

Digital Marketing Techniques in Small Business Management

Editors

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Chapter 21

INTERNET OF THINGS

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Abstract

The world is rapidly advancing toward modern technology, with significant developments in information technology, particularly in the Internet of Things (IoT). IoT involves connecting everyday objects to the internet by integrating hardware and software, enabling them to become smart and communicate with each other. This innovation creates new forms of interaction between people and devices, as well as among devices themselves, transforming traditional lifestyles into more efficient and connected systems. However, several technological and social challenges must be addressed to fully realize its potential. This review paper aims to provide a comprehensive overview of IoT from both technological and societal perspectives. It also discusses various sensors, actuators, and their communication methods, helping readers and researchers better understand IoT and its real-world applications.

Keywords: *Internet of things (IoT), Smart Communication, Sensors, Actuators, System integration, Smart house/city, Network interface*

1. Introduction

The term Internet of Things (IoT) was introduced by Kevin Ashton in 1999 during a presentation at Procter & Gamble. He is also a co-founder of the MIT Auto-ID Center, where he contributed to the development of RFID technology used in supply chain management. In addition, he founded Zensi, which focuses on energy sensing and monitoring solutions.

IoT has emerged as a significant technological, social, and economic concept. It connects everyday objects—such as consumer products, vehicles, industrial systems, and sensors—to the internet, enabling advanced data processing and communication. This integration is transforming how people live and work, leading to noticeable changes in daily life. Although IoT is widespread, its presence is often unnoticed. In the consumer domain, IoT enables smart homes through connected devices, improving safety and energy efficiency. Wearable health and fitness devices are also revolutionizing healthcare by supporting network-based medical monitoring. IoT further creates a data-driven ecosystem where physical objects—including wearable and implantable devices—share information seamlessly, enhancing quality of life, especially for the elderly and people with disabilities. Moreover, IoT plays a key role in the development of smart cities, with applications such as connected vehicles, intelligent traffic systems, and infrastructure sensors that help reduce congestion and energy usage. It is also transforming sectors like agriculture, industry, and energy by improving data availability across production and distribution processes.

2. Architecture

The main problem with the Internet of Things is that it is very broad and unlimited, so to implement its concept is fundamentally dependent on its architecture. In the initial stage of research, the three layer architecture was introduced.

2.1. The Three Layer Architecture

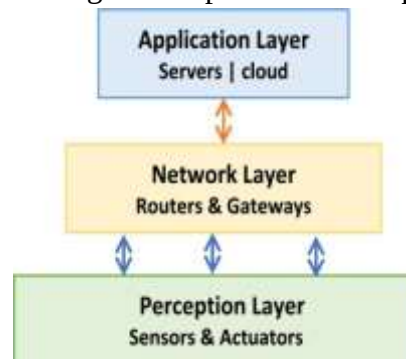
The IoT architecture is typically structured into three layers. The first is the perception layer, also known as the physical layer, which includes sensors responsible for collecting data from the environment. This layer detects physical parameters and identifies other smart devices within the system. The second layer is the network layer, which facilitates communication by connecting smart devices, network components, and servers. It is responsible for transmitting and processing the data collected by the sensors. The third is the application layer, which

delivers specific services to end users. This layer defines various practical applications of IoT, such as smart homes, smart cities, and smart healthcare systems.

Figure 1 depicted this architecture.

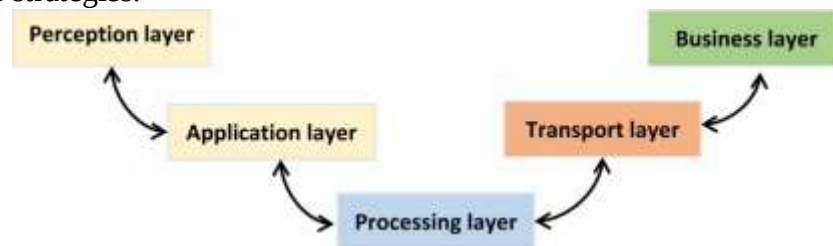
2.2. The Five Layer Architecture

The five-layer architecture is designed to provide a comprehensive understanding of the



functioning and development of IoT systems. It consists of five distinct layers. The perception and application layers operate similarly to those in the three-layer architecture.

The transport layer is responsible for transferring data between the perception layer and the processing layer through various communication technologies such as wireless networks, LAN, 3G, LTE, RFID, and Bluetooth. The processing layer, also known as the middleware layer, handles the analysis of data received from the network, making decisions using advanced computing techniques. Finally, the business layer manages and analyzes information generated by the application layer. It uses this data to support decision-making, planning, and the development of future strategies.



