A Brief Review on Internet of Things (IoT)

Tulasi Krishna Gannavaram V
Department of Electronics and Communication Engineering
Kakatiya Institute of Technology and Science
Warangal, India
tulasigvt@gmail.com

Uma Maheshwar Kandhikonda
Department of Electronics and Communication Engineering
Kakatiya Institute of Technology and Science
Warangal, India
kandhikondaumamaheshwar@gmail.com

Rahul Bejgam
Department of Electronics and Communication Engineering
Kakatiya Institute of Technology and Science
Warangal, India
rahulbejgam08@gmail.com

Sai Bhatt Keshipeddi
Department of Electronics and Communication Engineering
Kakatiya Institute of Technology and Science
Warangal, India
ksaibhatt@gmail.com

Saideep Sunkari
Department of Electronics and Communication Engineering
Kakatiya Institute of Technology and Science
Warangal, India
sunkarisaideep357@gmail.com

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***Abstract*- Internet of Things (IoT) is the most familiar technology to the modern society that has actually transformed the physical objects into smart things that are enhanced with capabilities like sensing, decision making and computing. The physical world is assisted by the digital world entirely connected to the global network infrastructure, starting the day with smart alarms and ending the day with smart beds. In today's world the modern humans are now more connected to the non-living objects, because Internet has been a common platform for human beings to interact and now, Internet is being a common thing for the physical objects also. With IoT, the tasks to be performed by humans are being made simpler, made humans go at an ease, navigation and assistance is now at the finger tips. Things in the human world are getting automated in a vast manner, extending from industries to homes, workplaces, classrooms, transport systems, medical fields and many. In this paper, a thorough study is presented on the emerging technology i.e. IoT, addressing how the devices are being the tiny building blocks of large applications, scope of IoT enabled applications, advantages, disadvantages, automation process, then and now era of IoT.**

Keywords: **Internet of Things (IoT), Smart Things, Sensing, Computing, Automation**

I. INTRODUCTION

The mechanism of connecting physical objects with each other and operating them remotely with the help of Internet is called IoT. Where the physical object can be, any type of sensor or a device which is capable of exchanging data over the network automatically without manual intervention. The embedded technology in the device like software, tiny electronic circuits and network connectivity enables the interaction between the internal and external states of the device for decision making processes. IoT can be considered as the giant network of smart devices over the Internet where the communication between the devices helps as experience for them to perform same task next time which in turn improves the performance accuracy. Protocols, infrastructure, interfaces and communication and many more functionalities are involved in the improvement of IoT. Taking a daily life-based example, we now a day's access data whatever required very quickly at our finger tips using Internet and a physical object whether it may be a mobile or a computer, the data we access is stored in the cloud, the technology involved in the whole process is called Internet of things [3]. Some of the IoT enablers are Radio Frequency Identification (RFID) which uses radio waves for transmission of data, sensors which are able to detect changes in external environment and nanotechnology which are extremely small devices with having dimensions around less than 100 nanometres. Considering many domains in IoT list, it is mostly used in industrial sector with 40.2%, in healthcare sector with about 30.3%, for security purposes around 7.7% and remaining 8.3% and some of the modern applications in IoT which are very helpful in reducing human work like domestic water flow monitoring, radiation and hazardous gas detection and natural disaster detection & alert systems [1]. This paper depicts about the technology intervention, application area, advantages and disadvantages of IoT.

II. HISTORY

The idea of connecting devices (Appliances and Peripherals) has been there ever since 1970 and it was called as the embedded Internet or pervasive computing. IoT is not a new concept, it is a modified concept. Internet protocol (IP) connected toaster device that can be turned on and off using over the Internet, was the first Internet enabled device and it was featured in the Internet conference in 1990 and later the Executive Director of Auto-ID centre MIT

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Kevin Ashton coined the term "Internet of Things" in 1999. In the year 2005 the major significant technologies of IoT were projected in the World Summit on the Information Society (WSIS) conference which are RFID, Nanotechnology, sensors and Smart technology. The Internet Protocol for Smart Objects (IPSO) alliance is formed in 2008 the Internet protocol for smart objects alliance which is an organisation that puts all sizes of companies together to work on IoT to discover and to implement new ideas for the future. And the first international conference of Internet of things held at Zurich in the year 2000 and in 2011, Internet protocol version 6 launched (IPv6) which allows around 340 undecillion IP addresses [3]. The ratio of world population and connected devices is drastically changing from the year 2010. IoT took almost around a decade to become commonly used technology in everyday life. And in the year 2012 in the European Internet conference LeWeb was devoted to this topic many companies began to use the word Internet of things. In the year 2018 IPSO alliance joined with the open mobile alliance together formed OMA spec works.

