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Applications of IOT: A Review of its Applications in different Sectors

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***Abstract*—IOT is known as one of the most emerging technology in the world nowadays. Mostly MNC and even the startups are working on IOT. IOT is a technology where devices (like sensor, embedded system boards and others) are connected with the network for exchanging the information remotely among each other and even in the surroundings. The main elements of IOT includes the GPS (global positioning system), RFID (radio frequency identification) and WSN (wireless sensor network) which are widely used in the aqua farms, farmland, monitoring of environment, cold chain management, in tracking and also in tracing the things. IOT finds its application almost in every sector some of which are agriculture, home automation, environment management, military and others. Through this paper you will learn about IOT, it's application in various fields and also about the recent and past researches done in the field of IOT and also about the challenges which one face during the use of IOT.**

***Index Terms*— IOT, Cloud, RFID, WSN, Communication, Protocols, GPS.**

I. INTRODUCTION

IOT as an emerging trends is widely used almost by every company. Companies like IBM, CISCO, Bosch IOT Sensor Company are among the top 20 best companies in the field of IOT. These companies not only work in their domain but also focus on the problems which were faced by the society. For example, smart farming is used in some areas nowadays, and what is used in that is basically IOT, the farmer can operate the water system even from their home through their smart phones without even visiting the farm. The farmer can get an alert about the soil humidity, moisture and the Ph level on his smart phone and according to that he can take the next step [1].
IOT basically used to connect all the existing system to a network and further they can use it for communicating among themselves or with others in the surroundings. This connection can be done with the help of unique ID which is called the IP address. This is used to connect many devices to a single network. IP address is used for the identification and then locating an object on the network and for routing the information. In simple words we can say that "IOT is a physical device which can connect to the internet".
In the initial state RFID (radio frequency identification) is used for recognizing the devices which are connected [2].
After that different sensors, actuators, smart phones and wireless development boards were used for locating the devices. RFID, communication protocols and the sensor leads to the foundation of IOT.
Researchers data is being used for showing that how tremendous is the extension in the area of IOT. Industries are not only working on the projects related to IOT but they focus on the projects which not only includes IOT but also keep in mind about the health care, smart farming, transportation, military and many more [5]. Analysis

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reveals that the industries working on IOT will gain a profit of around 22% in their growth. Nowadays the number of articles on IOT are also increasing which shows that industries are not only the one which are working on IOT.

In this paper you will see different sections which will includes: Section II will cover the Recent and the Past researches in the field of IOT. Section III will give you the basic information about the architecture of IOT. Section IV cover different technologies of IOT. Section V will cover the applications based on IOT. Section VI will cover the challenges in the IOT and lastly Section VII covers the conclusion.

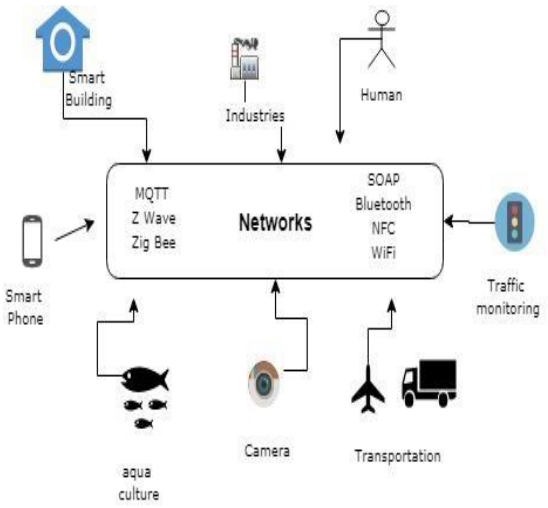

Figure 1. Demonstration of IOT in different sector [3]

II. Recent and Past Researches of IoT

During the initial period of IOT, RFID were being used, which uses the radio frequency signals for sending and receiving the information. At that time RFID was being served as the foundation technology. The devices which were connected basically uses RFID tags which consist of a reader and a transmitter inside them. People can easily locate and can recognize the devices with the help of RFID tags. The main application of these tags is transportation [4].

As the time passed research has been done and after RFID, WSN (wireless sensor network) became the main element of IOT. Previously RFID tags were used but now sensor and actuators were being used for connecting and locating the devices. The sensor present in the devices is used to sense the data and further with the help of actuators we can transmit the data. This technique mainly focuses on health- care [7].

As these technologies advances, they brought a great advancement in the growth of IOT. IOT finds its application in almost every sector, some of them are agriculture, heath care, transportation, aqua-culture, home automation, tracking and monitoring and many more. As the technology advances and with the advancement of smart phones, protocols used for communication and sensor used, now it become very easy to connect more devices on a single network.