3. Sensors & Actuators

Sensors and actuators are fundamental components of IoT systems. In most IoT applications, one or more sensors are used to collect data and monitor different aspects of the environment. This data is then processed, and appropriate commands are sent to actuators, which perform actions that influence the system. In this way, sensors gather and transmit information through the network, while actuators enable physical responses. For example, humidity sensors provide data to manage irrigation systems, traffic sensors help regulate traffic lights, and occupancy sensors control building environments. Together, sensors and actuators play a crucial role in enabling IoT applications across various domains, including smart cities, smart agriculture, healthcare, and intelligent transportation systems.

3.1. Mobile Phone Based Sensors—MPBS

In today's fast-paced world, certain technologies have become essential to our daily lives, making tasks easier and more efficient. Among these, the Smartphone stands out as one of the most important tools we rely on. It has become an integral part of modern living, offering a wide range of functions that support communication, productivity, and entertainment.

You may already be familiar with how indispensable smart phones are, but have you ever wondered how they perform such advanced tasks? Much of their functionality is made possible by a variety of built-in sensors. These sensors enable smart phones to interact intelligently with

their surroundings and users. But how many sensors are actually inside your device, and what are their main functions? Let's explore some of the most important ones.

(i) Accelerometer: The Accelerometer sensor detects acceleration, vibration and tilt to determine movement and exact orientation along the three dimensions. Applications use this smart phone sensor to determine whether your phone is in portrait or landscape orientation. It can also tell if your phone screen is facing up word or down ward. The data patterns captured by accelerometer can be used to detect physical activities of the user such as running, walking and bicycling. Figure 3, illustrate this sensor.



(ii) Gyroscope: The gyroscope provides orientation details and direction like up-down and left-right but with greater precision like how much the device is tilted. So Gyroscope has the ability of measuring rotation. Hence it can tell how much a smart phone has been rotated and in which direction. Google Sky Map Application use gyroscope sensor to determine the direction towards which your phone is pointed. Gyroscope sensor is also known as Angular Rate Sensor or Angular Velocity Sensor as shown in Figure 4. This smart sensor is installed in the applications where the orientation of the object is difficult to sense by humans. Measured in degrees per second, angular velocity is the change in the rotational angle of the object per unit of time. Furthermore Gyroscope sensor can also measure the motion of the object, so for more robust and accurate motion sensing, Gyroscope sensor is combined with Accelerometer sensor.

(iii) Magnetometer: Usually known as a compass, it can detect magnetic fields, so the Compass app in smartphones uses this sensor to point to the north pole of the planet. This smart sensor is used in metal detector, and you can find it whenever you open Google Maps or Maps App. The magnetometer is housed in a small electronic chip that often includes another sensor, and is usually built into the accelerometer that helps correct the initial magnetic measurements

using tilt information from the auxiliary sensor. Figure 5 shows a module of magnetometer sensor.

(iv) GPS: GPS speak short of Global Positioning System, units in smart phone communicate with the satellites to determine precisely our location on Earth. The GPS technology does not actually use internet data, this is why once we open the App we can find our location on maps even the offline of Network, but the map itself is blurry as it requires network to load details. GPS is used in all location-based Applications. Accelerometer, gyroscope, magnetometer and GPS work together to create the perfect navigation in your Smartphone.

(v) Microphone: The microphone is basically a sound sensor that detects and measures the loudness of sound. Smartphone generally use micro-sized electrets microphones as shown in Figure 6, because there are so many and diverse type of microphones.

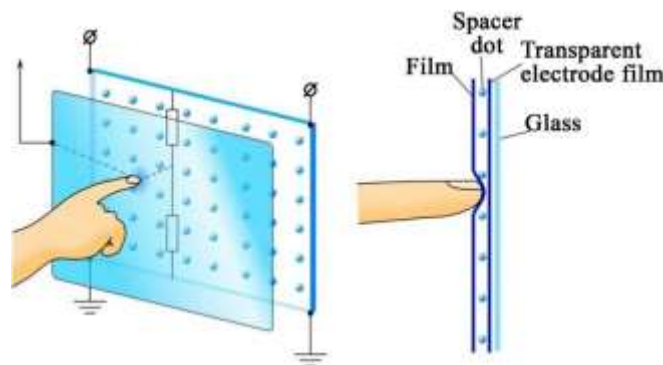
(vi) Ambient Light Sensor: The light sensor detects lighting levels in the vicinity to adjust



screen brightness accordingly. It is used in automatic brightness adjustment to reduce or increase the brightness of the Smartphone screen based on the availability of light, Figure 5. Dimming the screen on a mobile device also prolongs the lifetime of the battery.

