genetic Algorithms](#)
January 13, 2009 07:34AM

Admin
Registered: 17 years ago
Posts: 1,915

I doubt that my GA samples would be of much use to the effort contemplated. The major effort I undertook was to simulate heritable IQ drift over several centuries in traditional Russian Jewish Shtetl and Nguni kraals.

Hell, there are no rules here - we're trying to accomplish something.

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Thomas A. Edison

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 **VDX**

Re: Genetic Algorithms
January 13, 2009 07:40AM

Admin
Registered: 17 years ago
Posts: 13,988

... aiii 😊

By the way ... could you prove true the effect of IQ-multiplying when two long time separated genetic lines recombine?

Viktor

[Reply](#) [Quote](#)

 **Forrest Higgs**

Re: Genetic Algorithms
January 13, 2009 10:19AM

Admin
Registered: 17 years ago
Posts: 1,915

VDX Wrote:

> ... aiii 😊

>

> By the way ... could you prove true the effect of
> IQ-multiplying when two long time separated
> genetic lines recombine?

>

I'd need a clearer statement of the proposition that I think that you are making. Got any prior art or links you can point me at?

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Thomas A. Edison


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 **VDX**

Re: Genetic Algorithms
January 13, 2009 10:49AM

Admin
Registered: 17 years ago
Posts: 13,988

Hi Forrest,

... no links ... i read this somewhere and was interested if it's true that crossbreded animals (or people too) between long time separated genetic lines are significantly shrewder than their parents


Viktor

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 **Nil Einne**

Re: Genetic Algorithms

January 13, 2009 11:08AM

Registered: 16 years ago

Posts: 84

Your thinking of hybrid vigour [en.wikipedia.org] . However it's not really applicable here since it's most evident when the parents are highly inbred, usually in artificial selection cases where people have been inbreeding the plants/animals for years. I doubt any of the RepRap stuff qualifies and in any case, to work you'd need to actually have some sort of genetic algorithym at work in the background which we don't. Taking the best features from each model out there is not the same thing (even if it may be a good strategy.)

Also whether it has any real application to humans is also quite controversial. Sure if you're talking about highly inbred populations outbreeding has clear advantages but it may not make so much difference with humans since despite what the KKK et al want us to believe humans are actually a (mostly) incredibly mixed population.

Edited 1 time(s). Last edit at 01/13/2009 11:09AM by Nil Einne.

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 **Forrest Higgs**

Re: Genetic Algorithms

January 13, 2009 11:44AM

Admin

Registered: 17 years ago

Posts: 1,915

With generational genetic drift in a more or less homogeneous population you have some fairly well-understood statistical mechanisms. The most usual one you see says that the IQ of children of a couple will fall within a fairly narrow distribution curve the mean of which can be taken to be the average of the parents' respective IQ's.

I modeled two situations, the first was a Jewish Shtetl in which bright males were identified quite early in life and encouraged to undertake rabbinic studies. Socially, such males, on completing their studies were considered prized marriage material by the Shtetl and pretty much had their pick of eligible young women. The rabbi's family was also expected to be large and the children thereof were similarly considered to be prized marriage material.

The question that I posed was one of accepting this social mechanism for encouraging bright males to have large families who were married back into the community, how long would it take for the mean IQ of the Stetl to exhibit the 10 point IQ advantage that Jewish populations consistently show over other european populations. The answer came out to about 250 years. I ran about a dozen variations on the scenario and found that the time frame only deviated from 250 years by about +/-20 to 30 years.

Against that I modeled a the marriage and child rearing customs common in southern African Nguni kraal where families accumulate capital over generations and the family patriarch is able to purchase multiple wives which aid him in capital accumulation. My genetic models of that mechanism typically showed an extremely gentle downward drift of population IQ. The drift that I detected was so small that I wouldn't vouch for it even existing. The IQ drift for Jewish Shtetl, however, was very pronounced and much stronger than I would have guessed before the modeling exercise.

