

## The Quiet Spark Plugs Behind the IoT: Sensors

As the Internet of Things continues its astonishing growth, smart and connected technologies are at the forefront of most IoT conversations. Lesser recognized are developments in Sensors that are making these smart devices possible. The Boston Consulting Group predicts that by 2020, some \$267 billion will be spent on IoT technologies, products, and services. Sensors are the spark plugs behind much of that growth.

“They’re going to be bigger than the internet,” said Dr. Ali Akansu, professor of electrical and computer engineering at the New Jersey Institute of Technology, when asked about the impact of these technologies.

### WAKE UP AND SMELL THE SENSORS

From the high-end coffee maker that senses your pod and starts brewing your first morning cup, after you click a couple on your smartphone while still in bed, to the climate control zoning system that keeps your bedroom set to your ideal sleeping temperature—thank Sensors. These devices enable smart homes, smart healthcare and smart retail.

In Australia, a large health insurer has begun placing Sensors throughout the houses of elderly members to monitor their health and hopefully prevent falls. The program places Sensors in refrigerators, medicine cabinets, doorways and bathrooms. They can monitor movement and track the temperature inside of the home. When these Sensors detect a break in routine or change in temperature, family can be notified immediately.

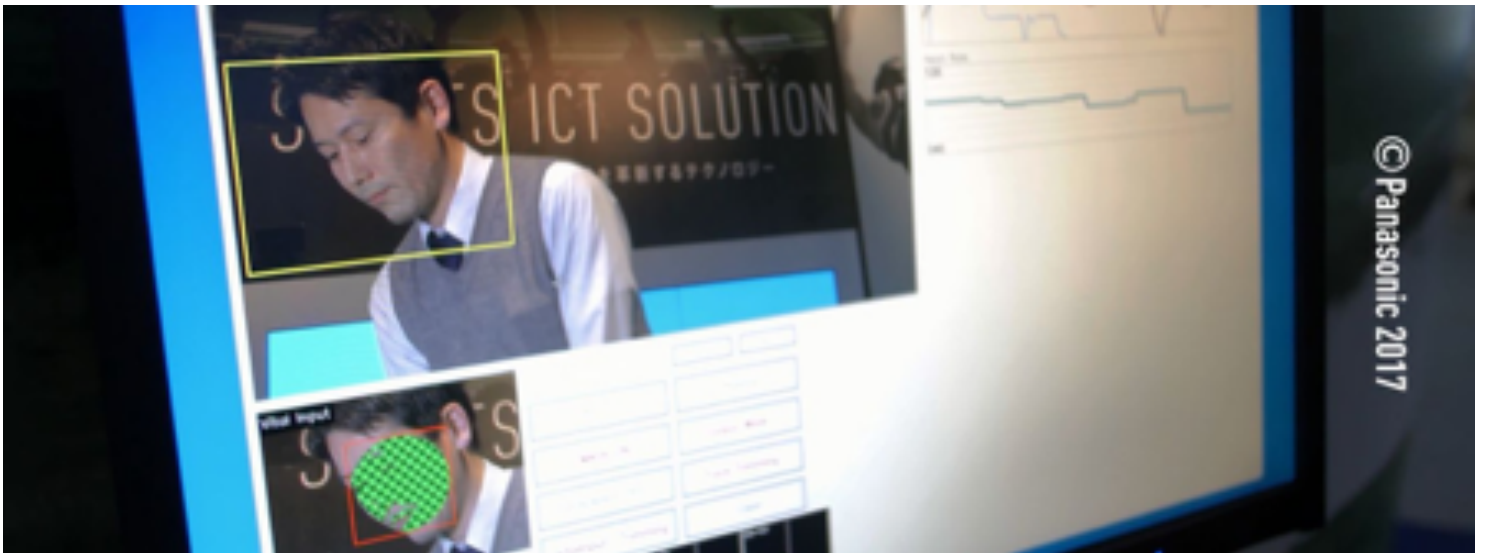
Meanwhile, Sensors are also being used to provide TV viewers information on heart rates of pro golfers. In late April, a couple of championship golfers had their stress levels broadcast on live TV as Sensors “read” their heart rates by monitoring their faces. It’s called “contactless vital sensing” and was used to give TV viewers fresh insight into the minds—and stress levels--of the athletes by way of a special camera and sensor.