III. TECHNOLOGY INTERVENTION

The development of various computing systems in the area of connected world in order to make physical object think, identify various objects, interact with other objects and collect data from systems and surroundings based on the automated actions and responses. This could be only possible by integrating the new, effective technologies helps in to make physical objects identify and communicate easily. In this section we will look deep into the technologies engaged in large scale development of IoT.

A. *Radio Frequency Identification (RFID)*

RFID is a type of transceiver microchip which is just as an adhesive tape sticker. RFID technology is used in making objects identifiable and making them unique. Based on the type of application, RFID are of two types they are Active RFID & Passive RFID. The manufacture cost is too low and its size is very small so that it can be affixed on to any object. Active RFID tags consist of power source such as a battery so that are active in nature and always emits continuous data signal. They are costlier than Passive RFID tags. Passive RFID tags are used in detection and they become activated when triggered. This RFID System consists of two parts they are associated RFID tag and reader. RFID tag emits radiation that includes the identification, location, other unique specification. The emitted continuous data signals are then transmitted to reader in form of radio frequencies and then passed to embedded processors for analysing the data. RFID frequencies are divided to four ranges based on area of application [4]. They are Low frequency less or equal to 135 KHz; High frequency lies between 135 KHz to 13.56 MHz; Ultra-High Frequency of 862 MHz; Microwave Frequency of 2.4GHz. RFID has a low range; communication is asymmetric in nature. They are used widely in marketing, supply chain managements. The difference between RFID and Barcode (which is also an object identification technology) is that Barcode is an optical based technology works only in presence of reader but RFID doesn't need any reader in physical, as it is being a radio technology and RFID has capability to use as actuator while a barcode can't, which indeed makes RFID better compared to Barcode.

B. *Wireless Sensor Network (WSN)*

Wireless Sensor Network (WSN) is a system in which network of sensors are connected wirelessly in a multi hop fashion. It is a bi-directional system. They are of IEEE 802.15.4 standard. 6LOWPAN standard integrates WSN with IoT. WSN is constructed from several sensor nodes which communicate in a multi hop fashion connected one sensor node to other sensors, collecting object specific data like humidity, speed and then processed by passing it into processing segment [11]. The sensors in WSN are transceivers. The WSN consists of sensors, antenna, microcontroller, memory unit for saving data, interfacing for sensors for communication along with a power supply / battery or energy harvesting technologies. They have a long-range communication and communication is between peer's networks. The combination Wireless Sensors Network (WSN) and Radio Frequency Identification (RFID) makes smarter devices.

C. *Cloud Computing*

The progression of technology lead to production of millions to millions of gadgets by 2050. Integrating, comparing, analysing of data of all the data by a single device with minimal hardware resources will be toughest at all time. The only intelligent system which can analyse data and store data is cloud. Cloud computing is system of converging all the servers i.e. a virtual platform for wide hardware resources to share, process the data or resources between them and access them remotely at any time and place with an Internet connectivity. The cloud computing system also processes, analyses, segregates useful data from sensors. Therefore, the future generation gadgets are connected to each other by cloud for a fast pace and hassle free decision making [2].

D. *Network Technology*

The objects are connected each other in cloud. To transfer data faster and to handle large devices, an efficient network technology is used in making this IoT era to work successfully. For wide range of

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communication, we have used 2G, 3G in making usual communication such as calling, texting in a high mobile traffic environment and for the short range of communication we use Wi-Fi, Bluetooth [2], [5]. But at this wireless stage we are using fifth generation wireless communication which is having large bandwidth with faster way of sending a text and making a call.

E. *Nano Technology in IoT*

The major advancement in making network more efficient is making Nano things to be interconnected. They help in decreasing power consumption, increase the efficiency and improve scalability. They are made of Nano materials and can be generally used as a sensor and an actuator which make things smaller and things connected in Nano environment and helps in making Nano IoT environment.

F. *Micro Electro Mechanical Systems (MEMS) Technology devices into IoT*

Micro Electro Mechanical Systems (MEMS) are made of electrical and mechanical components, are used in several application oriented sensor networks and actuators in commercial usage. The MEMS which are made by Nano Technologies which are of small size provides a better purity of communication in IoT [10].

G. *Optical Technologies*

Li-Fi, Cisco BiDi optical technology have been a breakthrough in IoT in terms of communication. Bidirectional technology provides 40Gbps Ethernet, similarly Li-Fi which is a visible light communication (VLC) integrated with IoT increases the bandwidth for connectivity of objects.

H. *Near Field Communication (NFC)*

Near Field Communication (NFC) is a wireless technology for short range of communication complementary to Bluetooth and IEEE 802.11 which provides a connectivity to range of 10cm. It was developed by Phillips and Sony corporations. The data exchange is around 424kbps. It even works at noisy environment. It makes life dealing with objects luxurious.

