



INTERNET OF THINGS (IOT) RESEARCH CHALLENGES AND FUTURE APPLICATIONS

¹Selvakumar K, ²Mrs Gowri A
¹PG Student, ²Assistant Professor,
^{1,2}Department of Information Technology,
^{1,2}Hindusthan College of Arts and Science (Autonomous),
^{1,2}Coimbatore, TamilNadu, India.

ABSTRACT - With the Internet of Things (IoT) steadily advancing as the resulting period of the development of the Internet, it becomes pivotal to perceive the different possible areas for utilization of IoT, and the exploration challenges that are related with these applications. Going from smart cities, to medical care, smart agriculture, coordinations and retail, to try and smart living and smart environments IoT is relied upon to invade into practically all parts of day to day existence. Despite the fact that the current IoT empowering technologies have significantly worked on in the new years, there are as yet various issues that require consideration. Since the IoT idea results from heterogeneous technologies, many examination challenges will undoubtedly emerge. The way that IoT is so extensive and influences basically all aspects of our lives, makes it a huge examination point for contemplates in different related fields like data innovation and software engineering. Accordingly, IoT is paving the way for new components of exploration to be completed. This paper presents the new advancement of IoT technologies and examines future applications and research challenges.

Keywords - [Internet of Things; IoT applications; IoT challenges; future technologies; smart cities; smart environment; smart agriculture; smart living.]

1. INTRODUCTION

The Internet can be portrayed as the correspondence network that interfaces people to data while The Internet of Things (IoT) is an interconnected arrangement of unmistakably address capable actual things with different levels of handling, detecting, and incitation abilities that share the capacity to interoperate and convey through the Internet as their joint stage [1]. In this way, the fundamental goal of the Internet of Things is to make it feasible for objects to be associated with different articles, people, whenever or anyplace utilizing any organization, way or administration. The Internet of Things (IoT) is slowly being viewed as the ensuing stage in the Internet advancement. IoT will make it feasible for standard gadgets to be connected to the internet to accomplish incalculable different objectives. Presently, an expected number of just 0.6% of gadgets that can be important for IoT has been associated so far [2]. In any case, constantly 2020, it is reasonable that over 50 billion devices will have an internet connection.

As the internet keeps on developing, it has become in excess of a straightforward organization of PCs, yet rather an

organization of different gadgets, while IoT serves as an organization of different Fig. 1. Nowadays, gadgets like smart phones, vehicles, modern frameworks, cameras, toys, structures, home machines, modern frameworks and innumerable others would all be able to share data over the Internet. In any case of their sizes and capacities, these gadgets can achieve smart rearrangements, following, situating, control, ongoing observing and cycle control. In the previous years, there has been a significant engendering of Internet fit gadgets. Despite the fact that its most huge business impact has been seen in the shopper gadgets field; for example especially the unrest of smartphones and the interest in wearable gadgets (watches, headsets, and so forth), interfacing individuals has become only a section of a greater development towards the relationship of the advanced and actual universes.

Considering this, the Internet of Things (IoT) is relied upon to keep extending its compass as relates the number of devices and capacities, which it can run. This is which makes it hard to layout the consistently developing restrictions of the IoT [4]. While business achievement keeps on emerging, the IoT continually offers a for all intents and purposes boundless stock of chances, in organizations as well as in research. In like manner, the understudy tends to the different expected regions for use of IoT spaces and the examination challenges that are related with the seapplications.

2. POTENTIAL APPLICATION DOMAINS OF IOT

Expected applications of the internet of Things are notably various yet additionally very assorted as they pervade into basically all parts of day to day existence of people, foundations, and society. As per [5], the applications of IoT cover wide regions including fabricating or the modern area, wellbeing area, agriculture, smart cities, security and crises among numerous others.