The problem with the crossbreeding, as it were, of human populations with respect to IQ is that most of the information that we have comes from the 20th century. During that period the Flynn Effect complicates separating out IQ drift resulting from other factors.

Someday, if I am spared for long enough, I hope to revisit that exploration and maybe get a handle on why the Flynn Effect set off the massive upwards IQ drift that it did in the 20th century in the industrialised world. Knowing the hows and whys of the Flynn Effect would be VERY interesting.



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Thomas A. Edison

[Reply](#) [Quote](#)

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 11:54AM

Admin
Registered: 17 years ago
Posts: 1,915

Nil Einne Wrote:

-
- >
 - > Also whether it has any real application to humans
 - > is also quite controversial. Sure if you're
 - > talking about highly inbred populations
 - > outbreeding has clear advantages but it may not
 - > make so much difference with humans since despite
 - > what the KKK et al want us to believe humans are
 - > actually a (mostly) incredibly mixed population.
 - >

DNA surveys consistently indicate that genetic variation amongst humans not originating from subSaharan Africa is extremely slight, less by several magnitudes for all five billion of us than what you'd encounter in the average Chimpanzee troop.

Not to put too fine a point on it, we're (the Euroasians amongst us, that is) are as inbred as a bunch of rough collies. That could go a long way towards explaining the average 30 point

difference between Euroasian and subsaharan African populations. Genetically, subSaharan Africans are humanity's root stock, to use a good horticultural term. Most of humanity's DNA variation is found amongst those who never left Africa. We should guard that treasure house of DNA very carefully. You never know when we might really, really need it.

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Thomas A. Edison

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Nil Einne

Re: Genetic Algorithms

January 13, 2009 03:29PM

Registered: 16 years ago

Posts: 84

Forrest Higgs Wrote:

- > DNA surveys consistently indicate that genetic
- > variation amongst humans not originating from
- > subSaharan Africa is extremely slight, less by
- > several magnitudes for all five billion of us than
- > what you'd encounter in the average Chimpanzee
- > troop.

But that's precisely my point. Given the low variation and the fact that what variation does exist has been shown to be not strongly linked to the concept of race, it doesn't make sense that hybrid vigour would be observed. The simple fact is, as much as certain groups would like to claim otherwise, there is no such thing (generally speaking) as all these pure races that shouldn't mix. In fact, most of what we think as races don't really exist on a genetic level. So it's unlikely your going to get hybrid vigour and mixing or not doesn't really matter since by and large, humans are already mixed.

- > Not to put too fine a point on it, we're (the
- > Euroasians amongst us, that is) are as inbred as a
- > bunch of rough collies. That could go a long way
- > towards explaining the average 30 point difference
- > between Euroasian and subsaharan African
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- > humanity's root stock, to use a good horticultural
- > term. Most of humanity's DNA variation is found
- > amongst those who never left Africa. We should
- > guard that treasure house of DNA very carefully.
- > You never know when we might really, really need
- > it.

 **Nil Einne****Re: Genetic Algorithms**

January 13, 2009 04:13PM

Registered: 16 years ago

Posts: 84

Forrest Higgs Wrote:

-
- > With generational genetic drift in a more or less
 - > homogeneous population you have some fairly
 - > well-understood statistical mechanisms. The most
 - > usual one you see says that the IQ of children of
 - > a couple will fall within a fairly narrow
 - > distribution curve the mean of which can be taken
 - > to be the average of the parents' respective
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 - >
 - > I modeled two situations, the first was a Jewish
 - > Shtetl in which bright males were identified quite
 - > early in life and encouraged to undertake rabbinic
 - > studies. Socially, such males, on completing
 - > their studies were considered prized marriage
 - > material by the Shtetl and pretty much had their
 - > pick of eligible young women. The rabbi's family
 - > was also expected to be large and the children
 - > thereof were similarly considered to be prized
 - > marriage material.
 - >
 - > The question that I posed was one of accepting
 - > this social mechanism for encouraging bright males
 - > to have large families who were married back into
 - > the community, how long would it take for the mean
 - > IQ of the Stetl to exhibit the 10 point IQ
 - > advantage that Jewish populations consistently
 - > show over other european populations. The answer
 - > came out to about 250 years. I ran about a dozen
 - > variations on the scenario and found that the time
 - > frame only deviated from 250 years by about +/-20
 - > to 30 years.

