Hard Disk Cafe Toastmasters,  CTM-11-06 presentation - 11th presentn, repeat CTM-06 Vocal Variety

# CTM-06-2nd  "Anti-engineering and the emergence of racism"

Bill Howell, 29Nov06

## Opening

Murphy's Law states that "..If nothing can possibly go wrong, it will..".  We can all relate to that expression in our daily lives and jobs, but it is particularly well illustrated by engineering and software programming of complex systems.  As an engineer or programmer, you must understand and control all aspects of a challenge to extreme levels of detail, or the part that you weren't so sure about will come back and bite you.

But recently I've seen extremely complex projects for which Murphy's Law doesn't seem to prevent at least some degree of success where you might expect none, and this I am calling "Anti-engineering".

## Daryl Kipke, University of Michigan - IJCNN04 Budapest

In Budapest during the summer of 2004, a researcher from Minnesota described the challenges associated with the design of electrode arrays that are inserted into the brain.  After speaking for 20 minutes, he then started a video showing recent experiments with a monkey.

The monkey was in very good spirits, clearly happy and looking for something fun to do.  He was strapped into his chair by a seat-belt, and he had a steel cap on his head from which wires ran to instruments and a computer.  Of course, underneath the cap an array of electrodes extended into his motor cortex. On the table beside the monkey was a sophisticated humanoid robot arm, with fingers, hand and wrist, and it was "bulked up" with plastic covers to make it look real, although you could still see the metal joints and some wiring in the gaps between plastic covers.  It was clearly a very sophisticated robot arm.

A researcher then entered the room carrying a bowl of big, red, juicy strawberries.  The monkey's eyes grew as big as saucers and he became very excited.  As soon a the researcher placed the bowl of strawberries on the table, the monkey reached out, grabbed a strawberry and stuck it in his mouth  - using the robot arm.

I was amazed!  I had never seen a robot arm move in such a life-like fashion - especially an arm so complex as the one that they used.  The amazement turned to awe, the awe changed to admiration, and the admiration turned to excitement.  Just think of what such a capability might mean!  The possibilities seemed endless!

Suddenly, a dark cloud came over my thoughts.   Then I felt anxiety, fear, and finally anger.  I realized that I was now completely outclassed by monkeys!  I couldn't hope to do with my arms what they could do with theirs.  From that point, I could no longer trust monkeys, nor could I ignore their motivations.  I had in an instant become a racist, because the monkeys were clearly a threat and had an unfair and unjust advantage over me.

But the second thing that struck me was that the researchers really didn't have a clue about how to analyse and process the signals in the motor cortex.  Nor, for that matter, did the monkey.  The brain did that, and we don't really know how.

**Tom DeMarse, University of Florida - IJCNN05 Montreal**

For my vacation the following summer of 2005, I was in Montreal when a scientist from the University of Florida presented their results for experiments with a Multi-Electrode Array (MEA). Now an MEA is an array of 8*8 electrodes in a very small circular dish. Neurons from a rat's spine are separated in a cultured, perhaps several hundred or a couple of thousand neurons then placed on the MEA. Some neurons are in contact with the MEA electrodes, and electrical signals can be sent to the neurons, or read from them as the neurons fire.

The scientist described how the MEA was built into a electronic system that could be used to control things. The electronics could do the normal engineering, and the neurons could do Anti-Engineering, that is, in spite of the fact that we don't understand much of what is happening, the neurons would learn by themselves to control a system.

The team had chosen a simple challenge - they would control a virtual aircraft in straight and level flight using Microsoft Flight Simulator. It was a brilliant approach - the simulator is very sophisticated, is well-known by many people, and it provides a consistent and reliable test-bed with more complex challenges for the future.

The results were impressive even though the rat spine neurons in the MEA were doing a chore that could easily be handled by a very primitive engineering control. The key was that the MEA could clearly learn how to control a system. Again, the implications for the future are profound, and again, powerful results are possible without understanding how the system works.

The virtual aircraft that the rat spine neurons had flown was an F-22 Raptor, the next generation fighter aircraft, that has awesome capabilities and which will be another beautiful flying machine. Man, would I ever like to fly that beauty! That would be my dream job!

Wait a minute! - In an instant my dream imploded, shattered by a horrible reality. The rats have stolen my dream job!

I **HATE** rats!!!

**Conclusion -**

Last summer in Vancouver, a Japanese scientist described the control of a small wheeled robot by a culture of neurons from a rat's spine on a Multi-Electrode Array. At the end of the session, a Polish scientist was walking past me for the exit, and he had a very serious, pensive look on his face. I was curious about his feelings, so I told him that I was impressed by the initial results of the Japanese team and asked him what he thought.

“What if those were human neurons?” he asked.

It was a profound questions, so I thought for a few moments, and replied:
“Well, if they were human neurons I'm sure that they would want a cup of coffee.”

