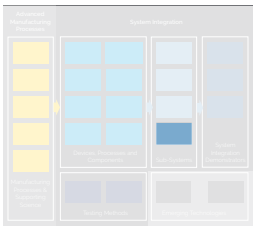

PATHFINDER 2015

SYSTEM INTEGRATION

Printed electronics for neuromorphic computing (pNeuron)

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Some of the most challenging issues in printable large-area electronics are related to the reliability, variability and relatively low speed of individual devices, which make it difficult to implement more complex functionality, especially analogue signal processing circuits. Remarkably, biological systems have evolved solutions to these problems: neurons are slow, highly variable and volatile, and yet brains have an amazing ability to achieve robust operation, and process information at high speed and with low power consumption. Hence a question arises: can circuits based on neural principles provide useable solutions to coping with device issues in large-area electronics?

Conversely, as the interest in brain-inspired systems continues to grow, with potential applications ranging from machine intelligence to brain interfacing and prosthesis, one of the challenges is to find suitable implementation technologies for the 'neuromorphic' (i.e. brain-mimicking) systems. These are usually implemented using conventional silicon integrated circuits; however, these have been optimised for high-speed numerical computation, and are not necessarily a most natural fit. Perhaps low-cost large-area printed electronics, with its inherently more "neuron-like" devices, could provide an ideal alternative technology for implementing such systems?

We have started exploring these questions in this project. Our goal is to demonstrate spiking neuron circuits mimicking biological behaviour, fabricated using printed organic electronics technology. We have focused on designing pMOS circuits implementing integrate-and-fire neurons, and we have advanced our in-house inkjet printing based device fabrication technology. We have characterised our devices, and elaborated device models suitable for SPICE simulations, and we are currently developing complete neuron circuits using these devices. In a parallel effort, we are designing circuits in collaboration with NeuDrive, to be fabricated at the Centre for Process Innovation. These initial proof-of-concept designs are preparing the ground for future research, including larger collaborative research proposals.