The application of IOT consist of both software and hardware. The hardware of IOT is categorized as: 1) Wearable smart bands, 2) Embedded development boards.

These wearable smart bands or other medical devices comes with inbuilt hardware applications and there uses are also limited to some applications. For example the smart watches or the smart bands are designed for a particular task such as receiving call, alert for notification and for monitoring fitness activities [8]. The main advantage of these devices is that they are very much user friendly. Some of the examples of wearable devices are: Apple watch, Fitbit bands, google glass etc. Apple is doing a great job in the field of noninvasive glucose monitoring.

The embedded boards used in IOT can be programmed according to the user needs. Nowadays we can find a huge variety of these boards in the market. Some of them are ESP 32 Wi-Fi and Bluetooth module, NodeMCU, Raspberry PI board, Bolt IOT module, and Lora module which is long range module and this will create a great impact in the coming future. After selecting any of these boards then the user has to select the software through

which he/she can program it. Different programming were used in different boards some of them are C, C++, python and many more [10].

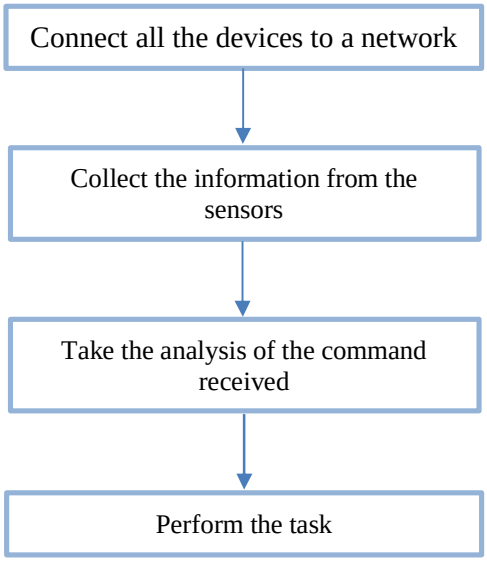

Figure 2. Demonstration of working of IOT

TABLE I. COMPARISON ON THE BASIS OF SURVEY

Review	Models/Architecture	Technology used for IOT	Applications	Miscellaneous
[3]	4 models were discussed namely 3-Layer model, Cloud based model, Fog based model and Service based model	Most of the technologies present in the market were discussed. They are Wi-Fi, NFC, Bluetooth, light fidelity, Power line area network and Halow	Monitoring of environment for pollution and different parameter, Smart farming in the field of agriculture, applications in the field of logistics and transports, and medical applications	Challenges faced while using IOT
[13]	Serviced based model was discussed	Some of the main technologies were discussed like NFC, Zig bee, WLan, RFID	How iot can be used in mining was discussed here and also application in other fields like medical and transportation were also discussed	Challenges faced while using IOT
[14]	Not discussed	Only two main components and their protocols were discussed namely Wi-Fi and Bluetooth	Not discussed	Different hardware used for IOT were discussed. Some of them are Raspberry Pi,Arduino, Cloud Bit etc.
[15]	Not discussed	Two major protocols used for IOT were discussed here namely MQTT and AMQP	Only the applications in the field of agriculture were discussed here	Some special approach was discussed here which is based on the IOT based pilot in the agricultural field.
[16]	Cloud based model	Only single protocol was discussed here and it is MQTT	Main application discussed here was of the exhaust fan used in the industries	Deep study on the exhausts used in industries.

In order to use IOT in your daily life then it is very necessary that it should be secure enough. So in order to use it some standards needs to be followed. Standardization gives inter- operability and compatibility on a global scale. Different professional bodies' works on the standards to be used in IOT. Currently working organization includes IEEE, International Electro- technical Standardization, Internet Engineering Task Force, IOT

Acceleration Consortium, American National Standards Institute and many more. If proper standards are being used while developing an IOT devices then it will be more reliable and also this can reduce its maintenance cost for long run [11].
Almost every country is investing in IOT applications. Indian government has also launched so many schemes in the field of IOT. One of the project of Indian government was Smart City Project in which they have invested nearly INR 7060 crores. The major focus of this scheme was on intelligent transportation, management of waste and smart lightening, and many more. Even different department are working in this field. DEPWD (Department of empowerment of person with disabilities), [Ministry of social justice and Empowerment] had started a scheme called (Sugamya Bharat Abhiyan), which mainly focus on achieving accessibility for the Physically Challenged And Disabled persons globally [14]. Also India has invested in developing IOT industries. This scenario is not only in India but countries like USA, Japan, UK, China, Russia and others are also working in the development of IOT industries. Japan had started different strategies and two of them are u- Japan and i- Japan, through this they can utilize IOT in their daily routine.