(vii) Touch screen Sensors: The smart phone sensors in the touch screen contain an electric current running through it at all times and touching the screen causes a change in the signals. This change is an input to the device. Figure 6 illustrate it. Nowadays, all smart phones use this screen technology. Deeply, the touch screen is responsible for basic input and output operations, and it is used for tapping and writing letters. The touch screen contains three main interaction actions:

- i) The main activity and goal of the touch screen is touching or tapping is defined as the process of clicking on the screen in any place to open, to close or to type a character.
- ii) Multi-touch is defined as the process of tapping the screen by more than one finger simultaneously, and this function is usually used in gaming applications.
- iii) Gesture is defined as the process of drawing a certain pattern on the touch screen. Gestures may be implemented with one finger as drag and drop or multi-fingers as in the process of editing photos exactly resizing and changing camera zoom.



(viii) Fingerprint Sensor: Gone are the days of saving passwords and all patterns to unlock your phone and now it's technology time, as many users prefer to use a fingerprint scanner.

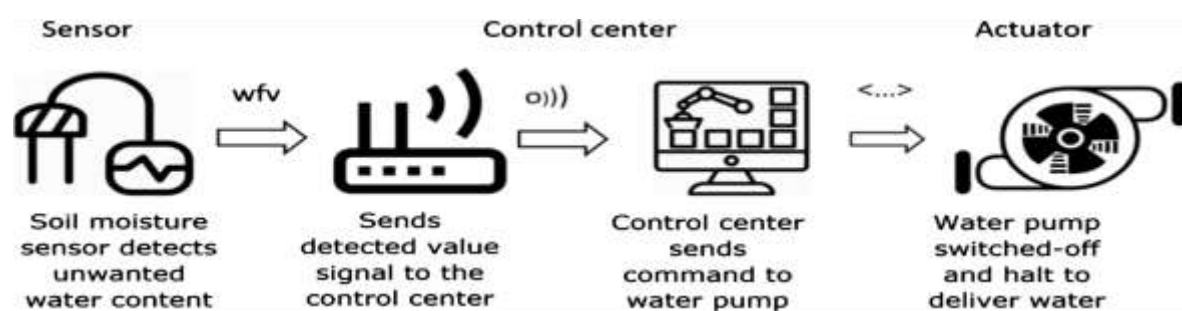
The fingerprint sensor enables biometric verification to secure many smart phones today. It is a capacitive scanner that records the user's fingerprint electrically. When you place your finger on its surface, the edges of your fingerprints touch the surface while there is a slight gap between the sockets between the edges. In short, it measures distances and the uneven pattern between the edges on the surface of your finger. This Smartphone sensor is very useful in applications that require authentication such as mobile payment applications (ex: Wechat pay).

(xi) Heart Rate Sensor: The heart rate sensor measures the heartbeat with the help of optical sensors and LED lights. An LED light is emitted towards the skin and this Smartphone sensor detects the light waves that are reflected on it. There is a difference in the intensity of the light when there is a pulse. Heart rhythm is measured by calculating changes in the intensity of light between minute pulses of the blood vessels. Many fitness and health apps use this method to calculate your heart rate.

(x) Barcode/QR Code Sensor: Most smart phones have barcode sensors that can read a barcode by detecting the light reflected from the code. It generates an analog signal with a variable voltage representing the barcode. Then this analog signal is converted into a digital signal and finally is decoded to reveal the information in it. Barcode sensors are useful for scanning barcode or QR code products. It is used in most social media applications and very useful in payment process.

4. Actuators:

Actuators are devices that create movement in a system. They can be mechanical or electromechanical and are powered by electricity, manual force, or fluids such as air and hydraulic pressure. Their main role is to convert energy into motion, which can be linear, rotational, or oscillatory. Linear actuators, such as electric and hydraulic types, produce straight-line motion and are often used for positioning tasks. Hydraulic actuators use fluid pressure to generate strong force, making them suitable for heavy-duty operations, although they may have slower acceleration. Electric actuators, on the other hand, use electrical energy to produce motion, often through motors that convert energy into mechanical torque. Rotary actuators generate rotational movement, commonly using pneumatic systems. Pneumatic actuators rely on compressed air to produce motion and can generate significant force with quick response times. They are generally safe, cost-effective, reliable, and efficient, making them widely used in various applications such as motor control and water pumping systems.



5. Conclusions

The Internet of Things (IoT) has slowly become a part of our everyday lives, bringing many technological changes that make things easier, faster, and more comfortable. From smart farming to healthcare and environmental monitoring, IoT is helping improve how we live and work. It also has great potential to support developing countries by improving areas like water management, agriculture, and industry. In fact, IoT can even play a role in achieving global goals such as better sustainability and quality of life. However, despite all these benefits, there are still challenges that need to be solved. To truly take advantage of IoT, we need a balanced approach that focuses on its benefits while also addressing its risks, ensuring it helps individuals, society, and the economy in a safe and effective way.

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