Three Exotic Sensor Technologies in IoT

Abstract

Humans have five senses, only three of which have commercial electronic substitutes—audio, visual, and touch. Major strides have been made in these three bionic faculties, which has resulted in creation of the mobile and Internet of Things landscape we see today.

Some new and exciting developments in sensor technology are emerging and three new promising ones are close to commercialization.

The Business of Sensors

The market for sensors is expected to grow to $154 billion by 2020—a CAGR of 10.1%—mostly due to cameras in smart phones and mobile devices. An even faster growing category will be medicine, where bio-sensors are being used to diagnose and monitor health. The market projections are ~11.5% CAGR through 2020, or about $33 billion annually.

Progress is being made by start-ups like British based Owlstone, eNose based in Netherlands, and Aryballe Technologies in making commercial releases that are able to detect volatile organic compounds

Three Types of Sensors

The three types of sensors are:

- The first involves developing a bionic nose. It is difficult to extract information from airborne chemicals, which would provide us a digital sense of smell. Sensors that can capture the effect of organic and inorganic solids and liquids as perceived by humans, in a digital form, would provide the artificial substitute for taste. Electronic sensors of taste and smell have been emulated in a laboratory environment, but only recently have they been commercialized.
- The second sensor enables our own hands and fingers to become input devices. It uses radar technology that has been miniaturized into the size of a chip and embedded on a PCB.
- The third is not a sensor by itself, but rather a system of sensors combined with high power, low latency, edge computing, which has revolutionized the auto industry. It has made it possible for computers to drive vehicles.

In general sensors can be classified broadly by the way they react to stimuli, like sound or light, and the principle on which the sensor converts the input into a digital numeric value. E.g., microphones convert sound energy into electrical energy which is measured as an analog voltage and then sampled at a frequency into discrete digital values. These numbers represent a sound wave. The reverse process is then a simple process of converting the values into electrical impulses that drive a speaker which recreates the sounds waves.

Smelling a Brighter Future: E-nose

One of the most promising fields of research into sensors is the bionic nose. The key problem is to translate chemical interaction with a sensor into digital data and use machine learning models like classification and pattern recognition, to decipher the data into an odor or taste, with magnitude and subtle characteristics that define the unique chemical signature detected. Doing all this within milliseconds on a silicon substrate, that will not decay or require replacement is a tall order. Chemistry by its very nature requires the sensor to transform and degrade.

and use a extensive database to convert the organic information into a form that can be mapped into a smell-taste map.

Google's Project Soli has been able to overcome these problems by creating a radar on a microchip, with the entire system on a silicon wafer 8mm x 10mm that can be embedded inside any mobile device. The range of the radar is limited to only a few inches, but the fact that we can use this sensor with no moving parts in a small form factor to capture up 10,000 frames per second has opened up a number of applications in virtual input and gesture detection.

Although this technology is difficult, it has limitless potential:

- Detection of toxins or hazardous elements such as CO, which is odorless; bacteria and infectious diseases; explosives and chemical weapons; environmental hazards; and contamination in milk
- Alcohol sensor systems for use without active participation by the subject
- Qualitative and quantitative analysis in the petroleum industry and QA in the automotive industry
- Cosmetic raw materials analysis; space applications; and plant disease diagnosis

Making Sense of Movement

Radar technology has been in use for over a long time in aviation, and has a unique property of being able to penetrate solid material. The problem with its widespread adoption has been due to the size of transceiver, the mechanical nature of its operation, and high power consumption.

Google's chip can transmit a radio wave and has a receiver that detects the reflected energy. This reflected signal is then processed in a gesture recognition pipeline to extract information about motion and gestures that a person is making with their hands or fingers. In effect we do not need a device to have a set of buttons, or a capacitive touch sensitive display or any other input device, our hands will be the device and their movement will be interpreted as commands. High positional accuracy, which works even through opaque material, gives it a edge over existing camera technology.

Sensing a Revolution

A revolution in auto transportation is the most exciting part of seeing how a system formed with a fusion of heterogeneous sensors can be combined.

Besides Google's self driving car, Nissan's Leaf EV, GM's SRX modified, and BMW also have their own initiatives in this field. Some of the technology developed has already been deployed in limited ways and branded as a driver assist feature. As the assistance from the computer systems increases over the next few years, you'll eventually be left with a car that can operate

IoT systems in vehicles are going to be a $210–740 billion value annually in 2025, and a majority of this is going to be by augmenting existing vehicles with sensors and enabling them to communicate with roadside infrastructure and other nearby vehicles.

Companies like Mobileye have specialized in building autonomous vehicle technology and plan to release a complete suite by 2018. Mercedes-Benz, Audi, and BMW all expect to have at least one commercial model on the market by 2020.

independently on public roads by seeing the road and communicating with roadside infrastructure to create a guidance system that is far safer than one with a person behind the wheel.

Some of the key technologies that in cars today that will be enhanced in self-driving cars are

- Blind spot detection
- Rear cross-traffic alert
- Lane change assist
- Forward collision warning
- Autonomous emergency braking
- Adaptive cruise control

The sensors being used to make this possible have been around for over a decade and have been perfected and reengineered to work together. E.g., Light Detection and Ranging (LIDAR), placed on the roof of a car, uses laser beams that bounce off a rotating mirror in a housing that captures the reflected wave to gather information about objects around the vehicle in 3D.

The social and economic impact of this technology is staggering, but the legal implications still need to be sorted out—for instance, in case of an accident between a human driver and an autonomous car, who would be held responsible how would insurance cover such an incident?

Conclusion

Sensors are the foundation on which IoT becomes possible, but current sensor technology is just the tip of the iceberg. Until recently, the investment needed to develop new innovative transformational sensors was too high. Over the last decade, sensor technology has been used in creative ways to demonstrate the value of data collection, and the opportunities that can become possible. This has emboldened companies to invest more aggressively to innovate and create exciting new sensors that fulfill a niche market need and can be adapted to new applications.

WHITE PAPER

TATA CONSULTANCY SERVICES

Contact

Visit for more information

Email: digital.enterprise@tcs.com

Subscribe to TCS White Papers

TCS.com RSS: http://www.tcs.com/rss_feeds/Pages/feed.aspx?f=w
Feedburner: http://feeds2.feedburner.com/tcswhitepapers

About Tata Consultancy Services Ltd (TCS)

Tata Consultancy Services is an IT services, consulting and business solutions organization that delivers real results to global business, ensuring a level of certainty no other firm can match. TCS offers a consulting-led, integrated portfolio of IT and IT-enabled, infrastructure, engineering and assurance services. This is delivered through its unique Global Network Delivery Model™, recognized as the benchmark of excellence in software development. A part of the Tata Group, India's largest industrial conglomerate, TCS has a global footprint and is listed on the National Stock Exchange and Bombay Stock Exchange in India.

For more information, visit us at www.tcs.com

Experience certainty. IT Services
Business Solutions
Consulting

TCS Design Services I M I 12 I 16