Smart Cities

As per [6], the IoT assumes an essential part in working on the smartness of cities and improving general framework. Some of IoT application areas in making smart cities incorporate; shrewd transportation frameworks [7], smart structure, gridlock [7, 8] waste administration [9], smart lighting, smart stopping, and metropolitan guides. This might incorporate various functionalities, for example, observing accessible parking spots inside the city, checking vibrations just as material conditions of extensions and structures, setting up solid observing gadgets in delicate pieces of cities, just as checking the degrees of walkers and vehicles. Computerized reasoning (AI) empowered IoT can be

used to screen, control and diminish gridlocks in Smart Cities [6]. Besides, IoT permits establishment of insightful and climate versatile road lighting and recognition waste and waste holders by keeping tabs of garbage assortment plans. Savvy parkways can give cautioning messages and significant data, for example, admittance to redirections contingent upon the climatic conditions or sudden events like gridlocks and accidents.

Utilization of IoT to accomplish smart cities would require utilizing radio recurrence ID and sensors. A portion of the generally evolved applications in this space are the Aware home and the Smart Santander functionalities. In the United States, some significant cities like Boston have anticipates how to execute the Internet of Things in the majority of their frameworks going from their stopping meters, streetlamps, sprinkler frameworks, and sewage grates are totally planned to be interlinked and associated with the internet. Such applications will offer huge leap forwards as far as setting aside cash and energy.

Healthcare

Most medical care frameworks in numerous nations are wasteful, slow and definitely inclined to mistake. This can without much of a stretch be changed since the medical services area depends on various exercises and gadgets that can be mechanized and upgraded through innovation. Extra innovation that can work with different tasks like report sharing to numerous people and areas, record keeping and administering drugs would go far in changing the medical services area [10].

A great deal of advantages that IoT application offers in the medical care area is generally classified into following of patients, staff, and articles, distinguishing, just as validating, people, and the programmed assembling of information and detecting. Medical clinic work process can be altogether improved once patients stream is followed. Moreover, confirmation and ID lessen occurrences that might be hurtful to patients, record support and less instances of bungling newborn children. What's more, programmed information assortment and transmission is crucial in process mechanization, decrease of structure handling courses of events, computerized method examining just as clinical stock administration. Sensor gadgets permit capacities focused on patients, especially, in diagnosing conditions and benefiting ongoing data about ors [6].

Application areas in this area incorporate; having the option to

The applications of Internet of Things (IoT) and Internet of Everything (IoE) are further being stretched out through the emergence of the Internet of Nano-things (IoNT) [3]. The idea of IoNT, as the name suggests, is being designed by coordinating Nano-sensors in assorted articles (things) utilizing Nanonetworks. Clinical application, as displayed in Fig. 2, is one of the major focal points of IoNT implementations. Use of IoNT in human body, for therapy purposes, works with admittance to information from in situ parts of the body which were up until recently in open to detect from or by utilizing those clinical instruments joined with cumbersome sensor size. Accordingly, IoNT will empower new clinical information to be gathered, prompting new revelations and better diagnostics.

Smart Agriculture and Water Management

As indicated by [11], the IoT has the ability to fortify and upgrade the agriculture area through looking at soil dampness and on account of grape plantations, observing the storage compartment distance across. IoT would permit to control and protect thquantity of nutrients found in rural items, and manage microclimate conditions to capitalize on the creation of vegetables and products of the soil quality. Furthermore, studying weather conditions allows forecasting of ice data, dry spell, wind changes, downpour or snow, subsequently controlling temperature and mugginess levels to forestall organism just as other microbial contaminants.

With regards to dairy cattle, IoT can help with distinguishing animals that munch in open areas, recognizing detrimental gases from animal waste products in ranches, just as controlling development conditions in offspring to improve chances of wellbeing and endurance, etc. Additionally, through IoT application in agriculture, a great deal of wastage and deterioration can be stayed away from through legitimate checking strategies and the executives of the whole agriculture field. It additionally prompts better power and water control.

