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Understanding Current Trends on Internet of Things - An Overview

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ABSTRACT

Internet of Things (IoT) is the concept of providing automation by adding some level of digital intelligence to physical devices. It relates to the activities of data sharing, data controlling and automation among billions of physical devices around the world. Lower price of processor, wireless network and inexpensive technologies result in turning any object into the part of internet. Smart environment equipped with sensors provide automation in interrelated computing devices, machines, animals and human resources. Data collected from different smart devices is being interpreted by different researchers for analyzing in order to make better business decisions. This review paper has shown experimental research on the Internet of Things published since 2013. We summarize different applications of IoT in various fields and highlighted various issues related to different factors of IoT enabled devices.

1. Introduction

Internet of Things (IoT) represents a general concept for the ability of network devices to send and collect data from around the world and distribute it across the internet where it can be utilized for various purposes Somayya (Madakam *et al.*, 2015). It is a system of interrelated devices that can communicate without any human interaction. It is the extension of the internet and other devices which comprise smart machine objects, environment and infrastructure. In other words, it pertains to different sensors connected to the internet in order to collect information about a real-world. IoT-enabled sensors may sense everything like pressure, sound, pollution, heat and light. The concept of IoT is in more trends in various sectors like marketing, agriculture, traffic control devices, health fitness products, self-driving cars, authentication devices, smart energy management, and environmental control devices. When things come to like someone think of a "Smart Home" then everyone must be thinking what a smart home can actually be. A person won't love a home which is smart enough that if someone forgets to lock the door and can do it even being at a far off place or even can switch on or off the lights before entering the home from a far off place. Besides a single application on the Internet of things there are many more applications of the real world. In spite of many applications, there are different risk factors relating to security, threats and privacy need to be taken care of in IoT in order to avoid following incidents:

➢ Information breach through interconnected IoT enabled smart devices by cyber intruders
➢ Unauthorized access to IoT devices
➢ Privacy and confidential information can be leaked
➢ Business losses may occur due to less security

IoT provides multi-way communication devices with intelligent sensors and consisting with four basic components-Sensors, Connectivity, Data Processing and User Interface (Magdum *et al.*, 2019). Sensors may sense light, pressure and sound from the external environment. Data collected through sensor transfers to cloud infrastructure and passed processed data to client interface. User can control air conditioner and refrigerator as well as operation of gas though mobiles and laptops. Students can get the best results with the help of IoT devices. Progress of students by teachers may be measured accurately with smart devices. IoT enhances self-education and promotes more professionalism by optimizing content. Online education institutes provide a virtual environment by connecting with smart devices equipped with IoT and artificial intelligence. The learner may enjoy the comfort zone by selecting the learning environment of his own choice. Attractive and smart sessions are possible only through technologies supporting IoT and in results providing virtual education. IoT is appeared in lot of action movies-The terminator(1984),The Matrix(1999),The Fast and Furious (2017), Robot 2.0(2019) and I, Robot (2004) and Transcendense (2014).
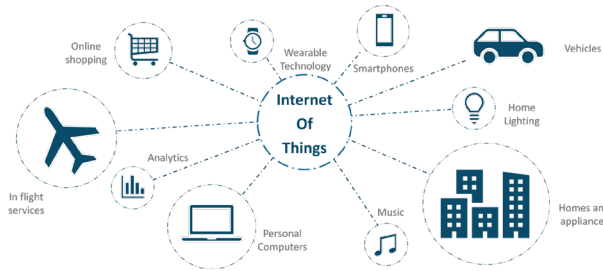
Figure 1: Overview of IoT System (Gubbi, J. *et. al.,* 2013)

As shown in Figure 1, IoT is changing much about the world in living like online shopping, wearable technology, smart phones, vehicles, personal computers, home lighting, home appliances, and many more real-life services. The other application beside smart home is the "Smart City". Smarter energy management systems, water distribution and security are examples of different applications for smart city. Many problems like pollution, traffic, etc. facing by people living in cities can be solved through IoT. By the installation of sensors, citizens are able to find free available parking slots across the city.

