

INTERNET OF THINGS: AN OVERVIEW

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ABSTRACT

This paper will be focusing on the advancement in the field of technology of connecting devices over the net also called as Internet of Things (IoT). With fast paced advancement and extensive research in this field it has become an area of great interest and future scope. The paper covers three major modules namely, a brief introduction to IoT, implementations of IoT in various walks of life followed by its two major drawbacks of security and privacy. This review hence provides a comprehensive survey of the evolving technology and the potential of development of this subject.

KEYWORDS: Internet of Things, Technologies, Smart Homes, Health Care, Smart Transportation, Sensors, Security

1. INTRODUCTION

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it” was Mark Weiser’s central statement in his seminal paper [Weis 91] in Scientific American in 1991.

The Internet of Things (IoT) is a concept reflecting a connected set of anyone, anything, anytime, anyplace, any service, and any network. The IoT is a megatrend in next-generation technologies that can impact the whole business spectrum and can be thought of as the interconnection of uniquely identifiable smart objects and devices within today's internet infrastructure with extended benefits. Benefits typically include the advanced connectivity of these devices, systems, and services that goes beyond machine-to-machine (M2M) scenarios [4].

1.1. What is the Internet of Things?

Statistics suggests that 2.94 billion of the 7.349 billion people are connected to the internet. This roughly estimated 6.4 billion devices to be connected to the net presently. Researchers expect that by 2020 for every person on this planet 6.6 of his devices will be connected to the internet thus making more devices but people, to be connected to each other. The smartphones are replacing all traditional means of communication today. With the urge of connecting with each other through the Internet has evolved an idea of connecting devices. This networking and communication of devices over the information highway is known as IoT.

Applications of IoT: Home Automation, Health Care, Smart Transport.

1.2. Definition

Internet of Things is a wave converting phones to smartphones, cities to smart cities and this world to a smart world with devices establishing a network with each other in *brontobytes*, the unit of data coming from sensors. It is the global mesh of linking physical and virtual devices with the use of networks, data structures and analytical algorithms where uploading, retrieving and storing of data with interaction of the user creates an augmented entourage. The following

figure shows the interconnection of various devices and the necessary privacy locks that are major concern of security issues related to IoT.

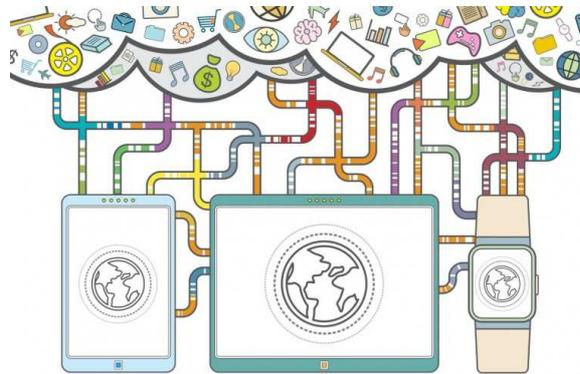


Figure 1: Connection of Various Devices Using IoT

2. APPLICATIONS

2.1. HOME AUTOMATION

2.1.1. Introduction

The major domain of IoT research is home automation also known as smart homes which are equipped with sensors able to sense a variety of activities. These programmed sensors can detect smoke and ring an alarm; they can be used to detect unwanted invasions by burglars. Home automation can be applied to various appliances at home such as the air conditioning systems. The maintaining of temperature is carried out by a device called a ‘thermostat’. Thermostats are widely used because of their property of accepting instructions through wireless media from their users and adjusting the temperature according to these commands. But with comfort comes cost. Thermostats are very expensive as they require the integration of WiFi with strong sensors.

2.1.2. Need of a Smart Home

The installation of sensors and NFCs for automation of homes is expensive using the existing policies. Then why should we automate our homes?

It can be summed in three reasons: Firstly, home automation brings interoperability. The temperature can be adjusted according to the requested criteria, lights can be turned on and off with sensing their needs. Secondly, home automation provides you the power to monitor the house on your laptop or even your cell phone. Thirdly, smart home encourages the usage of essential utilities and helps in optimizing the use of power and energy [1].

