Evolutionary Computation

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Conference Review: Evolvable Hardware 2004

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The Conference

About 1000 people were present at the conference, which was a bit bigger than earlier years (e.g., 768, etc.). There were 57 talks, invited discussions, 12 posters, and at least 7 group posters. One hundred authors of papers, both invited and submitted, came from 14 different countries: U.S., UK, Germany, Mexico, Brazil, and Italy, from Czech Republic, Korea, Japan, Switzerland, Spain, Norway, France, Italy, and at least 1800 researchers in the specialty, spread worldwide over at least 15 countries (according to Tim Thompson's list, to be found at http://evogene.mpg.de/researchers). One thousand attendees attended, and all started in September 2004. The UK is still the strongest nation in the world, as it has at least 15 in groups, closely followed by the US with at least 14 groups, then Germany, Italy, Brazil, China, France, Japan, and Korea, with Denmark, Czech Republic, Israel, Belgium, Switzerland, Korea, Mexico, Brazil, and Austrailia.

The conference was spread over 5 days, with invited speakers, each speaking in 30 minutes, and 12 parallel sessions each day. The first evening of poster session 127 posters included an additional group poster session 6 of them that allowed as much as 14 sessions to groups around the world show off what they do.

The paper sessions were grouped into 7 categories: Evolution of Analog Systems (2 sessions), Evolution of Analog Systems (2 sessions), Evolvable Technologies for Space (2 special sessions), Fault Tolerance and Reconfigurability, and Systems and
Hiroyuki Higuchi (NARAS, Japan)

Higuchi has focused on the use of new technologies in medicine, especially in the field of cell therapy. His team has developed a technique that allows for the precise delivery of therapeutic agents to specific areas of the body, improving treatment outcomes for various diseases. This work has gained significant recognition, leading to collaborations with leading medical institutions around the world.

Takayuki Ueno (NARAS, Japan)

Ueno is a leading researcher in the field of renewable energy. His work focuses on the development of efficient and sustainable energy solutions, particularly in the area of solar power. Ueno's contributions have been instrumental in advancing the technology and reducing the environmental impact of energy generation.

Yujiro Ito (NARAS, Japan)

Ito is known for his expertise in artificial intelligence and its applications in various sectors. His research has led to advancements in areas such as robotics and automation, with a particular focus on developing technologies that enhance human-computer interaction. Ito's work has had a significant impact on the development of user-friendly and efficient technologies.
Higuchi's parasitic hand that uses EE to adapt the circuit that maps a human patient's microscopical signals from his muscles in an artificial hand. Before the technology was demonstrated to a patient less than 5 months ago, it takes 5 minutes to reach the artificial hand to the muscle-signal. He currently trains to sell a cheap version of the artificial hand with a limited number of motions, costing less than $5000.

In compressing images, in one of the most relevant applications of EE, he managed to have his data compression technique become an international standard, which will be the headline for the Japanese emerging industry.

EE based on applications of clock speeds in digital circuits. By evolving the designs, he has managed to speed up clock speeds, lower power consumption, and decrease the surface area of his circuits.

The cellular phone example mentions earlier.

EE based on proper alignment of femtosecond lasers.

The people point cameras on the hand to feel a touch. The image is sent to a volunteer who helps blind people enhance the blind's feeling by having a deep awareness of the surface and feel.

Deformable surfaces used to aid in the CRIs. The EE circuit corrects the phase of the laser beam along the optical path. A genetic algorithm is used to adjust 37 parts of the mirror.

Jack Kezzi (Stanford University, 1983)

I'm very excited about the competitive environment around EE. I should have the same as John Kezzi at Stanford University. Kezzi is the father of Genetic Programming (GP), a new breed of representation approach to evolutionary computation, where crossover means swapping two sub-trees. GP is now considered one of the four "gates" of GA: evolutionary algorithms, along with GA (genetic algorithms), PS (evolution strategies), and EP (epigenetic programming). He is the author of 4 large books on GP approaches. (see details at http://www.cs.stanford.edu/~kezzi.