The definition of IoT is evolved around machine learning, embedded systems, and machine learning. The network of smart devices started in early 1982, with a modified Coke vending machine at Carnegie Mellon University. Kevin Ashton in 1999 who coined the term "Internet of Things" to describe a system of interconnected devices. Kevin Ashton, the co-founder of IoT gave this term as he found huge limitations at that time as the computers were senseless. The computers performed the task which they were commanded to do by humans. As Kevin Ashton found there was a huge data that used to be entered by the keyboard at that time. But through the Internet of things, the computers become more intelligent with sense ability. Finding location through GPS makes things more easier. Any automobile device has built-in sensors to alert the driver when the tire pressure is low or many other sensors that can indicate a driver about something that is not the way it should be. IoT saves time and money and enhances employee productivity. IoT encourages the companies to rethink the ways they can approach their businesses and markets as well as having ability to monitor the overall business processes. The Internet of Things is the next big revolution of the world and most trending technology that is contributing a lot to artificial-intelligence and robotics. A systematic review of different researchers on IoT from period 2013 to 2018 is presented in next section.

2. Literature Review

In today's scenario, IoT becomes one of the most trending topics in the smart world, especially in the field of artificial intelligence. There are variety of components and different kind of devices involved with IoT in order to make Smart campus, Smart Farming, Smart city, Smart

village, Ubiquitous computing, Wearable computing, and much more. Different researchers presented various models of IoT based system in order to transform manually operated machines into the automated machines. For the betterment of human life, IoT Technologies are to be integrated with electronic machines like installing a camera in coffee machine. In electronic devices, Sensors equipped with RFID technology are to be used for navigation purpose. Several test beds are to be applied on different types of simulators, testing results are analyzed and attempted to improve the performance (Marc, 2015). In Figure 2, Louis Columbus (2018) showed the expenditure growth on IoT from 2015 to 2020. According to Louis, by 2020 $40 B estimated to spend by transportation, manufacturing companies, and mechanical industries on projects. And health and process industries are also projected to spend $15 smart B on projects by 2020. Smart machines provide 24 hrs insight into disease, symptoms, and treatment of patients through the computation of medical-related information and activities. IoT applications enable to monitor of various medical equipment, activities, and cleanliness of the hospital. Some diseases like asthma, blood pressure, heart attacks can be monitored through IoT applications and can be quickly controlled by IoT enabled medical device which in further reduce extra hospital charges. The amalgamation of contact lenses with IoT provides an in-depth description of symptoms of eye disease.
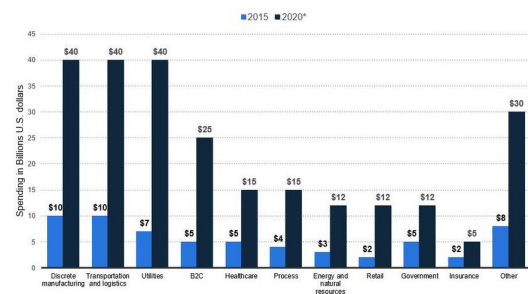

Figure 2: Cost Estimation for development of IoT devices from year 2015 to 2020 (Louis, 2018)

The concept of IoT has received the attention of many researchers around the world. Madakam *et al.,* (2015) describes IoT as a global computing network that connects human-to-human, human-to-machine, and machine-to-machine contributing to various fields such as innovators, researchers, etc. in a comprehensive view. Furthermore, the experts comprehensively mentioned the origin/evolution of IoT. To represent the significance and maturity of IoT development, Gartner's Hype Cycle is presented. As such IoT is a vast concept, several authors have proposed various architecture to explain the concept of IoT in their manner. Unfortunately, some experts has neglected security-related issues and clearly described the integration of IoT with WSN (Wireless

Sensor Networks), RFID (Radio-Frequency Identification), GSMA connection, COP (Common Pperating Picture) and cloud Computing (online storage). The advancement of IoT from 2010 to beyond 2032 through road map of various technological development has been shown in the respective years and performed linkage of Internet of Things with Cloud computing through the architecture of Aneka Cloud Platform.

