UNIVERSITY OF SOUTH FLORIDA
COLLEGE OF ENGINEERING

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Research Team has Findings Published in *Nature Nanotechnology*

Nano-scale magnets could compute complex functions significantly faster than conventional computers.

TAMPA, Fla (October 26, 2015) – Researchers from College of Engineering at University of South Florida have proposed a new form of computing that uses circular nanomagnets to solve quadratic optimization problems orders of magnitude faster than that of a conventional computer. A wide range of application domains can be potentially accelerated through this research such as finding patterns in social media, error-correcting codes to Big Data and biosciences.

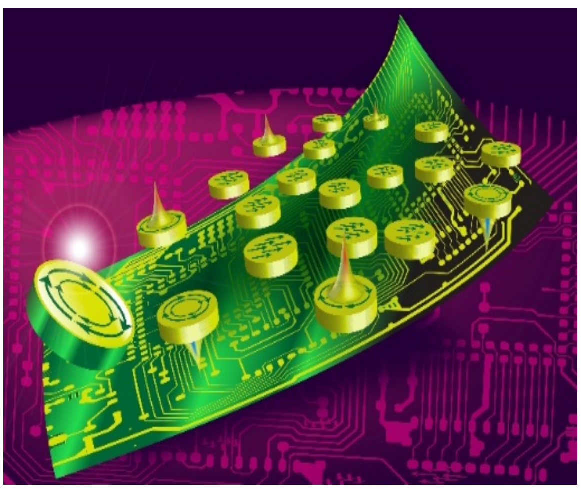

Illustration by Ryan Wakefield

Magnets have been used as computer memory/data storage since as early as 1920; they even made an entry into common hardware terminology like multi-"core". The field of nanomagnetism has recently attracted tremendous attention as it can potentially deliver low-power, high speed and dense non-volatile memories. It is now possible to engineer the size, shape, spacing, orientation and composition of sub-100 nm magnetic structures. This has spurred the exploration of nanomagnets for unconventional computing paradigms.

Figure 1. The artist's portrayal is an illustration of a nanomagnetic coprocessor solving complex optimization problems and highlights the shape-engineered nanomagnet's two unique energy minimum states – vortex and single domain.

In this work "Non Boolean computing with nanomagnets for computer vision applications" as published in Nature Nanotechnology[1], the USF research team has harnessed the energy-minimization nature of nanomagnetic systems to solve the quadratic optimization problems that arise in computer vision applications, which are computationally expensive. By exploiting the magnetization states of nanomagnetic disks as state representations of a vortex and single domain, the team has created a modeling framework to address the vortex and in-plane single domain in a unified framework and developed a magnetic Hamiltonian which is quadratic in nature. The implemented magnetic system can identify the salient features of a given image with more than 85% true positive rate. This form of computing, on average, is 1,528 times faster than IBM ILOG CPLEX (an industry standard software optimizer) with sparse affinity matrices (four neighbor), and 468 times faster with denser (eight neighbor) affinity matrices. These results show the potential of this alternative computing method to develop a magnetic coprocessor that might solve complex problems in fewer clock cycles than traditional processors.

The research team is comprised of faculty, alumni and students of electrical engineering and computer science and engineering. Associate professor in electrical engineering Sanjukta Bhanja; alumnus Dinuka Karunaratne, '13 PhD in electrical engineering, and currently at Intel; Ravi Panchumarthy, doctoral candidate in computer science and engineering; Srinath Rajaram, '14 PhD in electrical engineering and currently at Micron; and computer science and engineering professor Sudeep Sarkar.

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[1]. Sanjukta Bhanja, D.K. Karunaratne, Ravi Panchumarthy, Srinath Rajaram, Sudeep Sarkar. Non-Boolean computing with nanomagnets for computer vision applications. *Nature Nanotechnology* (2015). http://dx.doi.org/10.1038/nnano.2015.245