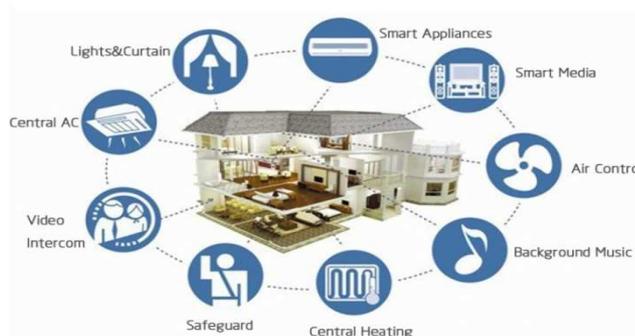


Figure 2: IoT for Smart Homes

2.1.3. Implementation

The integration of the computer to automate the domestic appliances and increase their usefulness is termed as 'domotics'. Domotics should be capable of performing all automated functions such as adjusting the temperature of the room; control garden sprinklers; operate audio and TV functions; monitor smoke alarm, burglar alarm and water overflow alarm.

Implementation of automation can be done with the use of computers known as 'Programmable Logic Controllers' which are used to synchronize and control the automation of these processes. Human Machine Interface (HMI) is used in the communication between PCL's and human users. A Radio Frequency Identification is a tag that the user wears so as to be identified by the domotic sensors. They adapt the surroundings according to the user's preferences and choice.

Some of the ways of connecting the domotics are:

Wireless Connectivity

WiFi: It can be utilized at a great extent as no wiring is required and it can be accessed by devices. The most well-known is 802.11b.

Wired Connectivity

Ethernet: Where WiFi connections can cause interference from external sources using an Ethernet wire will diminish them. The most well-known is Category 5e (Cat 5) Ethernet cable.[9]

2.2 HEALTH CARE

2.2.1. Introduction

The most challenging goal of health care system today is to provide quick and quality healthcare to the patients at reduced costs thus increasing the quality of life even of the masses. The present patient monitoring, care, management and supervision system is executed manually by the nursing staff [2]. Health management is one of the most crucial objectives which require the processes to be carried out with utmost care and accuracy. Involvement of man in this process leads to human error causing variations in the treatments provided to the patients. With the advancements of the Internet of Things we are capable to interconnecting various objects to the internet using them more efficiently and wisely. Quick responses and services can be dispatched as soon as the need arises.

2.2.2 Need for Health Care Automation

Automation is branching out in each domain. The health care section requires automation to deal with emergency situations and reduces the death rate thus increasing the quality of life by making services available to the common people effortlessly.

Automation has affected the health care in 2 major domains:

Operational Efficiency

The major operational tasks carried out by the hospitals generally involve managing equipment, inventory and time to tracking patients. All these are manual processes in most of the hospitals but when automated help in maintaining reminders and even placing an order before a particular drug goes out of stock. This prevents overstocking of drugs with a

constant fear of their expiry approaching.

Improved Patient Care

For the best quality treatment and care the staffs need to use the right equipment and allocate their time to patient care rather than general check-ups and documentation procedures. With IoT solutions of fitness bands and gears it makes it easy to integrate the information to the hospital database thus reducing the general efforts and focusing on the treatment of the ailment.[12]

2.2.3 Implementation

Various solutions for health care such as fitness bands, step counting gears, mobile fitness applications have been developed to make people aware of the health issues and keep them informed in the initiate stages itself if they are supposed to see the doctor. The fitness bands monitor the person's daily activities and display things like their blood pressure, sugar levels, heart rate and foot rate at a particular time also it observes their sleep patterns. This information can be automatically linked to the nearest hospital to handle emergency situations and avoid the manual procedures to some extent. Automatic Identification of people in the hospitals will make the health history of the person accessible to the doctor who can then prescribe medicines accordingly. This gives personal attention to each patient and drugs assigned not are on trial and error basis but that which suits his body type, systems and psychology.

