14.3: Internet of Things (IoT)

Rouse (2019) explains that IoT is implemented as a set of web-enabled physical objects or things embedded with software, hardware, sensors, processors to collect and send data as they acquire from their environments. A 'thing' could be just about anything, a machine, an object, an animal, or even people as long as each thing has an embedded unique ID and is web-enabled.

In a report by McKinsey & Company on the Internet of Things (Chui et al., 2010), six broad applications are identified:

- **Tracking behavior**. When products are embedded with sensors, companies can track these products' movements and even monitor interactions with them. Business models can be fine-tuned to take advantage of this behavioral data. Some insurance companies, for example, are offering to install location sensors in customers' cars. That allows these companies to base the price of policies on how a car is driven and where it travels.
- **Enhanced situational awareness**. Data from large numbers of sensors, for example, in infrastructure (such as roads and buildings), or to report on environmental conditions (including soil moisture, ocean currents, or weather), can give decision-makers a heightened awareness of real-time events, particularly when the sensors are used with advanced display or visualization technologies. Security personnel, for instance, can use sensor networks that combine video, audio, and vibration detectors to spot unauthorized individuals who enter restricted areas.
- **Sensor-driven decision analysis**. The Internet of Things also can support longer-range, more complex human planning and decision making. The technology requirements – tremendous storage and computing resources linked with advanced software systems that generate various graphical displays for analyzing data – rise accordingly.
- **Process optimization**. Some industries, such as chemical production, are installing legions of sensors to bring much greater granularity to monitoring. These sensors feed data to computers, which in turn analyze the data and then send signals to actuators that adjust processes – for example, by modifying ingredient mixtures, temperatures, or pressures.
- **Optimized resource consumption**. Networked sensors and automated feedback mechanisms can change usage patterns for scarce resources, such as energy and water. This can be accomplished by dynamically changing the price of these goods to increase or reduce demand.
- **Complex autonomous systems.** The most demanding use of the Internet of Things involves the rapid, real-time sensing of unpredictable conditions and instantaneous responses guided by automated systems. This kind of machine decision-making mimics human reactions, though at vastly enhanced performance levels. The automobile industry, for instance, is stepping up the development of systems that can detect imminent collisions and take evasive action.

IoT has evolved since the 1970s, and by 2023 it is now most associated with smart homes. Products such as smart thermostats, smart doors, lights, home security systems, home appliances, etc. For example, Amazon Echo, Google Home, Apple's HomePod are smart home hubs to manage all the smart IoT in the home. IoT applications have expanded to include smart watches, fitness trackers, smart appliances, virtual assistants, self-driving cars, and even smart cities with connected infrastructure and services.

14.3.1: Autonomous

A trend that is emerging is autonomous robots and vehicles. By combining software, sensors, and location technologies, devices that can operate themselves to perform specific functions are being developed. These take the form of creations such as medical nanotechnology robots (nanobots), self-driving cars, self-driving trucks, drones, or crewless aerial vehicles (UAVs).

A nanobot is a robot whose components are on a nanometer scale, which is one-billionth of a meter. While still an emerging field, it is showing promise for applications in the medical field. For example, a set of nanobots could be introduced into the human body to combat cancer or a specific disease. In March of 2012, Google introduced the world to their driverless car by releasing a video on YouTube showing a blind man driving the car around the San Francisco area (or search for "Self-Driving Car Test: Steve Mahan). The car combines several technologies, including a laser radar system, worth about $150,000.

By 2020, 38 states have enacted some legislation allowing various activities from conducting studies, limited pilot testing, full deployment of commercial motor vehicles without a human operator; The details can be found at ghsa.org.

The Society of Automotive Engineers (SAE, 2018) has designed a zero to five rating system detailing the varying levels of automation — the higher the level, the more automated the vehicle is.

- Level Zero: No Automation – The driver does all the driving without any help from the vehicle
- Level One: Driver Assistance – The vehicle helps steer or speed up/slow down, but the driver still does the driving.
- Level Two: Partial Automation – The vehicle helps with one or more systems, but the driver still does the driving.

- Level Three: Conditional Automation – The vehicle helps with steering and brake/acceleration, but the driver still needs to monitor, can intervene as necessary still sitting in the driver seat.
- Level Four: High Automation – The vehicle completes all driving duties even if the driver does not intervene in limited conditions (i.e., local taxis)
- Level Five: Full Automation – The vehicle completes all duties without a driver on all roads in all conditions.

Consumers have begun seeing the features in levels 1 and 3 being integrated with today's non-autonomous cars, and this trend is expected to continue.

A UAV often referred to as a "drone," is a small airplane or helicopter that can fly without a pilot. Instead of a pilot, they are either run autonomously by computers in the vehicle or operated by a person using a remote control. While most drones today are used for military or civil applications, there is a growing market for personal drones. For a few hundred dollars, a consumer can purchase a drone for personal use.

Commercial use of UAV is beginning to emerge. Companies such as Amazon plan to deliver their packages to customers using drones, Walmart plans to use drones to carry things in their stores. This sector is forecasted to become a $12.6B worldwide market by 2025 (Statista.com, 2019).

- This video takes you for a drive in Tesla's autopilot mode.: How Tesla'sAuto-pilot Mode Work (2023) [video file: 13:46 minutes] Closed Captioned

14.3.2: References:

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