I would like to know how you came out with those figures. The genetic basis for IQ is rather poorly understood. There is definitely an inherited component but how large it is remains an open question. Even if it's true "IQ of children of a couple will fall within a fairly narrow distribution curve the mean of which can be taken to be the average of the parents' respective IQ's" which I'm somewhat doubtful (most studies I've seen suggest the correlation with parental IQ is far from clear) this doesn't prove a genetic basis since amongst other things contrary to what some people claim, IQ isn't purely innate. Of course, if the correlation is there, it's possible/likely? it would increase whatever the cause but I would suggest that's far from certain.

For that matter, IQ is poorly understood. All it actually measures is your ability to do IQ tests. There appears to be some correlation with what we call 'intelligence' but it's at best only a loose one.

Also it doesn't sound to me like you study considered the IQ of the female partner. The fact that the male had the pick doesn't mean they choose the ones with the higher IQ. It's easily possible to imagine that they choose the ones with the IQ 10 points lower on average therefore likely cancelling out any advantage their higher IQ had presuming your theory of IQs holds true. Also, even though their children could may have been high up in the social scale, having large families means you can afford to devote less attention/resources to the children you have. For humans, having large families is not necessarily the most effective evolutionary strategy. It could easily lead to a lower IQ of the children and a lower chance of evolutionary success of the children which the social (and genetic?) advantage they have due to their parents may not be enough to make up for.

Indeed there are other factors to consider. Just because the parents are encouraged to have more children doesn't mean they do or are able to. It may be that the high IQ is correlated with other factors which reduce evolutionary success. For example, if the Father is more likely to die young. Or for that matter beyond having more children is less able to raise the children effectively. Indeed even social factors could come into play. Does the increase pressure on the father to perform according to societal expectations lead to a lower median age at death or negatively effect the way they raise their children?

Bringing the female into it again, regardless of the fact the father has the pick of the crop or the IQ of the female they select, there's no guarantee they will select the most evolutionarily successful females. Given the societal factors at play, it's possible that the females they pick are not the best choice. Perhaps for example, the females are more prone to infidelity (whose effect is going to be even more difficult to quantify) or has similar problems to those I raise for the father.

Of course sexual selection will likely come into play. The fact that they choose the females and they had the pick of the crop means that whatever the traits they must be those considered most important amongst their community and therefore whatever inherited component of these traits that's passed to the children would give them an advantage even if they paradoxically also give them a disadvantage. (The same of course for the father.) This of course plays back into the societal edge the children have. But again, rather extra fitness component they have must be weighed against any negative effect on fitness it may also have.

BTW, I would avoid the term 'drift' when talking about evolution. Drift usually refers to genetic drift which is random and doesn't seem to be what you're referring to. It does have to be considered in any calculation of evolutionary rates though.

P.S. A bit tired so apologise if any of that didn't make sense. I think I covered the basics though. Since this is OT and not really something of great interest to me, I'll probably stop there. I have some background in biology so know calculating evolutionary rates is an extremely complicated thing. And working out how a trait will change in a certain situation even more so given the near infinite number of variables many of which can have a fairly large effect. Particularly in a beast as complicated as humans. If you haven't already, I suggest you consult an evolutionary biologist (which I'm guessing your not) preferably one with a background in statistics/biometry who could advise you further on your calculations. I think you may not have quite understood the complexity of the calculations.

P.P.S. In case I was wrong about how far you went, were any of those calculations published in a peer-reviewed journal?

Edited 2 time(s). Last edit at 01/13/2009 04:21PM by Nil Einne.

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 **VDX**

Re: Genetic Algorithms

January 13, 2009 04:32PM

Admin

Registered: 17 years ago

Posts: 13,988

... now, that's the real spirit 🍻🍻🍻

I found some similarities with breeding pets, cultural/social relationships between long time separated folks (eg. eastern and western europeans after breakdown of the Sowjet Union) and developing reprints/repstraps with different strategies ...