Kezzi distributed a free copy of the conference explaining how he never works for money, instead of achieving human expert level design of analog circuits using genetic programming. Amongst other things, how Moore's Law (the doubling of electronic capacity of chips every 18 months) led to allowing GP techniques, as mentioned by Jack in the IEEE conference. I wonder, he's a very renowned person in his field and is associated with a number of circuits. He is an excellent example of what can be done with the right mindset and approach. He has been working on the development of GP for over 20 years, and has helped to advance the field significantly. His work has been recognized and awarded for his contributions to evolutionary computation. He has also been involved in the development of several software tools for genetic programming.
Marc Schneidscherer (INRIA Institute National de Recherche en Informatique et en Automatique) in France

Evolutionary algorithms that adapt

Marc Schneidscher was editor in chief of the most prestigious journal in the field of evolutionary computation, namely Evolutionary Computation (ECJ Press). He gave a talk on techniques that have revolutionized algorithms and could be adapted automatically, the values of the critical parameters used in an evolutionary run (e.g., the mutation rate, crossover rate etc). He encouraged the ECJ researchers to use these techniques they ought to use the best tools available to accelerate their evolution times, even in hardware. His adoration of Schneidscherer's talk was relevant, he was struck by the extraordinary comprehensive references and completeness of his talk, and after his seminar at the end of this talk with their morning coffee led to good cop cops. Some senior researchers of evolutionary needed techniques to reduce their evolution times, a review of Schneidscherer's talk should be used in them.

Session Speaker Highlights

Special Session on Evolutionary Technologies for Space

Anthony Copeland, of CAJ Northland, spoke on "Soft" Autonomous Control Systems; He explained how new materials in his "rubber plane" that could fly through their spaces and glide in the atmospheres of other planets. He presented the latest video for her ever seen at a conference, and I've been to the CAJ of conferences. Together it was produced by the same team that made the famous Mars rover video that featured on the NASA, Science, and Discovery channels on Cable television.

Marc Miles spoke on "Prospects for Breakthrough Decoupled from Physics, the art of being to use "triggers" physics effects such as the cosmic effect, quantum energy, gravity, shielding, electromagnetic effects, etc., to come up with breakthroughs in space travel. Be made the point that humanity will never reach the stars if we are confined to present-day techniques of space propulsion (chemical, ion, solar, etc) But something new and radical will be needed, but what? He talked about the studies he had made, and Jasper design. A satellite planned designed as a physical spacecraft possible, and others under idea.

Just what the relevance of these talks was to IT was highly questionable, but after some fascinating, I was struck by a point that one could learn that "hardware" can be broadly interpreted. It need not be confined to electronics, circuits. But then how would one engineer a new type of hardware based on truly "triggers" physics? This could be a topic for future research.

Andy Tyrrell (University of York, UK)

Andy Tyrrell is one of the most productive and respected members of the ECJ research community, and arguably leads the planet's most active ECJ research group. Each NASA/DARPA ECJ conference usually has several papers from members of his group. Julian Miller, one of the field's visionaries (more on that later) recently joined the group. Tyrrell spoke on "The Evolution of Supervised Hardware Implementation of a Multicellular System" and it was quite innovative. Since this is the first such

Hage-de-Garce (an area of time) was to be expected. A trilogy down to work to explode to circuits coming will have to be 2020 when the current IT program takes which pieces of tight transactions is for the control merge the overall so functionality, self-assembly, with acceptable in three decades.

Simon Halden (Simon Halden by Julian Miller) for the idea of using an edge-drawing device that would allow the fast processing of circuit simulations. In a short time, Halden would be able to see the output signal in the naming; this was quite fast. But then...

"Search for a strategy"
The N.Y.U. Tandon conference, the topic of the field, is becoming increasingly settled. Most of the talks at this conference were situated in a relatively new framework, built on decades of work on the interaction of analog and digital circuits, conceptions of robustness, and dependence on both tolerance and dissipation. Stressed was the need to break a nearly invisible layer of isolation on the communication layer, locally with neighbors, and far away, to the end-users. A new model was to show that if we can write a program that can be turned off, we can do it. The goal of the conference will be to perform a 2-bit multiplication, not particularly with the example compared to what is currently being used, but nevertheless, a potential tool, and therefore meaningful.