III. Architecture used for IoT

As IOT deals with both homogeneous and heterogeneous devices so it is not possible to use a fixed architecture for IOT. Different architecture are used for different devices based on there applications. We have discussed three types of architecture which are three layer based architecture, cloud based design, and fog based design.

A. Three Layer Architecture

1. Physical Layer: This layer is also known as perception layer. It consist of sensors, RFID tags and other necessary components. The major function of this layer is to gather the information from the linked devices.
2. Network Layer: This layer act as a gateway. It generally looks for the information related to servers, different protocols details and data transmission details. Data is being conveyed through network paths.
3. Application Layer: It is the topmost layer and its responsibility to transfer the data to the receiver.

The major issue with this architecture is that large number of tasks are scheduled for a single layer, due to which it creates difficulties in updating single and multiple layers.

B. Cloud Based Architecture

This architecture consist of cloud service layer, gateway layer, process layer, and the first layer which is physical layer.

1. Physical Layer: This layer is also known as perception layer. It consist of sensors, RFID tags and other necessary components. The major function of this layer is to gather the information from the linked devices
2. Process Layer: The major function of this layer is to check the information which was received.
3. Gateway Layer: This layer consist of the information of the networks like LAN or WAN etc. The main function of this layer is to transform the data and make the raw data acceptable for cloud services. It builds a path for long way communication.
4. Cloud Service: This is the major part of this architecture. The major function of this layer is to execute the data (collected from industries or from user) with the help of algorithms of data analytic. The element of cloud services are: 1) Broker and message queue, 2) Data Base, 3) Server and 4) Event manager.
5. Broker and message queue: The main function of this is to manage the messages which is to be arrived. It aligns various client's messages and further processes them and due to this there will be increase in the number of devices for a network.
6. Database: As the name suggest it is used to store the data.
7. Server: The main function of this is to visualize the data. It give assistance to the user to understand the data and it also give recommendations.
8. Event Manager: The main function of this is to handle the interrupts. It executes the interrupt according to its priorities. High priority interrupt are executed first in case of emergency.

C. Fog Based Architecture

This is the latest technology. Fog computing extends the features which are already present of cloud computing. This technology provides the processing of data, taking care of the storage and also providing information about the network between the client and the cloud service. The processing of data in this occur in decentralized manner. Both the cloud computing model and fog based model are similar to each other but the only difference

is that in fog computing the data is computed at the devices which are connected at the border of the network [15]. So this can also be known as edge computing. Also the scalability is also more in this architecture.

IV. Technologies used In IoT

There are two major categories in which these technologies are classified: 1) Identification Technology 2) Communication Technology

A. Identification Technology

The main function of this technology is to locate and monitor the devices. This includes bar codes, QR codes, RFID, WSN, sensors and many more.
RFID consist of a reader and a transmitter. The reader collects the data or the information. The transmitter is used for transmitting the information. RFID tags have higher price in comparison to the other devices like WSN [12].

B. Communication Technology

These technologies mainly provides the guidance for the transmission of data. Some of the examples are Zigbee, Z wave, MQTT, Bluetooth, Wi-Fi, Li-Fi, NFC, and many more.

- Zigbee: It follows 802.15.4 standard. This is used for creating a short networks as the range is very less (around 20 meters). The main focus of this is smart buildings.
- Z Wave: These are long range wireless protocols. There is unique id for each Z wave network and that is known as Network ID and further the devices available in the network of Z wave have a node id. The data here can be transmitted in high speed. The range of this technology is around 100 meters.
- Message Queue Telemetry Transport (Mqtt): This protocol is based on machine to machine basis. This is used mostly in cloud computing models and fog computing models. The main function of this IOT protocol is that it follows one to many function which means transmission can be done from a single source to many users through an intermediate node.
- Bluetooth: This is also a short range wireless protocol. This is mostly applicable in our daily applications. It follows 802.15.1 standard. For example we can share information through Bluetooth between the paired devices.
- Wi-Fi: Most of us will be aware that it follows 802.11 standard. Its scalability is high. It is used in Local area network as it is a medium range protocol.
- Li-Fi (Light fidelity): In this the transmission of data take in the form of light. It is short range protocol.
- NFC (Near field communication): The range of this protocol is very short approx. 4 meters. It provides point to point connection between the devices which are used for communicating.

These technologies used in IOT uses either IPv4 or IPv6 for providing addresses to the devices.

V. Applications of IoT

There is a huge network of the applications of IOT. They may vary from compact network like smart buildings to huge network like cloud computing applications. Some of the application we will discuss here are monitoring of environment, automation of homes, health care, smart farming, logistics and transportation etc.