Maybe there are some significant patterns we can use for faster 'rep-volution'?

Viktor

 [Reply](#)  [Quote](#)

 **Forrest Higgs**

Re: Genetic Algorithms

January 13, 2009 05:21PM

Admin

Registered: 17 years ago

Posts: 1,915

Nil Einne Wrote:

>

> There is definitely an inherited component but how large it is remains an

> open question.

>

Mostly it's a politically explosive question the possible answers to which fly in the face of a half-century of social orthodoxy.

Thank you for your review of the genetic programming project I undertook.

I mentioned the content of what I did mostly in reply to Viktor's query, not from any desire to spark a debate about IQ or the vexed IQ vs race question. After I got my PhD in 1990 I undertook a number of explorations using various techniques mostly to satisfy my own curiosity and relax. This was one of them. One of the others was slowly, painfully working my way through the proofs of Kurt G

Edited 1 time(s). Last edit at 01/13/2009 05:30PM by Forrest Higgs.

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Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

 [Reply](#)  [Quote](#)

 **[Samuel](#)**

[Re: Genetic Algorithms](#)

January 13, 2009 07:47PM

Registered: 17 years ago

Posts: 82

Fascinating.

How were G

 [Reply](#)  [Quote](#)

 **[Forrest Higgs](#)**

[Re: Genetic Algorithms](#)

January 13, 2009 07:58PM

Admin

Registered: 17 years ago

Posts: 1,915

I used the old Nagel and Newman explication of G

Edited 1 time(s). Last edit at 01/13/2009 11:41PM by Forrest Higgs.

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Thomas A. Edison

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 **[Colecoman1982](#)**

[Re: Genetic Algorithms](#)

January 14, 2009 01:47PM

Hi,

On the topic of applying GA (or, more generally, self-learning iterative algorithms) to reprop, my suggestion is that it might be more feasible than you think. You don

 [Reply](#)  [Quote](#)

 **[Forrest Higgs](#)**

Admin

Re: Genetic Algorithms
January 14, 2009 02:53PM

Registered: 17 years ago
Posts: 1,915

Colecoman: The problem with that approach is that it presumes a very high rate of interactive dataflow between the PC and the rewrap machine. That's not happening at the present time. Right now, rewrap machines are either stand alone or more or less peripherals to your PC.

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Thomas A. Edison

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 **vbgraphix**

Re: Genetic Algorithms
January 14, 2009 03:34PM

Registered: 15 years ago
Posts: 8

I really love the camera idea. Though, scanning may not require anything as complex as a camera. A camera might bring the cost up too much. A simple light detector or laser of some sort may do the trick.

As for data flow, it shouldn't be too hard to hack together a bunch of open source monitoring devices to record data like temperature, speed, vibration, etc. I think that would be a very constructive thing to do.

 [Reply](#)  [Quote](#)

 **Wade**

Re: Genetic Algorithms
January 14, 2009 04:10PM

Registered: 16 years ago
Posts: 536

Hm, I don't look forward to trying to code up a vision system from scratch....

but, an accelerometer on the write head might be useful. Keep an eye on the RMS power of the vibration the head experiences; that might be able to detect the next time I have an all-night long series of head collisions due to a bad programming job.

A strain gauge on the extruder mount would do that as well, and it could do a few other things as well, like finding the bed height automatically. Could take some time though.

Wade

 [Reply](#)  [Quote](#)

 **Mr. Seeker**

Re: Genetic Algorithms
January 14, 2009 05:02PM

Registered: 16 years ago
Posts: 96

Wade Wrote:

> but, an accelerometer on the write head might be
> useful. Keep an eye on the RMS power of the
> vibration the head experiences; that might be able
> to detect the next time I have an all-night long
> series of head collisions due to a bad programming
> job.