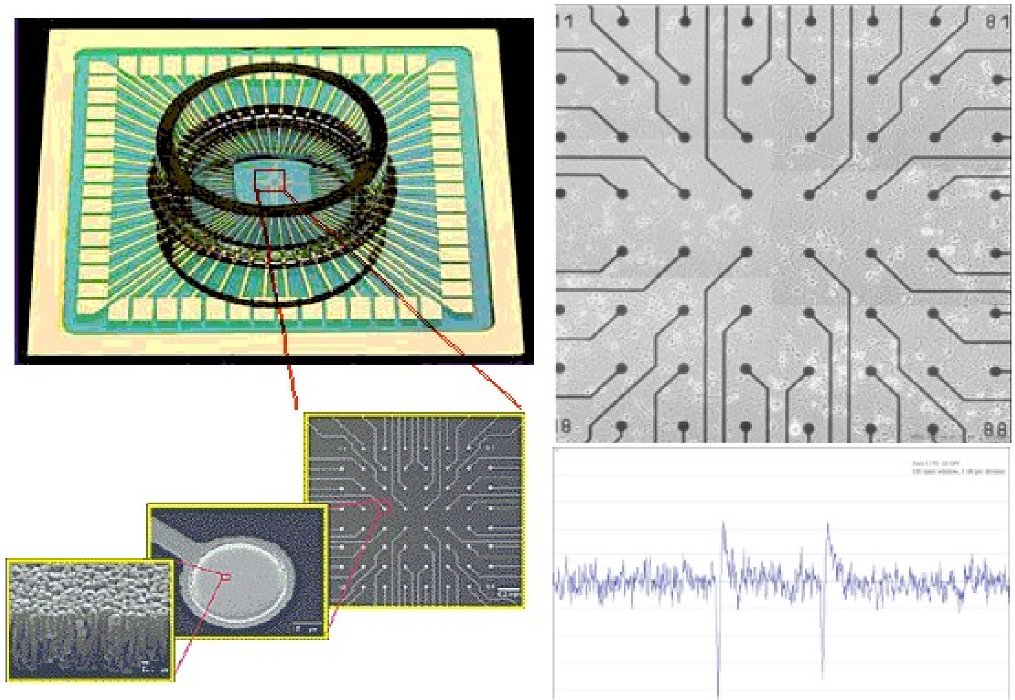


Fig. 2. A microelectrode array (MEA) commercially available from Multichannel Systems (upper left). 60 electrodes are arranged in an 8 x 8 grid spaced 200 um apart (lower left). The upper right panel shows neurons cultured on an array and lower left, and example of two spontaneous action potentials recorded

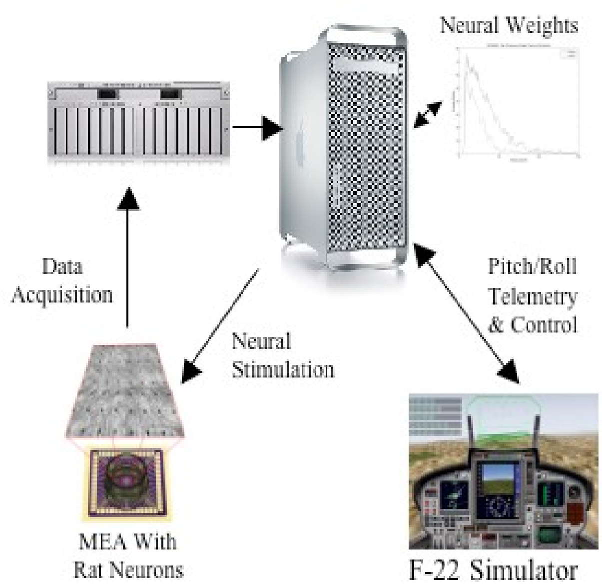


Fig. 1. Schematic of Neural Flight Control System using living rat cortical neurons for pitch and roll control.

T. DeMarse and K. Dockendorf "Adaptive Flight Control with Living Neuronal Networks on Microelectrode Arrays" 2005 International Joint Conference on Neural Networks, Montreal, 31 July – 4 August 2005, paper#1772, pp1548-1551

Fig. 7 Collision avoidance of Khepera II robot with living neuronal network (E18D96).

S. N. Kudoh, T. Taguchi, I. Hayashi "Interaction and Intelligence in Living Neuronal Networks Connected to Moving Robot" 2006 IEEE International Conference on Fuzzy Systems, Vancouver, July 16-21, 2006, paper #4516, pp6271-6275

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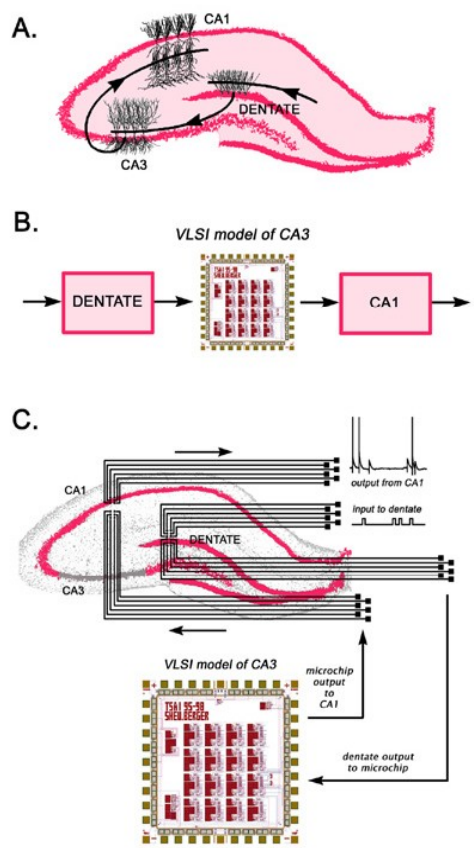


Fig. 2. A: Dentate CA3 -> CA1 circuit of a hippocampal slice; B: Concept of replacing the CA3 region with a biomimetic VLSI device; C: Bidirectional communication between a hippocampal slice (CA3 region removed) with the VLSI device through a multi-site electrode array.

T.W. Berger, J.J. Granacki,, V.Z. Marmarelis, A.R. Tanguay,, S.A. Deadwyler , G.A. Gerhardt "Implantable Biomimetic Electronics as Neural Prostheses for Lost Cognitive Function" 2005 International Joint Conference on Neural Networks, Montreal, 31 July – 4 August 2005, paper#1745, pp3109-3114

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