Some of the most promising technologies in the implementation of health care are [2]

- Radio Frequency IDentification (RFID): RFID is a low-cost, low-power technology consisting of passive battery-assisted passive (BAP) devices, which transmit data by electromagnetic field generated by an interrogator. Passive RFID tags do not need a source of energy to operate, their lifetime can be measured in decades, thus making the RFID technology well suited in a variety of application scenarios, including the healthcare one [2].
- Wireless Sensor Network (WSN): A WSN can generally be described as a network of nodes that cooperatively sense and may control the environment, enabling interaction between persons or computers and the surrounding environment.[13]

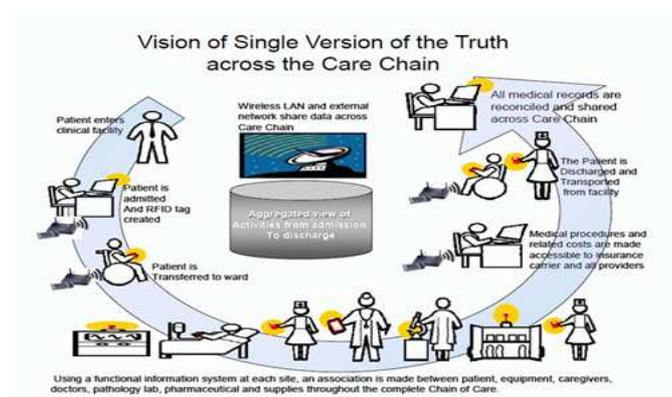


Figure 3: IoT in Health Care

2.3 TRANSPORTATION INNOVATION

2.3.1. Introduction

Intelligent Transportation Systems (ITS) plays a vital role in the transit of goods and passengers. In developing

countries like India, public transportation is the main mode of transit in urban as well as rural areas [6]. The course of urbanization being accelerated there is an increase in the vehicle count creating an imbalance in the existing transportation system. With the advent of Internet of Things (IoT) Intelligent Transportation Systems (ITS) are being implemented which are acting towards the reduction of traffic congestions and accidents. Traditionally, if we had to confirm the train timings it was a manual process through phone calls or visiting the railway station. Nowadays, such information can be obtained through the internet in just a few clicks. With IoT, connecting all devices across a centralized cloud network helps capture and share data to gain real-time access of the location of the trains through the GPS [Zebra Transportation]. Other useful implementations of IoT in mass transit vehicles include payment of tickets, crowd analysis through NFC and detection of ambience, temperature and humidity based on sensors[6].

2.3.2. Need for ITS

2.1 Transportation is one of the most vulnerable issues costing a number of lives. In a study based on the school bus transportation system it was studied that, in the United States from 2003 to 2012, 119 pedestrians (under 19 years) met with accidents involving school buses; 65% were beaten by school transportation, 5% operating as school transport vehicles and 30% by other vehicles involved in accidents [3]

2.2 The increasing number of vehicles causes traffic jams and congestions delaying the time we require to reach the destination. With ITS the traffic system will improve to an extent where cars will communicate amongst each other creating adhoc-networks without human intervention to control the traffic and make travelling smoother [5]. The drivers will also be informed about the shortest route with minimum traffic such that the carbon emissions can be reduced and unnecessary delays can be prevented.

2.3 ITS will provide a systematic and controlled transportation system which will minimize the congestions, number of deaths due to accidents, pollution and efforts of the driver. In case of an accident the ITS can send the location of the victim to the nearest hospitals to prevent any detention of required treatment and monitoring. ITS can look into the minor aspects of turning ON/OFF of the street lights when required to prevent misuse of energy resources.

2.4 Searching for parking spaces will become less cumbersome as the vacant parking slots near the drivers locations will be displayed to him and accordingly he can park his car in that spot instead of wasting time and burning his fuel to search for one. The driver can also be sent alerts when in a school zone about children crossing the road. [5] This is also termed as smart parking by some researchers which can be an integrated part of ITS.

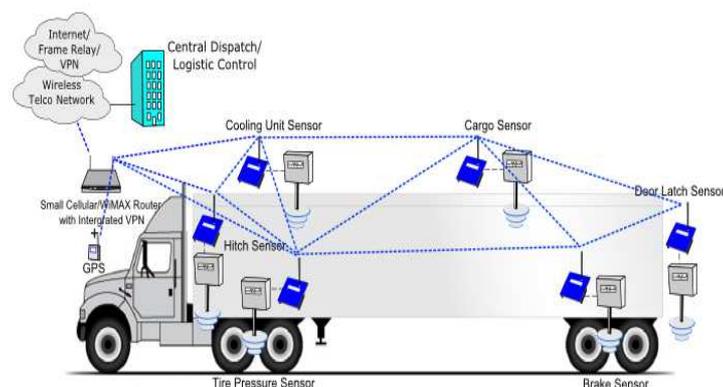


Figure 4: IoT for Transportation

2.3.2. Implementation

Intelligent Transportation Systems rely on three major pillars sensor system, monitoring system and display system [6].

