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Internet of Things (IoT): Future of Networked Devices

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Abstract

The internet, as a significant tool in the globalisation of the globe, has enabled humans to communicate, exchange, and access information on a massive scale without regard for location. The internet connects computer systems with extensive functionality such as the desktop, laptop, and smart phone. However, the Internet of Things goes beyond simply linking computer systems to the internet; it also links gadgets and things to one other and to the internet.

The Internet of Things (IoT) is a growing paradigm that allows electronic devices, objects, and sensors to communicate and gather data using internet technology, with the goal of increasing quality of life. IoT is viewed as a major participant in the networking of future devices and the internet, although it does face significant issues that must be solved. This research emphasised the progress achieved by IoT, its applications in many areas, the problems faced by this technology for complete actualization, and its future forecasts through a comprehensive literature analysis.

Keywords: *Internet of things, Networked devices, Internet technology, Globalisation*

INTRODUCTION

The Internet of Things (IoT) is a technology that imbues intelligence into less intelligent electronic items and links them for information exchange, interaction, and feeding into a larger system that will process the information gathered to help in better informed decision making. The Internet of Things (IoT) is a network of interconnected

electronic devices and things that acquire data in the environment through sensing, communicate and share the data gathered, analyse and process data to provide information, and start action depending on the information gathered.

Computer systems can communicate and share information using the existing internet framework, but items such as household appliances, objects, and things in general are unable to do so without IoT technology functioning as a connecting structure. The Internet of Things technology, as it has evolved, forms a link between these devices (or things), allowing them to communicate with one another by sharing data and acting as devices that input data into bigger networks.

Beyond linking computer systems such as laptops, desktops, and smartphones to the internet, researchers seek to connect an increasing number of devices, items, and daily objects around us to the internet via the Internet of Things. So, what will the Internet of Things bring us in the future years? According to research, IoT has a lot of potential; it can, in a nutshell, improve people's quality of life through its applications. These applications include, but are not limited to, data collection, processing, interpretation, communication/sharing, and bring up a whole new universe of data gathering and management difficulties.

LITERATURE REVIEW

Bassi and Lange noted in a demand for a common ground (standardisation) to be built for IoT that a good standard, if implemented, will provide interoperability and heterogeneous communication across platforms. This standardisation will make it easier to interpret the data transported from platform to platform, ensure that the correct data format is retained, and assure data accuracy for processing.

The work of researchers has demonstrated that the Internet of Things has a lot to offer us. In their paper, Bhuvaneswari and Porkodi highlighted some of the uses of IoT. They identified society, the environment, and industry as the major categories in which IoT will have an influence. This effect will provide a display of intelligence as well as a link to the internet for data transfer and processing. However, certain fundamental problems are impeding IoT's full potential realisation, such as design and standards, privacy and security, data intelligence or management, and so on.

Wortmann and Fluchter's assessment of the value creation of IoT represents a stance that looks beyond what a single connected object can give to what an array of connected things can deliver and the value that data acquired from the connected things can present. One example may be the optimization of farm equipment and monitoring for consumption and performance if these are linked items. Their studies also spoke to the constraints hindering the complete realisation of IoT.

In their research, Satpute and Deora highlighted data management as one of the constraints of IoT. They think that the IoT data collection capabilities can collect a large amount of data, both useful and irrelevant, and transfer it to the cloud over the internet. Because this procedure strains the network and storage capacity, they proposed a local IoT controller unit to limit the amount of data transported to a central storage site in the cloud. This local IoT controller device will filter out irrelevant data and send only relevant and necessary data.

In their research, Miraz, Ali, Excell, and Picking proposed three categories for networks of things, items, technologies, and even people. The classifications are as follows: "Internet of Things" (IoT), a network of devices, "Internet of Nano Things" (IoNT), a nano-network of nano-sensors, and "Internet of Everything" (IoE), a network of people, data, processes, and things. They also recognised some of the main restrictions associated with IoT, such as standards and energy sources, to name a few.

