A heterogeneous device technology reconfigurable logic fabric is proposed which leverages the cooperating advantages of distinct magnetic random access memory (MRAM)-based look-up tables (LUTs) to realize sequential logic circuits, along with conventional SRAM-based LUTs to realize combinational logic paths. The resulting Hybrid Spin/Charge FPGA (HSC-FPGA) using magnetic tunnel junction (MTJ) devices within this topology demonstrates commensurate reductions in area and power consumption over fabrics having LUTs constructed with either individual technology alone. Herein, a hierarchical top-down design approach is used to develop the HSC-FPGA starting from the configurable logic block (CLB) and slice structures down to LUT circuits and the corresponding device fabrication paradigms.

An orthogonal dimension of fabric heterogeneity is also non-determinism enabled by either low-voltage CMOS or probabilistic emerging devices. It can be realized using probabilistic devices within a reconfigurable network to blend deterministic and probabilistic computational models. Herein, consider the probabilistic spin logic “p-bit” device as a fabric element comprising a crossbar-structured weighted array. Programmability of the resistive network interconnecting p-bit devices can be achieved by modifying the resistive states of the array’s weighted connections. Thus, the programmable weighted array forms a CLB-scale macro co-processing element with bitstream programmability. This allows field programmability for a wide range of classification problems and recognition tasks to allow fluid mappings of probabilistic and deterministic computing approaches. In particular, a Deep Belief Network (DBN) is implemented in the field using recurrent layers of co-processing elements to form an n-m1-m2-…-mi weighted array as a configurable hardware circuit with an n-input layer followed by i hidden layers.

Major: Computer Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2010, Imam Khomeini International University (IKIU)
Master's of Electrical Engineering, MS, 2012, Sharif University of Technology

Committee in Charge:
Ronald F. DeMara, Chair, Electrical and Computer Engineering
Mingjie Lin, Electrical and Computer Engineering
Kalpathy Sundaram, Electrical and Computer Engineering
Deliang Fan, Electrical and Computer Engineering
Annie S. Wu, Computer Science

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The public is welcome to attend.