

BREAKING NEWS

NEWS & ANALYSIS: AMD Narrows Its Losses in Q1



Come connect with us
REGISTER TODAY!

designlines SoC

News & Analysis

Neuromorphic Roadmap Plots Analog Path

R. Colin Johnson

4/21/2014 02:00 PM EDT

[Post a comment](#)

NO RATINGS
[LOGIN TO RATE](#)

Like Tweet Share

PORTLAND, Ore. — Cognitive computers, artificial neural networks, neuromorphic systems, and similar efforts to cast the intelligence of the human brain into silicon chips is all the rage at major corporations, from [IBM](#) to [Qualcomm](#), and at major government-sponsored efforts, including the US Defense Advance Research Project's (DARPA's) Systems of Neuromorphic Adaptive Plastic Scalable Electronics [Human Brain Project](#). Now researchers at Georgia Tech have created a roadmap for the development of brain-like neuromorphic systems that, they say, can serve as a guide to all players.

Most Recent Comments



Jerry G What is even more amazing is that it always seems to come back to this 'ressurrected dead guy'. That in itself says much! If he is who he said he is, then he is more marvelous...

4/21/2014 1:57:16 PM

Education for the creators of technology

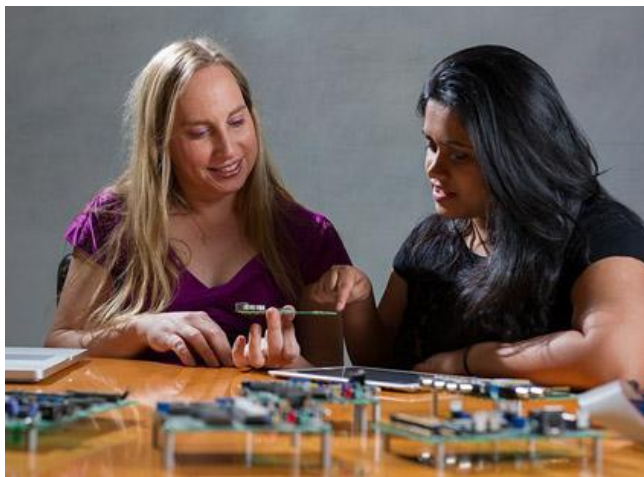
Courses
Tech Papers
Webinars
Videos
Company Directory



Find it all on the new **TechOnline.com**

WELCOME TO **IoT WORLD**

Come connect with us



Professor Jennifer Hasler (left) and doctoral candidate Suma George examine a field-programmable gate array board.

Navigate to Related Links

- [Slideshow: 10 Embedded Design Trends](#)
- [Smartphones, 28nm Tech Drive TSMC 1Q Revenue](#)
- [IMEC Adds Image Sensors to Commercial Development Service](#)
- [Samsung, Globalfoundries Prep 14nm Process](#)
- [Motorola People, Products Remembered](#)

Most Commented **Most Popular**

- [114 Engineers in America: Too Young, Too Old](#)
- [97 March's Caption Contest Is Up, Or Is It Down?](#)
- [89 January's Comic Is Fit for a King](#)
- [88 Check Out the CEO's Paycheck](#)
- [84 Creating Gender-Neutral Engineering Prose: ...](#)
- [75 HP Lays Off 5,000 More Employees](#)

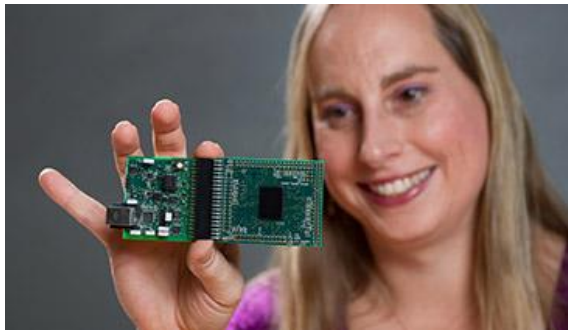
(Source: Rob Felt courtesy of Georgia Tech)

"If you look at the technology we have now, and forward to that which will soon be available -- for instance, 11 nanometer processes -- then you come to the conclusion that eventually we really could build a human-like cortex in something that could use as little as 50 watts of power and be small enough to put on your desk," Georgia Tech professor Jennifer Hasler told EETimes.