In their paper, Patel and Patel emphasised many key aspects affecting IoT: definition, characteristics, architecture, supporting technologies, application, and future problems. The researchers went on to define IoT and classify its enabling technologies into three categories: those that allow IoT to acquire data from its surroundings, those that allow it to analyse the data, and those that increase security and privacy. Privacy and security, cost vs usability, interoperability, data management, and energy difficulties were underlined while assessing the obstacles.

Atzori, Lera, and Morabito examined the Internet of Things phenomena from an evolutionary standpoint, noting that the IoT has gone through multiple alterations in its defining technologies and concepts since its inception. Three (3) generations of IoT were recognised by the researchers. The first concerned labelled items; the

second, the connectivity of things via web technologies; and the third, social objects, semantic data representation, and the cloud of things.

There is a shared awareness that there are constraints in data management, standards, privacy and security, energy sources, and infrastructure, among other areas. Bhuvaneswari and Porkodi, along with Patel and Patel, believe that careful thought should be paid to how the acquired data is managed. Moving beyond simply collecting data through sensing abilities, we must evaluate what we do with the data and the type of intelligence we may generate from it.

It is no news that the application of IoT technology is around us in this day and age. That which was once envisioned by researchers is becoming a reality today. IoT has been envisioned to connect things, devices and objects that are around us granting us access to them anytime and anywhere that is, we may be using virtually anything with internet connectivity but it is becoming more and more feasible with today's technological advancements. It is rightly stated by Patel and Patel "These interconnected objects have data regularly collected, analyzed and used to initiate action, provide a wealth of intelligence for planning, management and decision making".

The Alliance for Internet of Things Innovation in their paper, discussed various identification needs with related use cases and requirements. They further looked at identifier standards, their applicability for the different identifier needs and discussed identifier allocation, registration, resolution, security, privacy and interoperability. The paper provided a structured approach by classification of identifier usage and a categorization of requirements. The researchers admitted that in general, no single identification scheme fits all needs and that many identifications are already standardized and are in use.

Kumar, Tiwari and Zymbler, in a review paper, see IoT as not only providing services but also generating huge amount of data. They stressed the importance of big data analytics to provide accurate decision which could be of help in developing enhanced IoT systems. They also discussed some issues and shortcomings in the present technical approaches. The importance of its application in different domains was also highlighted in this research.

Hassan, Qamar, Hasan, Aman and Ahmed carried out a study that covered the applications of IoT in the areas of healthcare, environmental, commercial, industrial, smart cities, and infrastructural. Their work explained the concept of IoT and identified data privacy and scalability, authorization and cost issues, mobility and architectural problems for smart city applications, cost and implementation difficulties for commercial applications, hardware and production issues for industries, standardization and trust issues as the challenges faced by IoT.

Their research proposed a next-generation protocol as a solution to some of the challenges. These researchers also suggested the use of Block chain technology to help achieve extra safety, automatic business management, distributed platforms and offline-to-online information authentication.

This research work will be anchored on future projections of IoT and deriving intelligence from data for decision making and strategy optimization. This prognosis for IoT cannot be overemphasized because it is projected that there will be over 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025.

Applications of IOT

Bhuvaneswari and Porkodi broadly classified IoT applications under three domains:

- **Society:** IoT applications concerned with improving, developing the society, cities and people.

- **Environment:** IoT applications that help to protect, monitor and develop natural resources.

- **Industry:** IoT applications involving financial and commercial transactions between companies and organizations.

However, IoT is being applied in different sectors in the society and different areas of human existence, some of which are highlighted below:

- **Health Care:** IoT is being used as wearable devices that are used to gather patients' information and save online for medical practitioners to access in order to determine the medical state of the patients and how to diagnose further. There are also wearable devices that are used by individuals to monitor their health status.