Hugo de Carvalho of the University of Texas, USA

de Carvalho spoke of the implicit "Neuromorphic Machines" will have on AI in 15 years time. He presented two talks on the "New Arenas for Wearable Hardware" session. As neuromorphic machines are ones consisting of an analog's number of components, i.e., a trillion trillion, which will be the case on Moore's law taking electronic circuits down to molecular scale by 2020. Such circuits will have to be reversible, so as not to leave the kind generated by today's irreversible circuits. Such irreversible circuits cannot be used when electronic devices move to molecular scales. They will have to be robust, as the world of such circuits will become even harder to detect. As molecular circuits will probably not achieve their state in femtoseconds, the current paradigm of "electronic" computing, with a centralized computer program memory, will also be replaced by a "cognitive computing", approach, in which pieces of theprogram are distributed throughout the computational medium. Right now, a byte (20 cm) in a nanoscale, but only a distance of about 300 atoms in a femtosecond, and so there is no time to field an instruction from a distant central memory. So each cell in the medium executes its own local instructions, and the overall solution emerges as all the cells interact locally. To achieve a desired functionality, it will probably be critical. An analog circuit will also have to seek assembly endogenously. That is, its program is a 100% open, that will be possible with reversible computing. But, if the received signals, signals will probably have to be sent in units 2 times of the 3D "time". When, and where, they collide will influence the bit of output.

Simon Harding of the University of York, UK

Simon Harding is a graduate student in York, being supervised by Julian Miller. He spoke of the insights he has obtained reading a recent discrimination of the liquidic system. Miller is well known in the 11 community for advocating the use of alternatives to electronic circuits as a hardware mechanism for evolution. Harding showed that he would evolve a "true solution" similar to the famous experiment of Adrian Thompson of Sussex University, the closed loop invention of using the first person in the world to evolve an electronic circuit "intentionally" for using an actual circuit to perform the evolution, not doing it "automatically", i.e., in software simulations outside the circuit. However, if extreme conditions are true, Lycok in 1992 showed that this possibility is quite real, working in the same room with (Hugo de Carvalho). Thompson and Harding evolved detectors that would give a high voltage output when the input signal was 1KHz, and a low voltage output when the input signal was 1KHz. Harding got his liquid crystal to evolve, and in the using generations than Thompson looks, but Harding could be the first known by what means his system evolved. Miller
saves that this type of evolution is "exploratory," i.e., looking for new physical phenomena that the evolution can exploit. As an aside, Thompson has not been present at the last two EPC conferences, which is odd, because he used to be hampered for his glamorous appearance. What happened to him?

General Remarks
Looking back over the conference, what sticks in my mind?

I think two things. One is that the field seems to be stabilizing in the sense that the topics discussed will seem to pop up year after year. This is to be expected with the growth of any new research field. Another is that the topic of cellularity (embryological electronic) has become a stable element of EPC. There were two whole sessions on this topic at the 1991 conference. I consider this to be a most important development. As electronics evolves to molecular scale, it is likely that circuits will have to self-assemble in their trillions of trillions, i.e., they will have to "grow" in an embryological way, like cells.

I feel the use of the "morph" systems is essential, even though the broad approach seems so unapplicable to the "average" systems, systems having a trillion trillion components. It will perhaps within 120 years, as Winer's Law continues its relentless doubling of electronic capabilities. We need only look to biology to see how successful it has been in building its circuits, using a sequential gene-switch (controlled approach. As electronic circuits shrinks, both biological and electronic components end up as the same molecular size. I predict a successful and productive marriage between biology and electronics over the next few decades. The biologists will be able to test their theories in "electronic biology" based systems and the electronics people will be inspired by biological ideas for their systems building.

I am glad to be able to also report that Andy Terrell and team Greenwood have teamed up and are currently working at the University of Texas at Austin in this area. With a similar approach to mine, the field of "Embryological Evolution" has taken off, and the field of "Genetic Algorithms" took off after the appearance of David Goldberg's classic text in 1989.

Finally, and this is the most important piece of information in this report, most talks of this conference will be available at the following URLs:

- [Evolutionary Computation](http://example.com)
- [Genetic Programming](http://example.com)
- [Other Related Sites](http://example.com)