I. *ZigBee*

It is one of the protocols having the advance features of Wireless Sensor Networks (WSN). ZigBee technology was developed in the year 2001 by ZigBee Alliance. It is a wireless network protocol which using less power and it is based on IEEE 802.15.4 Standard. It has range of 100m and bandwidth of 250kbps. It supports the topologies star, cluster tree and mesh. It is a low cost, low data rate, scalability, reliability, flexible in design, relatively short transmission range, it is widely used in home automation, health monitoring, smart agriculture and power controls.

IV. APPLICATIONS

The Applications of IoT are generally summarised into four types based on its area of use, they are Home and personal usage that include Wi-Fi as the main system, transfers high bandwidth with higher sampling rate, this service is found in healthcare; Enterprise, the information from various networks majorly services in smart cites, smart homes and smart environment; Information from large scaler WSN's application is found in transportation sectors; Information is collected from various networks for achieving service and power optimisation [5]. Fig. 1 shows various applications of IoT.

Courtesy: www.researchgate.net

Fig. 1. Various applications of IoT

A. *Healthcare*

The IoT cloud system is used in health sectors for improving the level of diagnosis, treatment, monitoring health status of patients. The IoT system in healthcare has four major pivots which are tracking the motion and status of patient remotely, authentication and identification to reduce errors and improve security avoid data manipulation and theft, data collection uses RFID technology to reduce processing time [12].

B. *Smart Education*

The involvement of IoT in education reduces the existing loopholes and fulfil gaps in laying out the strong foundations in gaining knowledge and provides interactive method of learning. It makes education make smarter by interactive communications between teachers and students, knowing upcoming lectures, live sessions, monitoring and recording attendance and hence make next generation live and learn in world of interactive technology. The regular classrooms are transformed into digital learning spaces, where children learn everything in a visualized manner, workspaces much more productive and student progress tracking improves a lot [9].

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C. *Smart Environment*

Smart environment includes smart home and smart cities. The main motto is integrating IoT with cloud to provide and improve the service by introducing middleware technologies like RFID middleware, WSN middleware and providing scalability, virtualization and security. e.g., video surveillance is the security-related application replacing self-contained management systems of observing object behavior and noting down suspicious activities. The involvement of cloud improves the complexity of analyzing the video which need large storage and computational capacity.

D. *Agriculture*

The involvement of IoT in agriculture enables smarter vision towards the crop growth, yield prediction, plant measurement, nitrogenous content, canopy cover and drainage mapping. This way of smart agriculture technique helps in monitoring the soil nutrition, light, humidity [9]. It also helps in adjusting the temperature, provide required quantity of water, required amount of light, required fertilization helps in getting good and healthy yields and reduces crop failures and losses. The livestock system of monitoring helps in identifying the condition of crop stock at ware houses.

E. *Supply-Chain Management*

The supply chain management is the way of manufacturing goods and the process of reaching to the consumer. The involvement of IoT in this retailing sectors helps goods not to fall under out-of-stock. IoT including cloud computing, RFID technology helps in tracking goods, calculating stocks, detect shopliftings and it provides sales graph which are used in analyzing area of flaws and give best solution in improvement of sales.

F. *Smart Automobile Mobility*

The main goal of IoT in this area is to improve safety, reduce traffic congestions, concentration in transportation, and control vehicle traffic on roads. Integrating the cloud technology with IoT has a beneficiary advantage in improving security and safety [6].

G. *Smart Energy and Smart Grid*

The major problem in the world of sensors is power utilization. Batteries in sensors usually consume more power in order to deliver results which leads in faster drain of power from battery, in turn decrease life time of battery [6]. Integration of sensors with IoT and the cloud provides the better power management, distribution, utilization and increase the life span of sensors.

V. ADVANTAGES

Internet of things has the potentials to enable connectivity with the people, objects and environment organisation with certain standards. IoT supports the communication between the devices and at times its can also be referred as Machine to Machine communication (M2M). In this view, the physical devices are allowed to stay connected and hence the total clarity is available with smaller unproductive and larger quality. Owing to physical products getting connected and digitally controlled centrally with basic wireless structure and there is a high amount of technology which is controlled without human involvement, the machines will be able to communicate with each other at faster pace in future times [6]. It is apparent that having more data makes better decisions. Whether it is normal decision relating to know that what to buy at the grocery store or to our own company having enough gadgets and supplies, Awareness is power, and more awareness is better. The second apparent that IoT is monitoring, knowing about the quantity of supply can additionally provide more data that could not have earlier been collected easily. In addition of this, the monitoring the expiration of these consequences will improve safety. In today's day to day life saving money and time is assumed and proved to be one of the finest things. IoT is more advantageous in terms of cost reduction. Internet of Things will be very widely implemented if the price of monitoring and labelling expenditure is less than the amount of money saved. IoT fundamentally proves that, it will be more helpful in human daily routines by safeguarding energy and cost. It allows the data to be communicated and among the devices, it shares the data and then transfers to the machine in required way of better decision making and makes installed model of automation efficient. IoT enables us to proceed with the better resource management and there by improves intellectual benefit to standard of living.