- **Emergency Situations:** IoT systems equipped with sensors/detectors are

able to detect the presence of fire in the environment by identifying the presence of certain features like smoke, rise in temperature and even fire intensity then alert the responsible individuals for further action to be taken. They are also used to detect smoke or gas leakages in factories.

- **Agriculture:** WSNs can be deployed to help monitor soil moisture, available nutrients and weather conditions so as to get the information required to determine when to wet, apply nutrient supplements and generally take decisions that will help ensure a successful planting and harvesting period. Also, WSNs can be used to track livestock and monitor their movements.

- **Security:** Perimeter Access Control is a way to curb unauthorized access to certain premises. This system is able to determine when there is a forced entry into secured locations and alert those charged with the responsible to guard the place so they can respond accordingly.

- **Factory/Industry:** Industrial machine developers like Siemens have been able to develop systems that can connect industrial machines and human control terminals; both those that are locally present on-site and the ones with remote access making it possible for workers to remotely access the machines.

- **Smart Home:** This is the implementation of automation in homes. This kind of system is able to recognize and interpret spoken instructions that are to be executed. This application of IoT in homes is still partial, not yet fully implemented however, companies like Samsung (Smart Things) and Amazon have been able to develop AI software, making it possible for users to control home appliances both online and offline.

- **Transportation:** IoT application in this area assists with traffic control, real time information dissemination to citizens concerning emergency situations and gridlocks. It also helps with traffic diversions when there is a road block due to repairs, reconstructions, as so on.

- **Smart City:** This combines IoT applications in different areas such as transportation, smart homes/buildings, agriculture, factories, hospitals, and the

likes, to function. Its main goal is to improve the quality of life for the citizens.

- **Retail/Marketing:** IoT can help with marketing products by giving information about them when buyers move close to them in the stores. They also assist with self-checking out (payment without meeting a human attendant) when they are done with purchasing.

- **Military:** WSNs and smart dusts can be used to stealthily gather information concerning opposing forces to determine their strategies. They can also be used to man country borders so as to be able to detect unauthorized intrusions.

- **Others:** Smart Metering, Smart Energy Grids, Entertainment, Culture and Tourism, among others.

Some existing products that adopt IOT technology

- **Amazon's Echo Auto:** A small hands-free device used in the car as a driver's assistant, is able to provide traffic reports, update online shopping carts, play music via the infotainment system in the car and help control appliances in the home using its connection with the home automation system.

- **FIXD:** A mobile app and device which falls under the data gathering via sensors function of the IoT. The sensor device which is connected to an OBD-II port of a vehicle gathers information about the vehicle and relays it to the mobile app. When there is a vehicle fault, it gives explanation in plain language and guides the owner through a 'Do-It-Yourself' diagnosis and repair.

- **Car Play from Apple and Android Auto:** Car infotainment platforms that link smart phones for us to have access to mobile apps such as online maps and voice activated controls without directly operating the smart phones.

- **Nokia BPM+:** Wireless blood pressure monitor; It is a device that is self-operated and it relays the details concerning the user's blood pressure via a mobile app.

Challenges faced in IOT'S full actualization

Internet of Things is working towards full applications in virtually every area of man's existence; transportation and traffic

control, education, home automation, smart cities, energy grid, medical, wearable devices, entertainment, and so on. However, this full actualization remains a projection because of the present limiting factors.

Below are some of the limiting factors:

- **Standardization:** IoT is supposed to be able to connect any device using any platform. However, there is yet to be an acceptable standard for heterogeneous object connectivity.

- **Privacy and Security:** Making various forms of data available online, makes owners of data vulnerable to attacks from malicious persons.

- **Data Management:** Storage of data, carrying out proper analysis and determining how to fully maximize the data gathered by sensors is still lagging behind.
- **Energy Sources:** The devices in use today are battery powered and they require regular swapping but some devices will be used in locations where humans will not be able to regularly swap them.

- **Infrastructure:** If IoT must deliver connectivity to anything, anywhere and anytime, then researchers must work on the infrastructure that will make this a reality.