Pradnya *et al.,* (2017) explained the significance of the Internet of Things(IoT) as compared to manually operated devices in the past and its usefulness in day-to-day life. Furthermore, the researchers have proposed the system regarding the maintenance of any particular IoT based devices and its working on different sensors. Though the author has given a clear and simplified view of IoT, still the author has neglected some of the important issues regarding IoT that include security factors.

Nakrani *et al.* (2017) describes IoT as an interconnection of every object/device to make it work more smartly especially in terms of automation. The main idea in their research was to propose a system based on home automation. The authors proposed the system to make the Smart Home through IoT by using various devices and sensors that includes smart phone, Arduino micro controller, etc. Kamal *et al.* (2017) presented IoT as the way of making automated devices by connecting various objects through the internet proving to be a beneficial asset. Furthermore, some of the basic applications (Kamal *et al.,* 2017) regarding automation in different sectors are: Smart Cities, Smart Health, Smart Home and Buildings. Many IoT applications improve human life by providing various smart devices like remote patient monitoring, glucose monitors, fitness bands, smart tooth brush, smart shoes, smart watches, and many tracking devices. The smart toy provides a virtual environment of game playing to kids. In the end, researchers highlighted many challenges faced in the field of IoT but no solution is to be provided. In spite of creating new IoT devices, many researchers continue to replace old traditional devices with IoT. We highlighted some improvements on IoT made by different researchers in tabular form in Table 1.

Table 1: Detailed review in Internet of Things from period 2014 to 2019

Year of Publications Ref No.	Author/s	Title	Journals/ Conferences	Summary
(2014)	Ovidiu Vermesan	Internet of Things-From research and innovation to market deployment	River Publishers Series in Communication	Proposed improvements in IoT layered architecture supporting many smart devices
(2015)	Marc Benioff	Industrial Internet of Things: Unleashing the Potential of Connected Products and Services	World Economic Forum	Presented Convergence on the outcome economy and shown the amalgamation of digital and human workforce
(2015)	Somayya Madakam, R. Ramaswamy, Siddharth Tripathi	Internet of Things (IoT): A Literature Review	Journal of Computer and Communications	Shown the usage of virtual technologies in real life.
(2016)	Asma Haroon	Constraints in the IoT: The World in 2020 and Beyond	International Journal of Advanced Computer Science and Applications	Provide concise future view on technical aspects of IoT
(2017)	Kevin Fu, Tadayoshi Kohno, Daniel Lopresti	Safety, Security, and Privacy Threats Posed by Accelerating Trends in the Internet of Things	Computing Community Consortium Catalyst	Provided recommendations on security, privacy and usability factors to expand research agenda
(2018)	Wei Zhou, Yuqing Zhang, and Peng Liu	The Effect of IoT New Features on Security and Privacy: New Threats, Existing Solutions,and Challenges Yet to Be Solved	IEEE Explore	Highlighted threats and challenges faced in various smart devices
(2019)	Mr. Kumarswamy B.H	Internet of Things (IOT) Research: A Scientometric study of Indian publications during 2015 − 2019	International Journal of Library and Information Studies	Shown Scientometric study in order to identify on going research on IoT with in India
(2019)	Michel de Donnoo, Koen Tange, and Nicola Ragoni	Foundations and Evolution of Modern Computing Paradigms: Cloud, IoT, Edge, and Fog	IEEE Explore	Relationship and similarities among Internet of Things, Cloud computing, Edge computing, and Fog computing are shown

Iqbal *et al.,* (2016) shown the working of various emerging technologies from past to present and depicts the rapid growth of technologies related to IoT with the help of the Gartner Hype Cycle Graph Diagram. Furthermore, the authors focused on security challenges and threats in accordance with the security of newly emerging technology but also attempted to provide a solution towards various security issues. According to Sharma *et al.,* (2016), it is a big revolution around the world which is changing the world by converting manually operated devices to automation and providing many benefits to the people around the world but failed to handle threats related to the security of any IoT device. Varizani, (2018) describes the concept of IoT as a way of sending and collecting information around the globe in order to connect people around the globe.