Now, imagine that same technology being used on Wall Street traders, observes NJIT’s Dr. Ali Akansu. He says that collecting data and analyzing it as a preventative measure will become the new normal as more smart technologies use Sensors to collect data through every day use. “Everything will be pre-analyzed to improve efficiencies,” he says.

Las Vegas may be the best place to see how sensor technology is being used now and in the future. Earlier this year, CES 2017 provided a glimpse as creative, sophisticated, (and some very wacky) gadgets, appliances, plumbing, even equipment for our canine friends beckoned from show booths. There were ovens and smart fry pans that help you cook, video doorbells, wifi enabled plugs, even a smart device designed to scare deer away from your garden.

How did Sensors become so smart? Many experts credit encouragement by the U.S. Defense Department which put money and engineering talent toward Sensors in the 1980s. A decade later, costs of these devices were dropping as advancements persisted, and Sensors began to be used for both military and civilian purposes, such as automotive collision avoidance systems.

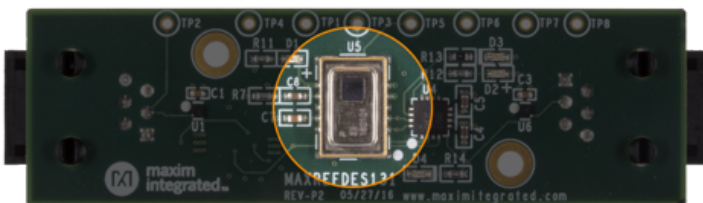


*Contactless vital sensing used Sensors to give TV viewers insight into the minds—and stress levels—of the athletes*

## INSIDE SENSOR TECH

Uncooled IR sensor technology has been improved with the development of more complex microelectronic systems (MEMS)-based pixel structure. By printing thin-film IR absorbers surrounded by free-standing thermal isolation structures, this MEMS-based technology is created. With this, it is possible to measure radiated power to remotely determine an object's temperature. Semiconductor technology allows for the development of thermopile Sensors made up of hundreds of thermocouples over several square millimeters. These thermopile array Sensors provide faster response time, are reasonably priced, and are accurate and small. They are ideal for medical instruments, security systems, people counting, building automation and more.

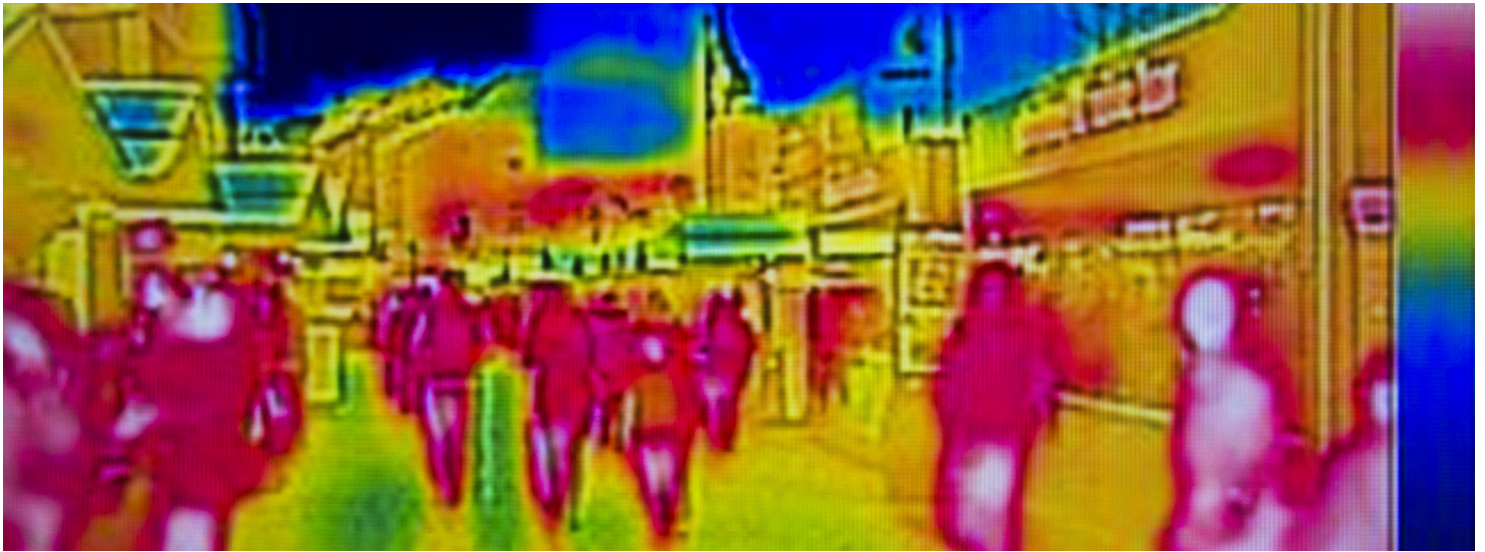
On such sensor is an 8X8 thermopile array device. This 64-pixel IR sensor fits within a reflow-compatible surface mount (SMD) package consisting of a MEMS detector chip, an RF-shielded metal cover, a digital ASIC with an I2C interface, and a silicon lens through which the infrared energy passes.