The [roadmap](#) is authored by Hasler and Georgia Tech doctoral candidate Harry Bo Marr, now graduated and working at Raytheon Co. in El Segundo, Calif., as the technical lead of DARPA's Arrays at Commercial Timescales (ACT) program and lead electronic warfare digital architect. Hasler and Marr's roadmap also relied upon [results](#) obtained by Georgia Tech doctoral candidate Suma George, who experimentally demonstrated, for the first time, that neuromorphic systems based on circuits that tightly model biological principles have clear advantages over other approaches, including typical analog signal processing techniques.

Hasler's own research emphasizes the key role that properly designed analog processing elements will have on neuromorphic systems, specifically field-programmable analog arrays (FPAAs) that she and colleagues at Georgia Tech have been perfecting for several years.

FPAAs are similar to field-programmable gate arrays (FPGAs) but include reconfigurable analog elements. FPAAs are commercially available from Mesa, Az.-based [Anadigm](#), but Hasler claims Georgia Tech's FGAs "dwarf the programmability and capability of the Anadigm components" by virtue of housing "hundreds of thousands of programmable parameters, enabling them to be used for system-level computing, not just analog glue logic."



Professor Hasler holds an FPA board she is using to emulate biologically based neural networks.

(Source: Rob Felt courtesy of Georgia Tech)

Hasler believes the clear path to desktop neuromorphic systems will require such analog system-on-chip (SoC) approaches to computation in order to achieve the low-power devices necessary to emulate billions of brain-like neurons connected by trillions of learning synapses. In all, she predicts that desktop neuromorphic systems that rival the compactness of the human brain will require "eight orders-of-magnitude" (100 million times) reduction in power over the digital supercomputers simulating them today. Going to configurable analog-digital systems, like FPAAs, gets you "four orders-of-magnitude" (10,000 times) improvement, but the remaining four orders-of-magnitude will have to come from milestones along the neuromorphic systems roadmap.

[EMAIL THIS](#) [PRINT](#) [COMMENT](#)

[PAGE 1 / 2 NEXT >](#)

More Related Links

- [Slideshow: 10 Embedded Design Trends](#)
- [Smartphones, 28nm Tech Drive TSMC 1Q Revenue](#)
- [IMEC Adds Image Sensors to Commercial Development Service](#)
- [Samsung, Globalfoundries Prep 14nm Process](#)
- [Motorola People, Products Remembered](#)

- [71 Do You Have a Working Paper Tape Reader?](#)
- [70 February's Caption Contest Is a Roll of ...](#)
- [63 Asynchronous Techniques Push Moore's Law ...](#)
- [60 Arduino Mega Proto Screwshield PCB, Part 2 ...](#)



Flash Poll

How do you characterize software patents? Are they useful to the semiconductor industry or just a hindrance to innovation?

- Software patents are increasingly key to future innovations
- Software patents are important but need to be better defined
- Software patents are probably a necessary nuisance
- Software patents should be outlawed
- Don't know

ALL POLLS

[DataSheets.com](#)



[IoT WORLD](#)

Like Us on Facebook

EE Times
Like

8,946 people like EE Times.



Facebook social plugin

Datasheets.com Parts Search
185 million searchable parts
(please enter a part number or hit search to begin)

BREAKING NEWS

S & ANALYSIS: Quantum-Dot Windows Harvest Solar Energy

NEW! 


Come connect with us
 REGISTER TODAY!

designlines SoC

News & Analysis

Neuromorphic Roadmap Plots Analog Path

R. Colin Johnson

4/21/2014 02:00 PM EDT

[Post a comment](#)


NO RATINGS
LOGIN TO RATE

Like
 Tweet
 Share 

In Hasler and Marr's roadmap they describe the specific computational milestones that have already been achieved -- such as the single-transistor synapse and the FPAA -- as well as the algorithms and computational models that have been proven out so far. The roadmap then proceeds to detail the areal density of artificial neurons and synapses that will be necessary to realize a low-power neuromorphic system whose size rivals that of a human brain.