Data handling

Data is very important to IoT devices in taking decisions and executing a specific task. Data are gathered by these devices using attached sensors. Over time, this data accumulates in the cloud but they are not fully utilized. Patel and Patel strongly opined that there is a wealth of intelligence that can aid planning and decision making in the data that interconnected devices gather.

Beyond just analyzing data and interpreting what it says, what can it be used for in terms of improving business output, optimizing operations and processes and ensuring profitability? Heflin's write-up made reference to data analysis and how it can help with business improvement. However, He sees this assertion to be too general. Data gathered over time about a piece of equipment for instance, does not just give us information about the equipment but it tells a story about:

- The suitability of the equipment for certain tasks.

- Its operational capability in certain weather conditions.

- How effectively it performs some tasks over others.

- The correctional decisions that must be taken to get more productivity from it.

When correctly examined and understood, data collected by sensors on IoT devices provides a plethora of information that may be used to lead improvements, investigations, corrections, and alterations. As a result, it is critical to move beyond obtaining information from data analysis to comprehending the story it tells about any product and environment in order to make the necessary judgments toward making improvements.

Prospects of IOT

Despite the above highlighted problems, IoT offers potential. Its future application will be extremely helpful to humanity. It will make system access, management, and usage easier. It will allow humans to engage with ordinary objects and technologies in their environment. The objective of the Internet of Things is to connect every object, gadget, anything, and almost anything to the internet. According to Bhuvaneswari and Porkodi's study, IoT will usher in a future in which physical items will be connected to the internet and identify themselves with other devices/objects.

The Internet of Things (IoT) will evolve into an efficient system capable of transmitting, giving, and sharing the best possible data feedback on our physical health as well as the best possible monitoring of real-time occurrences to aid in decision making on day-to-day happenings. IoT is projected to be the future internet in the next years, according to Malik, Magar, Verma, Singh, and Sagar. The researchers also suggested that the long-term implications of this technology be researched and examined, since many breakthrough technologies have negative consequences.

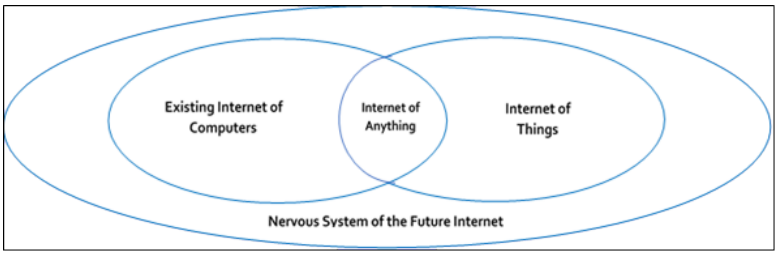

Figure 1 Nervous System of the Future Internet

IoT, which has arisen as a technology for linking items and devices together for communication, data exchange, and internet access, claims to have connected and will continue to connect more gadgets than the internet has. IoT can link these devices to the current internet of computers, rather of merely constructing a network for them. This implies that the Internet of Things is the future of networked gadgets. **Figure 1** depicts the existing internet of computers, the coming internet of things, and an overlap for the network of anything and everything. This graphic depicts the nervous system of the future internet.

Aside from just connecting devices and objects to the internet, the future of IoT will include more real-time applications in industries like as automotive, aeronautics, and many more. In addition, IoT will seek to provide answers to current difficulties in our environment. This will be the realisation of Gershenfeld's notion of embedding solutions in common items.

CONCLUSION

Despite the current hurdles, there is optimism that the various academic efforts that have been and will be done will lead to the complete realisation of the IoT idea. There will be more connections of devices and items that are now unconnected, the realisation of smart homes through the connection of home gadgets, electrical appliances, smart cities with communication between automobiles, buildings, filling stations, and other objects, and so on (moveable and immoveable). In a word, the Internet of Things will be fully realised - a network of everything capable of connecting to the internet everywhere, at any time.

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