*IR sensor in a unique sensing solution*

In operation, this thermopile array sensor first absorbs emitted thermal energy across a 60-degree field of view. Each one of the array's 64 sensing elements converts the thermal energy it absorbs into a proportional output signal. All 64 temperature signals are then amplified, converted from analog to digital and referenced against an ambient temperature value supplied by a thermistor, and are then transmitted out of the sensor into a microprocessor. Once the sensor outputs the information, the microprocessor maps the temperatures from the individual thermopile elements into a complete thermal representation of the entire field of view. From this thermal grid, it is possible to detect moving people as well as the direction they are moving and the presence of motionless people. The sensor's widest thermal detection range is -20°C up to +100°C and it has a maximum recommended detection distance of 7 meters and frame rates up to 10 fps

Other applications, like building automation, can benefit from IR sensor technology. For example, this enables the ability to detect someone's presence when they enter a room to trigger the lights to switch on, can identify when the room is empty to shut off electronics and also work with the HVAC system to adjust to a preferred temperature depending on the room's occupancy.



Sensor technology is also spurring changes on the retail floor by providing data on consumer behavior without collecting sensitive personal information. Industry leaders are using it to help turn in-store experiences into sales.

Sensors with high pixel counts let retailers count and track multiple heat sources as they move. By tracking body heat, these Sensors can be leveraged to monitor people through an entire retail space—from providing information on how many people have stopped at the store window, and how long they stayed, to the numbers of people waiting to use the in-store VR gaming booths or details on the crowds gathered for high tech video displays.

But sophisticated Sensors aren't just tracking the number of people who enter a space. The consistent stream of information allows users to track movements through the location and measure the time and frequency shoppers spend in specific areas.

Medical institutions can use it to monitor a patient's activity, such as whether or not they're in bed or up and about in the room. By tracking the body heat of the individual, as opposed to collecting an image with a camera, these Sensors can be utilized to provide information and respect privacy.

In a similar setting, hospitals can monitor whether or not doctors are following procedures by tracking, for instance, whether or not the medical professional moves toward the sink and washes hands before and after inspecting a patient. Along with these applications, further uses for the Sensor include: digital signage, security, lighting control, kiosk and ATMs, medical imaging, portable devices, automatic doors, thermal mapping and robotics.

And urban dwellers may see some of the most interesting uses of Sensors. Already city planners are teaming up with tech providers to use Sensors to save energy and create safer spaces. Street lights, for instance, can be fit with Sensors that detect pedestrians as they approach and light their way home. And airport operators are receiving weather data from Sensors mounted on planes collecting storm information, in real-time, and using that data to make flight decisions. NJIT's Professor Akansu points to other beta-stage developments which he called e-flies that use tiny Sensors to monitor a particular area for suspicious activity. These are like bugs flying, with chemical Sensors in their wings. Or sneakers with Sensors that can help monitor our exercise and weight. "A sensor embedded in my smart shoe could inform me if I'm over or undercreating, and totally eliminate the need for scales," he says. Or tell a consumer to skip that steak dinner.

Learn more about [uses of Sensors now and in the future.](#)