Research Challenges in IoT and its application

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Abstract -With the exponential growth of Internet of Things, it's very important that we identify potential domains for the applications of IoT. Starting from smart cities, healthcare, smart agriculture, IoT is about to change all aspects of life. Although the current IoT enabled technologies have become advance in recent years, there are still so many problems that require attention. As IoT uses heterogeneous fields, many research problems may arise. The expansion of IoT devices in almost all areas of our lives, makes it a much focused topic for research. Thus IoT is creating way for new dimensions of research to be carried out. This paper represents recent developments in the field of IoT and talks about research challenges for the same.

*Keywords***:** Internet of Things, future technologies, smart cities, smart agriculture.

I.   INTRODUCTION

The Internet can be designated as the communication network that joins individuals to information while The Internet of Things (IoT) is an organized system of typically address able physical items with various degrees of processing, detecting, and actuation abilities that share the competence to interoperate and link through the Internet as their joint platform [1]. The prime objective of the IoT is to provide a way for objects to be connected with other objects, at anytime, anywhere and by any path. It's considered as the next phase of evolution of Internet. IoT will make ordinary devices capable of achieving many goals that was almost impossible without the IoT support. If we talk about the data, by end of year 2020 over 50 billion devices will have internet connection.

Now, the internet has become more than just a network of computers. It has become a network of various other devices. IoT can be defined as network of various connected devices. It can be easily shown in the figure 1. Now the devices like Smartphones, different kinds of Vehicle, Systems in Industries, cameras and so many other type of appliances can do all sort of communication over the Internet. It does not matter what is their size and what are their functionalities. These type of devices can help in real time monitoring, controls and controlling different type of process. The most important significance of these devices were seen in consumer electronic field. We have seen a revolution particularly in smartphones and smart wearable devices.

Keeping all this in mind, the expansion of IoT will not stop here. Its reach continue to expand to a great number of devices that it can run. With the saleable success of IoT, it offers a boundless supply for opportunities.
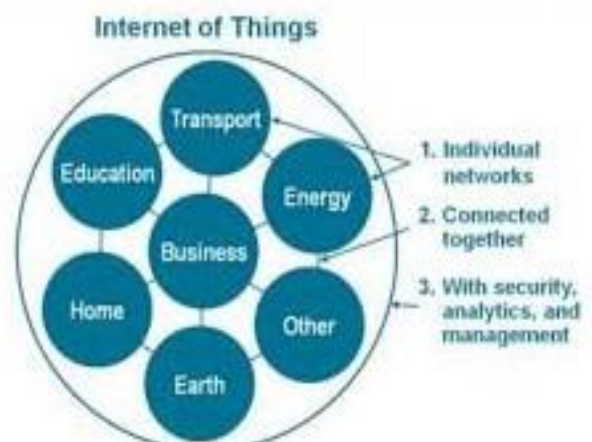

Figure 1: IoT as a Network of Networks

II.   APPLICATION DOMAIN FOR IOT

The diverse application of IoT touches the everyday life of individuals, institutes and the society. As per [2], applications of IoT shields industrial sector, agriculture, smart cities and emergencies.

A. Smart Cities

In accordance to [3], IoT plays a very vital role in improving how we live in cities. The IoT changes the way, by which we look at the infrastructure of the cities. IoT application in context with smart cities includes intellectual transport system, smart buildings, decongestion of traffics, and different type of waste management and the lightings which uses smart technologies. The smart urban mapping

helps us in many ways. This will include monitoring the available parking spaces, monitoring the conditions of bridges and the buildings based on the vibrations of these structures. These vibrations are continuously monitored and actions are taken based on the change in the data. The IoT devices enabled with AI are helpful in monitoring and de congesting the traffic in cities. IoT also helps in installation of weather adapted lighting systems. Smart dustbins help in waste management. Smart highways can alert us depending on the weather conditions. They help in choosing diverted routes based on the weather. The warning messages about any traffic jams can be given in advance to help the drivers.

IoT enabled devices uses different RFID and sensors. Aware home and smart Santander are the two developed applications in this regard. In some developed countries, plan is laid out to connect water sprinklers and sewage systems also with internet. These system will establish a breakthrough in saving energy and money.