Retail and Logistics

Executing the IoT in Supply Chain or retail Management has many benefits. Some include; observing storage conditions throughout the supply chain, product tracking to enable trace ability purposes, payment processing depending on the location or activity period in public transport, theme parks, gyms, and others. Inside the retail premises, IoT can be applied to various applications such as direction in the shop based on a preselected list, fast payment processes like automatically checking out with the aid of biometrics, detecting potential allergen products and controlling the rotation of products on shelves and warehouses in order to automate restocking procedures [12]. The IoT elements mostly used in this setting include; wireless sensor networks and radio frequency identification. In retail, there is a current use of SAP (Systems Applications and Products), while in logistics numerous examples include quality consignment conditions, item location, detecting storage incompatibility issues, fleet tracking among others. In the industry domain, IoT helps in detecting levels of gas and leakages within the industry and its environs, keeping track of toxic gases as well as the oxygen levels within the confines of chemical plants to ensure the safety of goods and workers and observing levels of oil, gases and water in cisterns and storage tanks. Application of IoT also assists in maintenance and repair because systems can be put in place to predict equipment malfunctions and at the same automatically schedule periodic maintenance services before there is a failure in the equipment. This can be achieved through the installation of sensors inside equipment or machinery to monitor their functionality and occasionally send reports. Furthermore, washing machines can allow one to remotely monitor laundry. In addition, a wide range of kitchen devices can be interfaced through a smartphone, hence making it possible to adjust temperature, like in the case of an oven. Some ovens which have a self-cleaning feature can be easily monitored as well. In terms of safety in the home, IoT can be applied through alarm systems and cameras can be installed to monitor and detect window or door openings hence preventing intruders [3].

Smart Environment

The environment plays an indispensable part inside all parts of

life, from individuals, to creatures, birds and furthermore plants, are completely impacted by an unfortunate environment somehow. There have been various endeavors to establish a sound environment as far as wiping out contamination and decreasing wastage of assets, however the presence of businesses, just as transportations squanders combined with foolish and unsafe human activities are normal spot components which reliably harm the environment. Thus, the environment requires smart and creative ways of aiding in checking and overseeing waste, which give a lot of information that powers state run administrations to set up frameworks that will ensure the environment.

Smart environment techniques joining with IoT innovation ought to be made for detecting, following and appraisal of objects of the environment that offer possible advantages in accomplishing a practical life and a green world. The IoT technology permits noticing and overseeing of air quality through information assortment from far off sensors across cities and giving nonstop geographic inclusion to achieve better methods of overseeing gridlocks in significant cities. Furthermore, IoT innovation can be applied in estimating contamination levels in water and thusly edify choices on water utilization. In squander the executives, which comprises of different kinds of waste, similar to synthetic substances and toxins being hindering to the environment and to individuals, creatures, and plants as well, IoT can also be applied. This can be achieved by environmental security through controlling modern contamination through momentary observing and the board frameworks joined with oversight notwithstanding dynamic organizations. This serves to reduce waste [13].

In climate anticipating, IoT can be used to convey a critical precision and high goal for checking the climate by data sharing and information trade. Through IoT technology, climate frameworks can gather data like barometric tension, moistness, temperature, light, movement and other data, from vehicles moving and send the data remotely to climate stations. The data is accomplished by introducing sensors on the vehicles and surprisingly on structures after which it is put away and examined to aid climate estimating. Radiation is additionally a danger to the environment, human and creature wellbeing just as farming productivity. IoT sensor network scan control radiation through steady observing of its levels, especially around atomic plant premises for recognizing spillage and spreading discouragement.

3. RESEARCH CHALLENGES

For all the above expected applications of IoT, there must be legitimate plausibility into the various spaces to learn the accomplishment of certain applications and their usefulness. Similarly as with some other type of innovation or advancement, IoT has its challenges and suggestions that should be figured out to empower mass reception. Despite the fact that the momentum IoT enabling technologies have enormously worked on in the new years, there are as yet various issues that require consideration, consequently preparing for new elements of exploration to be conveyed out. Since the IoT concept stems from heterogeneous

Privacy and Security

Inferable from the way that IoT has turned into an essential

component as respects the future of the internet with its expanded use, it requires a need to sufficiently address security and trust capacities. Scientists know about the shortcomings which by and by exist in numerous IoT gadgets. Moreover, the establishment of IoT is laid on the current remote sensor networks (WSN), IoT in this way compositionally acquires a similar protection and security issues WSN has [3, 15]. Different assaults and shortcomings on IoT frameworks demonstrate that there is to be sure a requirement for wide going security plans which will shield information and frameworks from one finish to another. Many assaults by and large adventure shortcomings in explicit gadgets subsequently obtaining entrance into their frameworks and thus making secure gadgets defenseless [16, 17]. This security hole further inspires complete security arrangements that comprise of exploration that is productive in applied cryptography for information and framework security, non-cryptographic security procedures just as structures that help engineers to concoct safe frameworks on gadgets that are heterogeneous.

