Improving Human Health with Low-Power Cyber Physical Systems

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Technological innovation on the health care front means better data management—like being able to monitor multiple vital signs of a patient on an operating table—as well as enhanced patient outcomes, such as the use of implanted pacemakers that use electrical impulses to prompt a heart to beat at a normal rate. Now, science is exploring how to take technology to the next level in order to further improve human health. That step will require the design of complex, interoperable medical devices that would be able to vary their operation to suit changing body conditions, detect minute physiological changes that signal disease, and transmit such data to medical professionals, who could take remedial action before the disease is significantly developed.

The development and use of cyber physical systems that interconnect the human body and external computers (and thus medical professionals) will be dependent upon several things: minute scalability of the system and power source, long-term operability, functional robustness regardless of environmental factors, and security of the transmitted information. Creating nearly invisible implantable medical devices is challenged by conventional circuitry and system-design techniques that fail to deliver energy efficiency to satisfy a lifetime of service.

Mingoo Seok works to combine new circuitry and architectural design elements with ultra-low-voltage systems to make the possibility of millimeter scale implantable medical devices possible. He has demonstrated a very small (1 mm^3) computer that consumes pico- to nano-watts of power—consumption that is more than 1,000 times smaller than previous state-of-the-art technology.

His research interests are in low-power digital and mixed-signal design and methodology, and he has devised approaches that deliver record-setting energy efficiency in microcontrollers, embedded memories, power conversion circuits, and DSP accelerators. As part of the technical staff at the research and development centers of Texas Instruments, he focused on developing ultra-low-power security-enhancing circuit techniques.

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Photo: Mingoo Seok