B. Healthcare Domain

The healthcare domain is not in good shape at Global Level. In many countries they are slow and inefficient. This can be changed because this sector depends on so many devices that can be automated and made fast. The report can be shared online and we can talk about med ATMs to dispense drugs based on the prescription provided by the doctors. This can bring a lot of difference for the users. The benefits that can be seen with the use of IoT includes tracking of patients, monitoring the staffs and data gathering. The work in the hospitals can significantly be improved once we track the patients. Sensor devices supports functions that is completely centered for patients. These will be used particularly while diagnosing the patients for availing real time data of patient's health [4].

The applications used in this domain are mainly medicines and alerts over the phone over the phones. Nowadays we have Bluetooth dental devices that sends the patient's information once they are used. Other IoT devices that can be used in this domain are RFID, Wi-Fi and so on. These techniques put together can enhance measurement of important entities such as heart rate, blood pressure, body temperature, sugar level and many others.

The extensive use of IoT and IoE (Internet of everything) has given birth to IoNT (Internet of Nano things). It can be seen the Figure 2 how accurately they are helping us in day to day life [3]. Nano sensors and Nano networks are being used extensively for the medical applications as shown in the same figure. The IoNT thus enables us to find new ways of data collection in medical domain.
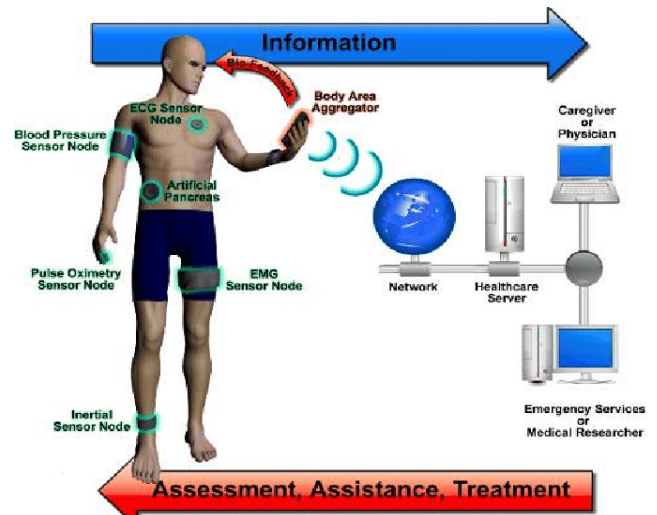

Figure 2- The Internet of Nano things [3]

C. Smart Water Management and Agriculture

The IoT has capability change the face of Agriculture for good. As we know that soil moisture is very important parameter for any kind of crop, vegetation or in case of different vineyards. The use of IoT can be extended for determining the content of different kinds of Vitamins in any agricultural products. These levels can be fully monitored and regulated by use of different IoT devices. These devices also help in weather forecasting, draught and amount of rain that will be received in the coming time. By knowing these information in advance we can prepare ourselves for any sort of natural disaster.

When this comes to Animal husbandry, the help of IoT can be taken in a greater extent. The open area for grazing can be monitored and searched with the help of IoT devices. Their health and off springs can be also monitored with the help of IoT devices. If we use IoT devices efficiently a lot of wastage can be avoided through proper monitoring.

As [5] tells, the IoT can also play an important role for studying the chemical and other properties of water to check whether it can be used for drinking and agriculture. The different IoT sensors can be used to monitor the pressure in pipes, tanks, dams and different reservoirs. These can send and receive the data using wireless sensor network.

D. Role in Smart Environment

The term life is heavily dependent on the environment. Take any form of life like animal life, plant life or human life. There have been a lot of work and efforts to create a healthy environment. The pollution and wastage from different industries create damage for the environment.

So the environment must require some innovative ways to help it from different types of pollution. With the help of IoT devices we can constantly monitor the air quality of different cities. In big cities already we have seen that big LCD are put which constantly shows the content of

different gases in the Air. The IoT devices can also be applied to detect the pollution levels in the water and accordingly its usage will be decided. The control on the Industrial pollution is a must in any country. This also will be monitored through different IoT sensors. These things will help in decreasing the amount of waste. [6]

The impact of weather on agriculture or in our day to day life is very vital. Through the data exchange, weather systems can collect information about pressure, temperature, light, motion and different other parameters. These sensors can be installed on vehicles as well. These vehicle can transmit the data even when they are moving. Radiations are very dangerous for any living organism. The IoT devices can control these radiations by keeping constant watch. If there is any leak of radiations from any type of source, that will be also alarmed by them. This is very important if the radiation is from some nuclear plant.