Processing, Analysis and Management of Data

The method for handling, examination and information the executives is colossally difficult on account of the heterogeneous idea of IoT, and the huge size of information gathered, especially in this time of Big Data [18]. Presently, most frameworks use incorporated frameworks in offloading information and completing computationally concentrated assignments on a global cloud stage. In any case, there is a steady worry about traditional cloud models not being viable as far as moving the gigantic volumes of information that are delivered and devoured by IoT enabled gadgets and to be capable further help the going with computational burden and all the while meet planning imperatives [19]. Most frameworks are thusly depending on current arrangements, for example, portable distributed computing and haze figuring which are both dependent nervous handling, to moderate this challenge.

Monitoring and Sensing

Regardless of whether technologies worried about observing and detecting have gained colossal headway, they are continually developing especially zeroing in on the energy effectiveness and structure viewpoint. Sensors and labels are ordinarily expected to be dynamic continually to acquire immediate information, this perspective makes it fundamental for energy effectiveness particularly in lifetime expansion. All the while, new advances in nanotechnology/biotechnology and scaling down have permitted the improvement of actuators and sensors at the Nano-scale.

M2M (Machine to Machine) Communication and Communication Protocols

While there are as of now existing IoT arranged correspondence conventions like Constrained Application Protocol (CoAP) and Message Queuing Telemetry Transport (MQTT), there is still no norm for an open IoT. Albeit all articles require availability, it isn't required for each object to be made internet skilled since they just need to have a specific capacity to put their information on a specific passage. Also, there are a great deal of choices as far as appropriate remote technologies, for example, LoRa, IEEE 802.15.4, and Bluetooth despite the fact that it isn't evident whether these accessible remote technologies have the required ability to keep covering the broad scope of

IoT connectivity henceforth. The correspondence conventions for gadgets are the main thrust in realizing IoT applications, and they structure the fundamental help of information stream among sensors and the actual articles or external world. While different MAC conventions have been anticipated for quite a long time with Frequency Division Multiple Access, Time Division Multiple Access and Carrier Sense Multiple Access (FDMA, TDMA and CSMA) for low traffic effectiveness that is sans impact, more hardware in hubs are required separately. The primary goals of the vehicle layer incorporate ensuring a start to finish dependability just as performing start to finish control of blockage. In this angle, most conventions can't coordinate suitable start to finish reliability [20].

Blockcha in of Things (BCoT): Fusion of Blockcha in and Internet of Things

Like IoT, blockchain technologies have likewise acquired huge prevalence since its presentation in 2018. Despite the fact that blockchain was first executed as a hidden innovation of Bitcoin cryptocurrency, it is currently being utilized in diverse nonmonetary applications [21]. Miraz contends that both IoT and Blockchain can strengthen one another, in a complementary way, by wiping out their individual inborn design restrictions [22]. The fundamental innovation of IoT is WSN. In this manner, comparable to WSN, IoT also suffers from security and protection issues. Actually, the primary implementation trend in non-money related applications is because of its inbuilt security, changelessness, trust and straightforwardness. These attributes are Disseminated Ledger Technologies (DLTs) which require broad reliance on taking an interest hubs. Hence, the combination of these two technologies Blockchain and Internet of Things (IoT) imagines another thought for example the Blockchain of Things (BCoT) where blockchain strengthens IoT by providing partaking hubs for blockchain environments [22]. Hence, blockchain empowered IoT environments will give upgraded by and large security [23] just as advantage from one another.

Interoperability

Generally as respects the internet, interoperability has consistently been and keeps on being an essential thing esteem in light of the fact that the underlying essential in Internet availability conventions. At present, different enterprises utilize an assortment of norms in supporting their applications. Because of the huge amounts and kinds of information, just as heterogeneous gadgets, utilizing standard interfaces in such different substances is vital and surprisingly more critical for applications which backing cross hierarchical, notwithstanding a wide scope of framework restrictions. Subsequently, the IoT frameworks are implied towards being intended to deal with much higher levels of interoperability [24].