Furthermore, the author has mentioned some of the popular keywords in the field of IoT which includes NFC(Near-Field correspondence), RFID(Radio Frequency Identification), GSMA, Bluetooth, etc. that are empowering IoT. In the end, the author has explained some of the applications including in the field of Smart Industries, health, transportation, etc. in the form of Application Domain Framework Diagram.

According to Faroq *et al.,* (2015), IoT will be emerging soon with new technologies. The authors described the six-layered architecture along with supporting technologies and applications. Some of the technologies mentioned are:

➢ Wireless Sensor Network (WSN)
➢ Optical Technologies
➢ Nano Technologies etc.

Some of the applications are:
➢ Smart Environment
➢ Smart Home
➢ Smart Hospitals etc.

Omran *et al.,* (2018) discussed the concept of IoT as related to medical care. IoT provides support in capturing the health data of the patients with the help of intelligent smart devices embedded with medical applications. Furthermore, experts even mentioned the technologies for health care like- Radio Frequency Identification (RFID), Medical Sensors, Big Data, etc. The mobile sensors that include:

➢ Heart Rate
➢ ECG (Electrocardiography)
➢ Skin Conductivity etc.

The Big data tools integrated with IoT applications for the purpose of:

➢ Data Cleaning
➢ Data Analysis
➢ Data Mining
➢ Data Integration etc.

The main focus of the author was on health care but an existing health care system requires to be introduced with more new technologies. Zhou *et al.* (2018) explained the security and privacy-related issues of any smart device and highlighted various threats issues, challenges being faced by society and also provided a solution to some threats. The author has neglected following issues while implementing security factors:

➢ Maintenance-related problems as such, if the device is not properly maintained, can also lead to security and privacy-related issues
➢ No appropriate solution is being provided for handling different types of attacks
➢ Limited effectiveness and performance of smart devices
➢ No representation of IoT as an emerging technology in spite of mentioning in the literature

Rghioui *et al.,* (2017) proposed integration of IoT with RFID (Radio Frequency Identification), WSN(Wireless Sensor Networks), Middleware and Cloud Computing. Unfortunately, researchers failed to handle security and privacy-related issues of various smart devices. Rao, (2017) proposed an Automatic Smart Parking System which includes Wi-Fi, Micro-Controller, sensors, LED indicator, Regulated Power Supply(RPS). Zanella, (2014) proposed "Pandova Smart City" which is based on real-life applications and shown a detailed description of Smart Urban Area which includes:

➢ Waste Management.
➢ City Energy Consumption
➢ Traffic Congestion
➢ Structural Health of Buildings etc.

In addition to the report, experts proposed the architecture of urban IoT that divides the architecture into Data Layer, Transport Layer and Network Layer for various constrained and unconstrained factors. Hopali *et al.,* (2018) proposed security architecture for IoT enabled devices using in banks, companies and government and provide architecture Louis Columbus, (2018) for medical health care services and technologies which are being used- RFID (Radio Frequency Identification), Medical sensors, Cloud Computing, Big Data and Augmented Reality (AR) system, etc. Researchers attempted to remove security and privacy related issues of health care devices for maintaining privacy of patient details and management of resources.

3. Conclusion

Every technological evolution has some negative and positive aspects of society. We presented various optimistic approaches followed by different IoT experts where existing technologies are doing rapid transformation into novel ones. By reviewing existing literature, we found that most of the work is done related to smart homes and smart cities. As IoT is rich in research and

a flourishing area to explore with cloud computing and wireless sensor network, future research may be carried out in order to solve various current issues facing by society. IoT based E-advertisement system will replace the current advertisement system of various shopping malls. Humidity inside public malls, theatres and in other public and private places can be controlled without human efforts through virtual components as well as forest fire can be sensed with intelligent sensors by the integration of IoT and WSN.

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p. 74