Most Recent Comments




junko.yoshida @me3, absolutely, you are correct. The goal of small startups should not be "help chip guys." But then, the question comes... what else chip guys should be doing to help small...

4/21/2014 2:11:43 PM


Hadoop Projects 15x Faster From Months to Minutes
[Download Article](#) →



Navigate to Related Links

- Slideshow: 10 Embedded Design Trends
- Smartphones, 28nm Tech Drive TSMC 1Q Revenue
- IMEC Adds Image Sensors to Commercial Development Service
- Samsung, Globalfoundries Prep 14nm Process
- Motorola People, Products Remembered

Most Commented Most Popular

- 114 Engineers in America: Too Young, Too Old
- 97 March's Caption Contest Is Up, Or Is It Down?
- 89 January's Comic Is Fit for a King
- 88 Check Out the CEO's Paycheck
- 84 Creating Gender-Neutral Engineering Prose: ...
- 75 HP Lays Off 5,000 More Employees

WELCOME TO
IoT WORLD
 Come connect with us



FPAA developed at Georgia Tech by professor Jennifer Hasler as a power-efficient, mixed-signal SoC for neuromorphic computing. (Source: Rob Felt courtesy of Georgia Tech)

Finally, the roadmap addresses the software tools that will be necessary to design these neuromorphic chips as well as the learning techniques, network topologies, novel interconnection devices -- such as [memristors](#) -- and how these components could



be developed into usable chip arrays. For instance, memristors could serve for slow-scale modulatory parameters in neuromorphic systems.

Throughout, the roadmap emphasizes a modular approach, such as successfully emulating one layer of a human brain cortex before attempting multilayer devices, as well as the major engineering hurdles that need to be surmounted, such as using local-interconnection techniques to reduce the complexity of communications traffic among billions of neurons and trillions of synapses. The paper's overall conclusion is that "useful neural computation machines based on biological principles at the size of the human brain seems technically within our grasp."

Funding was provided, in part, by DARPA's SyNAPSE program.

— R. Colin Johnson, Advanced Technology Editor, [EE Times](#)

Related posts:

- [IBM Founds Watson Group](#)
- [Qualcomm Reveals Neural Network Progress](#)
- ['Corelets' Prime Cognitive Computers](#)

[EMAIL THIS](#) [PRINT](#) [COMMENT](#)

[< PREVIOUS PAGE 2 / 2](#)

More Related Links

- [Slideshow: 10 Embedded Design Trends](#)
- [Smartphones, 28nm Tech Drive TSMC 1Q Revenue](#)
- [IMEC Adds Image Sensors to Commercial Development Service](#)
- [Samsung, Globalfoundries Prep 14nm Process](#)
- [Motorola People, Products Remembered](#)

Comments

VIEW COMMENTS: [NEWEST FIRST](#) | [OLDEST FIRST](#) | [THREADED VIEW](#)

Be the first to [post a comment](#) regarding this story.

- 71 [Do You Have a Working Paper Tape Reader?](#)
- 70 [February's Caption Contest Is a Roll of ...](#)
- 63 [Asynchronous Techniques Push Moore's Law ...](#)
- 60 [Arduino Mega Proto Screwshield PCB, Part 2 ...](#)



Flash Poll

How do you characterize software patents? Are they useful to the semiconductor industry or just a hindrance to innovation?

- Software patents are increasingly key to future innovations
- Software patents are important but need to be better defined
- Software patents are probably a necessary nuisance
- Software patents should be outlawed
- Don't know

ALL POLLS



Like Us on Facebook

EE Times
Like

8,946 people like EE Times.

Facebook social plugin

Datasheets.com Parts Search
185 million searchable parts
(please enter a part number or hit search to begin)