Why dont you get a shock absorber? Foam works pretty well for this kind of problems 😊

The accelerometer wont be very useful if you have lots of vibration because when you want to fill a gap quickly, the "vibrations" will shut the machine off. Try to look at [forums.parallax.com] from parallax, there is shown how their X-Y accelerator works.

Also thinking about the strain gauge... You could also use it to calibrate the Z-axis, but its also possible with IR or ultrasonic sensors... Or in the case of "money is not a problem" a webcam?

Edited 2 time(s). Last edit at 01/14/2009 05:15PM by Mr. Seeker.

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 **Wade**

Re: Genetic Algorithms
January 14, 2009 05:29PM

Registered: 16 years ago
Posts: 536

Well, I figured that the rms power of the vibration will be much higher for stuck head situation, where the stepper is jumping steps at high speed. It's certainly noisy as hell when it happens! Should be easy to set a limit that will pass a zig zag path, but fail multiple head collisions. A single head collision would be more difficult to detect without a strain gauge.

I prefer the Analog Devices ADXL series, but I haven't used them for a few years. Even so, my webcam only cost me \$10 new; I'd be hard pressed to put together an accelerometer monitoring system for less than that. Still, it could be fun.

I wonder, does anyone make a sort of instrumented bolt for a reasonable price? The extruder mount could use a pair of bolts with strain gauges, and you could watch the change in bolt tension when you run into something. Probably cost as much as the RepRap. 😊

Wade

edit - the neat thing about strain gauge vs optical measurements is that the strain gauge will tell you how much your extruder has elongated due to heating, warping, or in my special case, catastrophic failure.



Edited 1 time(s). Last edit at 01/14/2009 05:31PM by Wade Bortz.

[Reply](#) [Quote](#)

VDX

Re: Genetic Algorithms
January 15, 2009 03:30AM

Admin

Registered: 17 years ago
Posts: 13,988

... the camera could do a better scanning job when treating with photogrammetry - take two pictures from different positions and calculate the displacement of some relevant edges or previous placed colour-dots ...

Even GA or NeuralNetwork-simulation could help a lot - i knew someone who built high-speed-3D-scanners with two cameras that acts like the human brain with image-recognition ... extremely fast, super precise but extremely expensive too 🤖

Maybe an open source approach and some clever people can do the same?

Viktor

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Genetic Algorithms



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[Advanced](#)Posted by [vbgraphix](#)[Forum List](#)  [Message List](#)  [New Topic](#) [Larry_Pfeffer](#)**Re: Genetic Algorithms (now instrumented bolts/load cells)**

January 15, 2009 07:37AM

Registered: 16 years ago

Posts: 251

Wade Wrote:

> I wonder, does anyone make a sort of instrumented
 > bolt for a reasonable price? The extruder mount
 > could use a pair of bolts with strain gauges, and
 > you could watch the change in bolt tension when
 > you run into something. Probably cost as much as
 > the RepRap. 😊

Wade, et al,

If we had such a sensor (crash/no-crash), how would it be used? Stop everything and wait for help? Or is some more complicated, automatic recovery envisioned?

Generally, strain gauges (particularly applying them) is labor intensive (read fussy work) and in consequence usually not cheap. The signals from foil strain gauges are small, so one needs high amplification (with low time & thermal drift) to get a usable signal.

Metals have much lower failure strains (order of 1e-3) than plastics (10 -- 1000x as a WAG), so instrumenting a plastic "bolt" or other structure would be easier -- except that plastics are terrible heat conductors, and have much higher thermal coefficients of expansion, which makes it difficult to match coefficients, such that one can measure mechanically-induced strain, separately.

Plastics generally creep, if you strain them long and hard. And some are virtually impossible to glue strain gauges (or anything else!) to them.

However, there may be a way to skin this cat.... I did some preliminary experiments (read, played around with) some conductive-plastic fiber I got a sample of, and it serves as a pretty good strain gage, and well matched to plastic, because it is plastic. Since it has high intrinsic resistance (compared to foil gauges), it develops a larger signal, with minimal resistive heating. (The mfg. didn't seem very interested in this aspect -- may have been too far out of their area of expertise....)