VI. DISADVANTAGES

There are main three concerns that go with the Internet of Things are privacy breach, over-reliance on technology, yields unemployment. Privacy breach means without the permission the device or any of the third-party vendor access personal information. Over reliance on technology means it may misdirect the users or provide incorrect information that leads the way to an error and it results serious typical effect for users. When anything we put on Internet to be available there, there are certain measures of security that should be taken to protect the data. There is possibility of hackers to break into the system and steal the sensitive data [1], [7], [8]. And some companies

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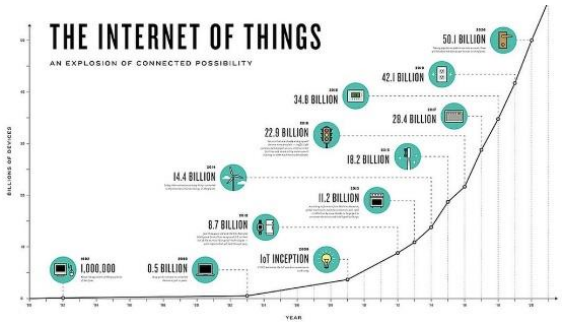
misuse the data which they given access to. This is a common issue that happen within the companies constantly. The data collected and set aside by IoT, can be extremely beneficial to companies.

The privacy issues indeed raise the question about control of the IoT, if there is only single company that could possibly lead to an ownership hurting consumers and additional companies. If there are multiple companies, they give access to information which acquired and raise about the storing of data. Ultimately the connecting gadgets more and more to Internet yields unemployment. For example, People who judge directory will lose their jobs why because the gadgets not only communicate to each other they also transmit the data to the owner. We already witnessing that jobs essence lost to automated machines that are like supermarkets and in even automated teller machine. These can be largely destruct people's employment as in one section, in addition specific individuals and user.

VII. CONCLUSION

In the completed years, enormous growth of IoT has enabled millions of devices to connect with each other where ever they are irrespective of location and every device is getting smart which in result can be connected to Internet and can be operated remotely. With the integration of many evolving technologies into the IoT it has become the trend of next Internet with huge scope for research. From micro sensors to huge machines everything has its own importance in IoT and when it comes to industrial sector & educational institutions and health care sector IoT has been a base and backbone and is considered as a level shifter.



Courtesy: www.medium.com

Fig. 2. Growth in connected devices using IoT

Finally IoT can be a leading technology to show a path for the smart world with ubiquitous computing and networking and in IoT the daily life things, devices are enhanced with the integration of communication technology to meet various services like M2M communication and machine to person communication (M2P) and person to machine communication these will be a part of Internet which will create new data, new services that can be carried out for the future Internet. Human senses the most important and most used functionalities will be implemented in IoT such as locating, identifying and decision making with the help of other technologies like robotics, nanotechnology and RFID. The growth in connected devices is illustrated in Fig. 2.

VIII. FUTURE SCOPE

Internet of things emerged a major technology throughout the world. It is having a lot of popularity with in lesser time. As well, the developments in artificial intelligence and machine learning have made the automation of IoT gadgets easy. To give the proper automation, the basically required artificial intelligence and machine learning programs are combined suitable to this, IoT has also expanded in several sectors in its application area. IoT has proved that health care industry to be one of the best tools for this sector. It provides the facilities to researchers, patients and doctors etc. In this facility, that includes smart detection, vesture gadgets for tracking health, patient superintendence many more. The health care gadget can send patients information about health to doctors over a secured and private network. This allows the doctors to monitor the patients from the remote locations. In agricultural sector, Information and communication technology is a gadget enable idea used for smart farming. With the help of IoT gadgets, Crop fields are recognized. To calculate the moisture of soil, temperature and humidity in this technology sensors are used. As well as in irrigation system to make sufficient use of water. This farming helps farmers to monitor their fields and their productivity. Agriculture drones are used for planting crops, spraying of the pesticides. In these future developments, people are getting connected to the technology and will become dependent on the Internet. With the massive increase in usage of Internet of things the security and trust issues may arise, but a secured network increases the liberties of the users.

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