Sensors: Strong sensors are required to be fitted in cars and on the roads which monitor the traffic and send updated information wirelessly to a 'central traffic control system hub' which compiles data to be shared with other users. For instance, if there is a traffic jam at a particular location it will be notified to the hub (through these sensors) and the shortest alternate route will be provided for transit. Later the congestion can be dealt with by various ways of diversions or imposing speed limits in the congestion affected areas. [5]

In smart parking, the sensors are installed on the parking slots. A person searching for a particular vacant parking space switches on the GPS (Global Positioning System) of his cellular device and sends a parking request. The parking server captures the location of the client and thus suggests him various available parking slots. When a slot is occupied the sensor on that slot updates by changing colour of the LED (Light Emitting Diode) sensors. This slot is removed from the available slots database and inserted in the allocated slots database [10]

Monitoring Systems: Monitoring Systems are used to extract raw data (data from sensors and convert it into context data (meaningful information) which can be shared on demand. This conversion is done by IPS (Information Processing Systems). Servers are important components for storing information from the sensors. The sensors connect the server through IP addresses and port numbers. The request and response take place from HTTP (HyperText Transfer Protocol), on connection establishment the data is ready to be transmitted. IPS can also send triggers for various events.[6]

Display Systems: It is important to display this collected information to the commuters [6] so that they can plan their route accordingly. Display screens installed at traffic signals, railway stations, and airports and at certain distances on the highways display the essential information such as traffic congestion at any place, accident taken place, diversion of any route. These systems should be connected to the internet keeping them updated at all times.

3. SECURITY & PRIVACY

3.1. Issues

Medical: A health monitor will collect patient's information, such as heart rate and blood sugar level and then send the information directly to the doctor's office over the network. When the information is transferred over the network, patient's data could be stolen or compromised. [11]

Industrial: A biosensor used in the food industry can be used to monitor temperature and bacterial composition of food stored in the refrigerator. When some food becomes deteriorated, data can be sent back to the food company through the network. However, such data should be kept strictly confidential in order to protect the reputation of a food company.[11]

Home: The appliances communicate amongst each other and turn the power off if there is no-one at home. But if this information is leaked then it can cause malicious activities. This information is moreover captured by a number of things such as our cameras, sensors but being highly confidential shouldn't be given out.

The above three are some instances in this vast oceanic application of IoT. For forming connectivity over the internet it is necessary to strengthen and secure the transaction of data through the wireless medium. The data bits being

transferred have to avoid malicious practices such as Loss of data, Hacking, Manipulation of data, cloning of useful information, Man In The Middle (MITM) problem and similar such problems. As we make our system more secure we work on its privacy also at the same time. Higher the security layers of the network channels more privacy will be maintained. Security and Privacy go hand in hand as they are directly proportional to the threat for the automated environment.



Figure 5: Security is Mandatory for Exchange of Data

4. CONCLUSIONS

Extensive research and growth in the subject is the documentation of the changing life for everyone. Everything will be automated and on your fingertips. Information extraction will become easy and knowledge will be gained through a variety of sources and means. Most of the tasks will be automated and will consume less time. The paradigm of networking will be integrated in our life through automated homes, smart transportation and quality health care. This cyber-complex using sensors and authentication technologies making them more powerful and less expensive. In this paper we have discussed a general overview of IoT. There exist a number of definitions but there has been no worldwide accepted definition. The help that Internet of Things has been for enhancement of various domains is showcased in a section. Security and Privacy are the two major pillars to be strengthened to build the IoT platform.

We are all awaiting the day when on returning home after a tiring day at work; the sensor senses your fatigue and communicates it with the audio player. Responding to this the audio player sorts from the various playlist feed in its database and thus plays soft soothing music helping you to relax. The Air Conditioner automatically sets its temperature through communication with the MET Department. This paradigm also underlines main foundation of growing creativity and simplicity of life for building up of IoT. IoT is ready for us, are we ready for it.

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Figure: All images from www.google.com