Typically, bolts aren't the best shape for instrumenting, even if one turns down the thread for a flat surface (and smaller section to increase the strain) because bolts are usually strained mainly in tension. Load-cell structures are typically designed to strain the instrumented areas in bending, torsion (or sometimes shear), to get us usably large strains. I don't have a darwin, and I'm a bit hazy on the attachment of the extruder to the cartBot. If you (or anybody else) can post some photos (or sketch w/dimensions) of the attachment, I might be able to come up with a mod that'd serve as a load-cell structure and try putting some of my "strain gauges" on it.

I know we'd *like* three forces and three moments, resolved about a common point, e.g. the extruder tip. However, a 6-DOF load cell is usually a complicated (hard to machine) structure, and usually needs 6 -- 8 pairs of gauges.

Can folks with extruding experience suggest what the minimum set of forces/torques would be? And what part of the rewrap usually hits things, the tip, or someplace else?

Larry Pfeffer,

My blog about building repstrap Cerberus:
[repstrap-cerberus.blogspot.com]

 [Reply](#)  [Quote](#)

 **freds**

Re: Genetic Algorithms (force Sensor)

January 15, 2009 09:18AM

Registered: 16 years ago
Posts: 300

Here's a force sensor that should be fairly easy for use to use in our environment.

[www.hvwtech.com]

 [Reply](#)  [Quote](#)

 **Colecoman1982**

Re: Genetic Algorithms

January 15, 2009 11:22AM

@Forrest: A high data rate between rewrap and PC shouldn't be necessary. What I was envisioning was more of an auto-calibration process done as a pre-process before printing. Basically, the rerap would print a simple test pattern, use the imaging system to measure the accuracy of the pattern, modify it's print parameters based on the image information, and then repeat the process until calibrated. This would save the need for someone to hand-adjust the each rewrap/repstrap for temperature, flow rate, and slop/backlash in the support frame/stepper motors. If done well, it could even prove to be more efficient at it than all but the best human operators (similar to how ABS breaks, in cars, can react better than is possible with human reflexes). This strikes me as an important feature to have in Rewrap if the project is to ever allow for mass distribution as most people you are looking to distribute to won't have a fraction of the mechanical aptitude you guys have.

As for the 3d scanning feature, that might be slower due to direct control of the print head from the

computer but shouldn't be all that time consuming based on the DIY 3d scanning algorithms I've seen posted online.

@Wade: True, recreating a computer vision library from scratch would be difficult, but there might be some open source resources that might speed the process up such as the open source OpenCV library released by Intel and a similar library released by Nvidia (the name, of which, escapes me at the moment).

The primary advantage I see in a webcam, as opposed to accelerometers or strain gauges, is price. Cheap webcams can be had for as low as ~\$10 (though I don't necessarily suggest going for the absolute cheapest ones). The resolution and color quality won't be the best, but moving the print head closer to the target can get around resolution and color quality doesn't matter as much since most computer vision calculation are done in black and white anyway.

-Shawn

 [Reply](#)  [Quote](#)

 **Larry_Pfeffer**

Re: Genetic Algorithms

January 15, 2009 11:28AM

Registered: 16 years ago

Posts: 251

Wade Wrote:

>
> I wonder, does anyone make a sort of instrumented
> bolt for a reasonable price? The extruder mount
> could use a pair of bolts with strain gauges, and
> you could watch the change in bolt tension when
> you run into something. Probably cost as much as
> the RepRap. 😊

If all that's wanted is a (binary) crash sensor, then a simpler approach (than strain gauges or accelerometers) might be a springs & contacts approach, similar to what's commonly used (in a steering wheel) to sound the horn, no mater where you press on it.

