Uic engineer tackles nanoscale computing challenges

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Today's best computer chips boast staggering transistor arrays exceeding 2 1/2 billion, but new nanometer-level technologies hold the promise of boosting that number even more. Nanotransistors may be fabricated from materials ranging from silicon to carbon nanotubes and even large molecules.

But how do you guarantee such ultra-small electronic circuits will perform reliably?

Wenjing Rao, University of Illinois at Chicago assistant professor of electrical and computer engineering, will explore that question using a five-year, $450,000 National Science Foundation Early Faculty Career award she just won.

Today's chips are built based on the device called CMOS -- complementary metal-oxide semiconductor -- which can be fabricated with very high reliability. But tomorrow's nanotransistors may need to be made using entirely new processes.

"If you switch to a different mechanism, there will be change," Rao said. "Just as if I switched building materials from brick to glass and steel, you get a different character. While I may be able to build a taller building with lighter materials, new problems may occur."

Future nanotransistors, she said, are likely to be subject to faults and defects. Research may even prove it is not worthwhile to manufacture

them for conventional use, such as desktop computers. But nanoelectronics-based systems may prove useful for entirely new application domains, such as embedded systems and sensors. Rao will explore this as part of her NSF Career Award, along with the theoretical limits, capabilities and applications of nanotransistor chips.

"If each transistor will be that small, you're subject to a lot of defects and faults," she said, "so, how do you deal with that? We have to be able to detect faults and find way to tolerate them, perhaps by using a different component to do the same computation, or -- long-term -- by self-repair."

Rao will study possible ways to best test and diagnose problems with nanotransistors and determine if and how redundant systems can act as safeguards against faults.

"You have to have a work-around," she said. "A chip for a sensor, for example, could be subject to environmental variations such as background noise, cosmic radiation and environmental vibrations. You'd also expect to see a lot of faults during computations."

Rao said computer engineers are asking many far-ranging questions about electronic nanosystems in an attempt to set up design and manufacturing rules that will ensure that new products using them will be reliable.

"We're really trying to probe for where's the boundary. What can and cannot be done? We're looking at what we can do from an engineering perspective into what's possible, what's not, and what's too costly."

Rao's grant will also be used in part to support doctoral students assisting in her research, and to develop new coursework on the subject at both the undergraduate and graduate levels.

Provided by University of Illinois at Chicago