Millimeter-Scale Smart Sensing Semiconductor Devices for Next-Generation IoT Applications

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Abstract

Miniature sensing semiconductor devices have unique feature sets that include wireless communication, energy harvesting, and a small form-factor, thus enabling non-invasive, secure placement for the next-generation Internet-of-things applications including biomedical, ecological, surveillance, and infrastructure applications, among others. There has been substantial research on the miniaturization of sensing semiconductor devices. The size of the bare die is often only 1-2 mm; however, the associated systems are typically much larger than just the die, resulting in centimeter-size systems due to included peripherals such as batteries and casings. This leads to a design challenge for the electronics of miniaturized systems because the maximum physical battery size and battery storage capacity are severely limited. I will discuss the challenges in developing small systems and introduce a millimeter-scale system. The semiconductor device has been developed as the world smallest computer. To optimize the performance, the system is constructed from die fabricated in different technologies which are then stacked and wire-bonded together. The stacked structure increases silicon area per unit volume and also makes it easy to swap layers in and out for flexibility in system configuration. Also, I will describe several examples of the miniature smart devices developed for different applications.