Larry Pfeffer,

My blog about building repstrap Cerberus:
[\[repstrap-cerberus.blogspot.com\]](http://repstrap-cerberus.blogspot.com)

 [Reply](#)  [Quote](#)

 **Wade**

Re: Genetic Algorithms (now instrumented bolts/load cells)

January 15, 2009 10:32PM

Registered: 16 years ago

Posts: 536

I'm more interested in closing the loop on extruder height control - I'd like to know exactly how high my extruder head is above the bed, as height changes of 0.1 mm make significant differences in raft and part adhesion. My current method is on the crude side. The PTFE length changes with temperature, and time, and sometimes the frame itself warps over time, so I'd like to measure the important variable - nozzle to bed height - directly.

Collision detection is a nice side affect; I'd have the machine shut down and flag me if it happens, as opposed to breaking something. Right now I have the Arduino shut everything off, print an error message to the serial port and go into an infinite while loop when something really bad happens, like a thermocouple malfunction. That saved my machine once already.

That IESP-12 force sensor is priced right at \$7, but I'm a little skittish about the "estimate" language in the datasheet. It doesn't sound like it works well over long periods of time under force though, which could be bad in our setup if it's always measuring the weight of the extruder.

A metal bar with some strain gauges could work too, but the heat flow from the extruder might mess with things.

In general, this sounds like a little more fun that I'm interested in at the moment. 😊 And no, this has nothing to do with genetic algorithms, sorry.

Wade

Edited 1 time(s). Last edit at 01/15/2009 10:38PM by Wade Bortz.

[Reply](#) [Quote](#)

 **freds**

Re: Genetic Algorithms (now instrumented bolts/load cells)

January 15, 2009 11:42PM

Registered: 16 years ago
Posts: 300

Wade Wrote:

>
> That IESP-12 force sensor is priced right at \$7,
> but I'm a little skittish about the "estimate"
> language in the datasheet. It doesn't sound like
> it works well over long periods of time under
> force though, which could be bad in our setup if
> it's always measuring the weight of the extruder.
>
> Wade

Hi Wade

My idea was that it would measure upwards pressure from a calibration touch down or abort if it had run into the bed.

It could also be used for a calibration cycle where you touch down on the four corners of the bed or the maximum build area to check for alignment or height of Z; which in IMHO is the measurement

that can be the most variable.

The other idea that I had was measuring contact force for a stencil cutting blade or drawing pen to get more uses out of the bot.

As a stencil cutter it could cut logos, labels, paper or PCB exposure or silk screen masks; other capabilities to show off why we are into this 3D stuff.

Since it is variable resistance it could interface to one of the analog ports for the Sanguino in place of the second extruder which no one has really done yet.

Though if you still wanted to have a second extruder you could do away with the separate Z-enable (tie it to X & Y enable for a generic stepper motor/movement enable) and then devote that pin to Z contact pressure.

You know that

Edited 3 time(s). Last edit at 01/15/2009 11:48PM by freds.

 [Reply](#)  [Quote](#)

 **Wade**

[Re: Genetic Algorithms](#)

January 16, 2009 12:04AM

Registered: 16 years ago
Posts: 536

The upward pressure is the same thing general idea, but if you've got it truly not touching the sensor (as that datasheet recommends), then you've got a certain amount of backlash to take up before the sensor registers, which would prevent me from knowing exactly when the head touches, which is what I'm really interested in. There's fair amount of give in the entire system when you're looking at scales of less than a mm, so I was thinking a constant measurement of the force on the head (including it's weight) would be useful. That points more towards strain gauges.

Yeah, the 4 corners calibration was what I was thinking as well. It could also pick up on a tangled plastic filament feed, which has wrecked a few builds of mine in the past as well. That would probably just trigger the head collision detection, due to the upward force on the extruder.

Mostly I just squint at the webcam feed every few hours and try and deduce if something bad has happened. 😊

Wade

 [Reply](#)  [Quote](#)

 **Enrique**

[Re: Genetic Algorithms](#)

January 16, 2009 02:44AM

Registered: 16 years ago
Posts: 213

A cheap bump sensor is described on instructables at:
[\[www.instructables.com\]](http://www.instructables.com)

Basically, stick a metal rod through a pipette extending out a bit, put a spring around the pipette extending also, and check for continuity. For the rewrap, the spring & rod would be pointing upward, like a car antenna, and whenever the nozzle bumped into something, as long as the acceleration was high enough, the spring would then bend and bump into the rod. The continuity would trigger the switch circuit:

[www.instructables.com]

and a signal would be sent to the Arduino to shut down.

