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18 February 2016

Major Technological Advancement of BrainChip Artificial Intelligence – Autonomous Feature Extraction (AFE) System Developed

In a major advancement to its existing and patented SNAP (Spiking Neuron Adaptive Processor) technology, the research and development team at BrainChip have completed development of a unique Autonomous Feature Extraction ("AFE") system.

Utilising the hyper-speed SNAP neural processor, the AFE system is able to process and learn complex and overlapping real-world digital features, and has been used on a range of input patterns and shapes.

Highlights

- **The AFE system is digital and hardware based (not a software program);**
- **Using SNAP technology, it is able to process 100 million input events per second, which are distributed to thousands of dynamic synapses;**
- **The hardware is commercially ready and demonstrable to potential licensees;**
- **It has been established in a completely configurable design for use as a commercial product with other neural network designs;**
- **The AFE system has substantial application opportunities in easily applied markets;**

CEO and inventor of BrainChip's SNAP technology, Peter van der Made said "This is a major breakthrough in the high speed application of Artificial Intelligence systems and presents a world-first in cutting edge technology. Our AFE system is possibly the fastest autonomous learning network invented so far. The potential applications of the AFE system are considerable, and we look forward to integrating this exciting technology into a number of applications as the year advances".

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Recent events and media coverage have highlighted areas of technological demand that BrainChip believes can be met by its AFE system, examples of which are:

Financial Data Analytics
Global hedge funds and brokerage firms including JP Morgan Chase have highlighted the opportunity that predictive analytics presents.
http://www.wired.com/2016/01/the-rise-of-the-artificially-intelligent-hedge-fund/

Sports Performance Analytics
Sporting teams are embracing artificial intelligence to help to analyze individual player performance and to predict in-game play scenarios.
http://www.wired.com/2016/01/football-coaches-are-turning-to-ai-for-help-calling-plays/

Border Protection Systems
A system designed with multiple sensors including a camera (for facial recognition), an artificial retina (for shape recognition) and an e-nose (for scent detection) would be deployable to detect persons of interest and contraband.

Driver Experience Enhancement
Car manufacturers including Tesla, have highlighted their desire to improve the driving experience with autopilot devices and other significant improvements, focused on bettering the driver experience from a number of angles including safety.
http://fortune.com/2015/10/16/how-tesla-autopilot-learns/

Drone Safety
The need for safer use of commercial drones in public airspace has driven the likes of Amazon and the US Government to investigate how AI can enhance the control of these vehicles deployed over flight paths.
http://mashable.com/2015/11/30/amazon-prime-air-reality/#Zble1x1olkqH

BrainChip's AFE system can be configured to provide solutions not only to those mentioned as examples above, but across a significant number of sectors.

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About the Autonomous Feature Extraction system (AFE)

The AFE system is comprised of a SNAP spiking neural network that learns from input patterns and performs autonomous feature extraction and data labeling for pattern recognition. The system can be used to process a wide range of real-world events and digital data from a multiple of sensors. The system can learn from both recorded and real-time input data. The learned features can be stored in a knowledge library. This library of learned behavior can be loaded on to further systems in order to instantaneously assimilate the learned features.

The system is composed of three SNAP units. The first unit consists of sensory neurons that map input data to spike patterns that are distributed spatially and over time. Similar to a biological brain, these sensory neurons will fire spikes at different times depending on the input they receive. The outputs of the sensory neurons are then transmitted at a rate of up to 100 million events per second to the next unit that performs autonomous feature extraction, also called unsupervised feature learning. These 100 million events are distributed to thousands of synapses in parallel, which are updated one million times per second. This unit learns the main features that characterize a given set of data. For example, this unit learns the features of letters and digits when the input data consists of handwritten characters.

The autonomous feature extraction unit is composed of a spiking neural network that utilizes an unsupervised learning rule (e.g. Spike Timing Dependent Plasticity: STDP), and lateral inhibition so that different neurons in the network learn different features. Lateral inhibition means that the first neuron to recognize a specific input pattern inhibits all others in the same layer. The learning process that occurs in this unit can run continuously or over a specific period of time. The SNAP learning method has proven to be very fast.

The output of the autonomous feature extraction unit is forwarded to the labeling unit. This unit consists of a spiking neural network that is trained in a supervised way to map learned features to output labels. For the handwritten characters' example, the output labels could be letters and digits, or complete words that the system has learned to recognize. The output labels can be used in an external device like a Central Processing Unit (CPU) for post–processing.

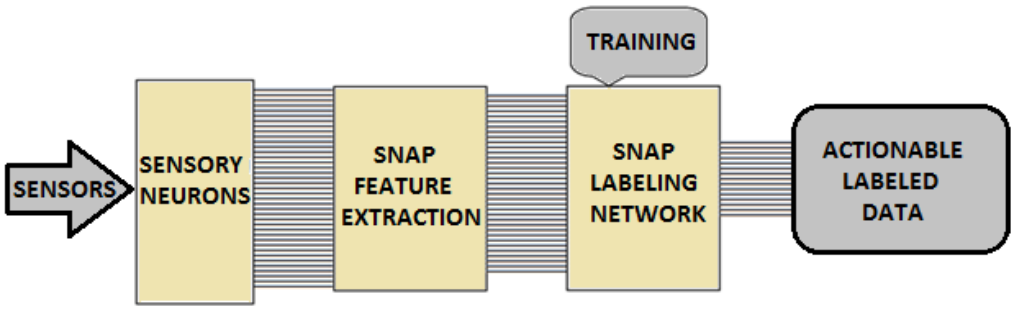

Figure 1: Schematic diagram of BrainChip's Autonomous Feature Extraction System

The system is implemented in digital hardware using BrainChip's unique parallel technology. All neurons and synapses are updated at a rate of one million per second. BrainChip's spiking neural network connectivity can be externally configured. Synapses are dynamic, that is, the properties of synapses change over time using the STDP learning rule. The output of many synapses is integrated by dendrites and a soma. The output of a soma is fed to a neuron's axon that emits one or more output spikes when a previously learned pattern is recognized. The spike from an axon is transmitted to the connected synapses using a proprietary fast communication protocol.

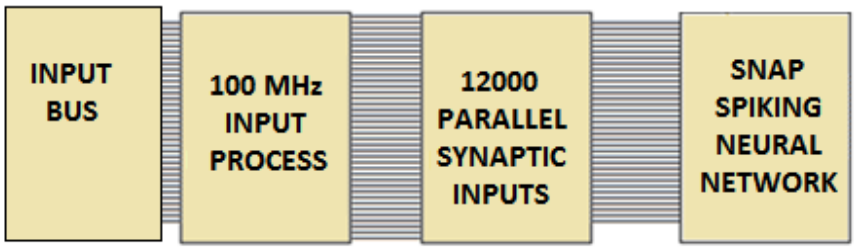

Figure 2: Method of input processing at 100 Million events per second

Peter van der Made continued, "BrainChip is very pleased and excited to unveil this major technological breakthrough in Artificial Intelligence technology, as a significant

advancement of its patented neural processor, SNAP. We will be providing the market with a visual demonstration of our AFE system, alongside Milestone 3 later in the quarter. We look forward to providing further updates on the application of this exciting new technology through the year."

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