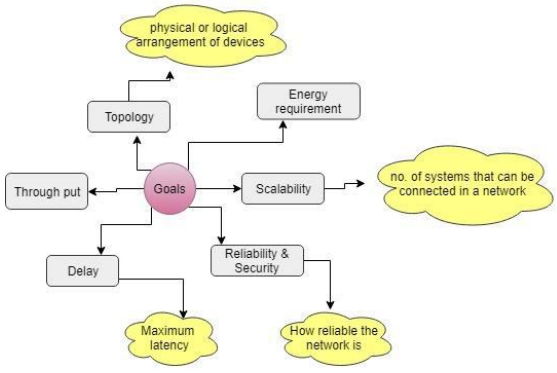

Figure 3. Constraints of an IOT Application [3]

The above figure shows various design constraint of an IOT application. These should be addressed properly in order to make a stability among efficiency and the price.

A. Home Automation

Controlling your home appliances from anywhere is generally known as home automation. It is also known as domotics. One can use different sensor (like temperature and humidity, gas sensors etc.) for measuring the parameters and then controlling the appliances according to the parameter from their smart phones. Some of appliances like Smart Tv, AC, LED bulbs, ceiling fans etc. can be connected to your smart phones by using Bluetooth, NFC, ZigBee, Wi-Fi etc.

B. Environmental Monitoring

Nowadays drones are being used for the environmental monitoring. They will measure the parameters through the sensor and will upload the data on the cloud. Different sensors are available for sensing different parameters. DHT 22 sensor can be used for temperature and humidity. For analyzing the air pollution one can use the dust sensor or even different gas sensor are also there which can detect different gases. With the help of electronic tongue and electronic nose we can detect the chemicals present. These technology generally uses the software which uses pattern recognition for keeping an eye on the pollution level in the cities [16].

C. Agriculture

Everyone must be aware about the Smart Farming as it is being used in several areas. Farming drones are used for the shower of fertilizers and pesticides. Even the tractors were controlled with the GPS. Smart irrigation system is also a part of this technology in which we can detect the soil moisture and humidity level through different sensors and can control the water pump through an IOT devices which can be a simple embedded board [6].

D. Health Care

Medical industries are working at a great speed in the field of IOT. One can keep record of the patient health condition using IOT. Different devices are used 1) Wearable in the form of bands or watches and 2) Sensors used inside the body. With the help of these wearable devices one can keep a track on parameters like heart rate, temperature of body, blood oxygen level, calories etc. Some of the companies of these wearable devices are Apple, Fitbit, Amazfit and many more. The second type is that in which a sensor is fixed inside the body which perform a particular task. Example of this type is the Heart Pacemaker which controls the Heartbeat of the person. One can control the pulses of that person using there smart phones but they have a unique id.

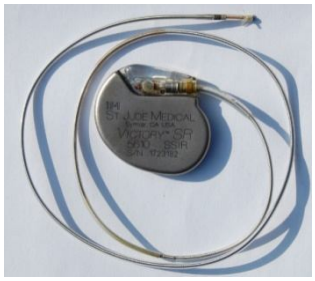

Figure 4. Artificial Cardiac Pacemaker

E. Transportation and Logistics

IOT has a great impact in the field of transportation and logistics. We can keep a track record of the information of the transportation in real time with the help of the RFID tags or barcodes attached to the vehicle. We can trace the location of the vehicle even one can adjust the speed of the vehicle with the help of IOT. In logistics one can keep the track of the inflow and outflow of the items with the help of barcodes. We can also use IOT in the different fields like mining, traffic management etc. but with proper standards.

VI. CHALLENGES FACED IN IOT

- As IOT can connect heterogeneous devices together, so in order to have proper communication among them standardization needs to be done. Security, privacy and interoperability's are included in standardization.

- Another major challenge in the field of IOT is related to the technical issue. For example we should do the analysis of the delay in advance so that the efficiency of the network being used can be increased.
- Other main issue with IOT is the privacy and security of the information. As the IOT devices deal with the transfer of data from user to user, there is major risk of the attacker being using the private data. So this the main issue with should be improved properly.

VII. CONCLUSION

IOT has a great impact in different industrial sectors. It combines the pattern recognition, sensing devices, models of communications, and networking all together for establishing communication properly. Currently we cannot say that IOT is fully developed. It is in developing stage. Currently artificial intelligence and machine learning is also used along with IOT. As there will be enhancement in the sensor and the embedded system board there will be enhancement in IOT for sure. We can see complete automation in the coming years as work under this field is achieving great heights.

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