If the sensor trips in regular operation, the spring would be trimmed bit by bit, until it doesn't quite trigger during operation.

In that bump sensor, the red wire is connected to the middle of the spring, but I think it would be better to connect it at the base of the spring.

 [Reply](#)  [Quote](#)

 **Mr. Seeker**

Re: Genetic Algorithms

January 16, 2009 03:59AM

Registered: 16 years ago
Posts: 96

What is also possible is just having a long thin rod in the middle of a tube. When the rod touches the tube, the IO goes zero...

Same principal, different layout.

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 **BeagleFury**

Re: Genetic Algorithms

January 16, 2009 10:17AM

Another option to detecting height might be to use several hall effect sensors embedded at strategic locations in the print table, and a magnet on the print head?

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 **vbgraphix**

Re: Genetic Algorithms

January 23, 2009 04:15PM

Registered: 15 years ago
Posts: 8

Found some cool resources:

[blog.makezine.com]

[www.cs.nyu.edu]

For those more technically inclined:

[\[www.cogs.susx.ac.uk\]](http://www.cogs.susx.ac.uk)

 Reply  Quote

 **grael**

Re: Genetic Algorithms

January 31, 2009 05:40PM

Registered: 15 years ago

Posts: 242

The Hybrid vigour side of GA is fascinating.

There's an interesting site:

[\[www.rdos.net\]](http://www.rdos.net)

Which goes over an alternative to the mitochondrial DNA evidence for the African "Eve" theory. Basically, it's saying that the "proof" was more along the lines of "absence of evidence", than "evidence of absence", and that the African emigration occurred in waves. As a result, recombination of the partially speciated peoples, (probably the rape, pillage and plunder scenario), resulted in some interesting mixes in following generations. Certainly, the more competent level of inventiveness seems to have flourished from some 20,000 years back, and onward. The site points out various gene "defects" that do not appear as defects when the environment is altered to be more like some of the precursor environments. One of the interesting points made, was the speciation of kept beasts, away from the wild animals, and of the DNA changes over time that point to at least one separation/speciation period, which is far in excess of that proposed by the Out of Africa proponents.

On another site:

[\[www.evolutionpages.com\]](http://www.evolutionpages.com)

is some interesting data on our critical difference from the other great apes, if I recall correctly, they have 23 chromosome pairs, and we have 22. one of our pairs appears to be a splice of two of theirs. I like to think of us as being like Win CE, the cut down version of windows.

Back on track though, I suspect GA are a little like fuzzy logic. Forest points out that to create the environment in which they would be fruitful, is a huge mission in itself. "Expert systems" are what most programs today can be defined as.

In the blood and bone world, "mother nature" practices the ultimate determinism, trialing solutions in the actual environment. In that scenario, successes are not always rewarded, and failures are not always culled.

In the reprop development environment, the determinism aspect is not so honest, with people watching the experiments, there is bound to be tampering with the results. However, sometimes people get lucky, and notice something that works, nurture it, and in time, we have a new feature, that has escaped a premature cull, for some other reason.

Tools continue to advance, and given another 10-50 years, it's certainly not inconceivable, that AI systems may have environmental sensing systems good enough to take deterministic modeling many significant steps forwards.

The human factor... As our tools advance, the disparity between their and our intelligences diminish, normally, the human race has needed people like Nicola Tesla, Leonardo Da Vinci to

lead the way. The Nicola Teslas aren't in every generation though, and so typically we've had, as a species to wait many generations for the next breakthrough/s. As our tools become more A.I like, the human factor in co-evolution is going to become more of a "flavour", than a control, you have only to look at technologies developing around us, to see the progression, and our place within the progression becoming less of masters, and more as symbionts with the machines we create.

Graham Daniel

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