III.   RESEARCH CHALLENGES

For all above mentioned applications, we should ascertain that they are feasible and successful. As we find challenges with all the technologies, IoT has its own challenges. In recent years IoT has enabled numerous technologies and devices that have changed our lives, but still there are finite number of problems that require attention. As we know that IoT concepts cover a lot of fields, as sensing, processing, managing and storing the data and the list goes on. So these give room for a lot of challenges. The challenges that require attentions have spawned across different areas.

A.   Management and Analysis of Data
In today's world the data has become very important. The methods for processing, managing and analyzing the data has become very challenging. A very large amount of data is collected because of the heterogeneity of IoT in the era of Big Data [7]. Most of the systems use centralized systems in downloading the data. The downloaded data is used on an international cloud platform and intensive tasks are performed on that. There has also been a concern about the used cloud architectures. They are not effective in terms of sending the data that is generated from various IoT devices. This does not support further computation of these data. Because of this, most of the systems are depending upon current methods such as edge computing and fog computing.

B.   Privacy and Security
Accepting the fact that IoT has become an important part, the usage of internet has increased. All the researchers are aware that IoT devices have some weaknesses. The foundation of IoT devices are Wireless Sensor Networks. So it automatically inherits all the privacy and security issues that is there with WSN. The attacks and weaknesses of IoT devices have proved one thing very clearly that IoT devices need a better security designs that will cover them from end to end. The attacks on these devices take

advantages of their weaknesses and enters into system. The moment they gain access they make these devices vulnerable.

There is a need of introduction of applied cryptography in IoT devices. The cryptographic approaches are capable to operate on IoT devices. This will enable different skillful users to use and set up IoT devices independent of their user interfaces. There are some other pressing issues in IoT devices other than privacy and security. The other issues are secrecy in messages, trust and authenticity of senders and receivers. The other important issue is the integrity of messages. So the above points must be taken into consideration for improving the functionalities of the devices.

C.   Detecting and Monitoring
There is no doubt that technologies related to detecting and monitoring have made a lot of progress. These technologies are regularly growing and mainly focusing on energy efficiency. Whenever we talk about sensors and tags, the energy becomes very vital parameter. They should be active all the time to gather all the instantaneous data. This aspect of these devices make it essential that they must be energy efficient. At the same time, the progress in the nanotechnology and miniaturization have given us flexibility to develop there sensors and actuators at Nano scales.

D.   Integration of IoT and Blockchain
With the recent developments in IoT, blockchain has also gained the popularity. It was first implemented for Bitcoin cryptocurrency but now it is being used in so many areas [8]. As suggested by Miraz [9], IoT and blockchain can complement each other by eliminating their respective architectural limitations. The WSN is base of IoT technology. So as part of WSN, IoT also suffers the security and privacy issues of WSN. The blockchain technology is another form of Distributed Ledger Technology which has gained more attention in the areas beyond the cryptocurrency. The combination of these two technologies has conceived a new notion of Blockchain of things (BCoT).Blockchain works as an extra layer of security for IoT nodes. So the Blockchain provides enhanced overall security.

E.   Interoperability
Interoperability is the ability for different systems or the components of the system to communicate among others them. Different connected systems has the ability to speak among them. As we are aware that different industries use heterogeneous devices, this concept really become very important as so speak. Now a day's variety of industry use standard in their application. As these devices generate a lot of lot of data because of heterogeneity, the use of standard interfaces becomes very crucial and more significant. So overall, the IoT systems are being developed to deal with highest degree of interoperability [10].

IV.   CONCLUSION

The IoT is a system which will continue to evolve and it will always need new innovative forms. The software engineering, system engineering and all other different disciplines will continue to emerge. The term for IoT is Complex Adaptive Systems (CAS). The application areas of IoT are too vast. IoT serves mainly three kinds of users: the individuals, the society and the institutions. When we talk about implementations, obviously it has a tremendous power to change the way we look at different systems. It affects billions of life across the globe. As per [9], it has become very popular after the government agencies has shown positive view towards IoT applications. A very good example is Chinese government. A lot of research groups have contributed from different part of world and that has given a IoT a completely new growth. As the area of research continues to grow in all dimensions, new objects and new technologies can be connected with IoT. This just tells that IoT is paving way for a lot more applications that we expect. The practical implementation of IoT has touched our lives in so many ways that it's difficult to detach it from our lives. This makes it a significant topic of research. This paper focuses on different vital applications and domains of IoT and the research challenges associated with it.

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