CONCLUSION

The IoT can best be depicted as a CAS (Complex Adaptive System) that will keep on advancing subsequently requiring new and imaginative types of software designing, frameworks designing, project the executives, just as various different disciplines to foster it further and oversee it the coming years. The application are a soft IoT are required diverse to enable it to serve various clients, who thus have various necessities. The innovation serves three

classifications of clients, people, the general public or networks and foundations. As examined in the application section of this search paper, the IoT has with out a question a gigantic ability to be an immensely extraordinary power, which will, and somewhat does as of now, decidedly sway a huge number of lives around the world. As per [25], this has Countless examination bunches have been, and keep on being, started from various areas of the planet, and their primary target is to finish IoT related researches. As increasingly more examination studies are led, new aspects to the IoT processes, technologies included and the articles that can be associated, keep on arising, further clearing way for substantially more application functionalities of IoT. The way that IoT is so sweeping and influences for all intents and purposes all parts of our lives, makes it a huge exploration point for examines in different related fields, for example, data innovation and PC science. The paper features different potential application areas of the internet of things and the connected examination challenges.

REFERENCES

- [1]. M. H. Miraz, M. Ali, P. S. Excell, and R. Picking, "A Review on Internet of Things (IoT), Internet of Everything (IoE) and Internet of Nano Things (IoNT)", in 2015 Internet Technologies and Applications (ITA), pp. 219– 224, Sep. 2015, DOI: 10.1109/ITechA.2015.7317398.
- [2]. P. J. Ryan and R. B. Watson, "Research Challenges for the Internet of Things: What Role Can OR Play?," *Systems*, vol. 5, no. 1, pp. 1–34, 2017.
- [3]. M. Miraz, M. Ali, P. Excell, and R. Picking, "Internet of Nano-Things, Things and Everything: Future Growth Trends", *Future Internet*, vol. 10, no. 8, p. 68, 2018, DOI: 10.3390/fi10080068.
- [4]. E. Borgia, D. G. Gomes, B. Lagesse, R. Lea, and D. Puccinelli, "Special issue on" Internet of Things: Research challenges and Solutions", *Computer Communications*, vol. 89, no. 90, pp. 1–4, 2016.
- [5]. K. K. Patel, S. M. Patel, et al., "Internet of things IOT: definition, characteristics, architecture, enabling technologies, application future challenges," *International journal of engineering science and computing*, vol. 6, no. 5, pp. 6122–6131, 2016.
- [6]. S. V. Zanjali and G. R. Talmale, "Medicine reminder and monitoring system for secure health using IOT," *Procedia Computer Science*, vol. 78, pp. 471–476, 2016.
- [7]. R. Jain, "A Congestion Control System Based on VANET for Small Length Roads", *Annals of Emerging Technologies in Computing (AETiC)*, vol. 2, no. 1, pp. 17–21, 2018, DOI: 10.33166/AETiC.2018.01.003.
- [8]. S. Soomro, M. H. Miraz, A. Prasanth, M. Abdullah, "Artificial Intelligence Enabled IoT: Traffic Congestion Reduction in Smart Cities," *IET 2018 Smart Cities Symposium*, pp. 81–86, 2018, DOI: 10.1049/cp.2018.1381.
- [9]. Mahmud, S. H., Assan, L. and Islam, R. 2018. "Potentials of Internet of Things (IoT) in Malaysian Construction Industry", *Annals of Emerging Technologies in Computing (AETiC)*, Print ISSN: 2516-0281, Online ISSN: 2516-029X, pp. 44-52, Vol. 2, No. 1, International Association of Educators and Researchers (IAER), DOI: 10.33166/AETiC.2018.04.004.
- [10]. Mano, Y., Faical B. S., Nakamura L., Gomes, P. G. Libralon, R. Meneguete, G. Filho, G. Giancristofaro, G. Pessin, B. Krishnamachari, and Jo Ueyama. 2015. Exploiting IoT

technologies for enhancing Health Smart Homes through patient identification and emotion recognition. *Computer Communications*, 89:90, (178-190). DOI: 10.1016/j.comcom.2016.03.010.

[11]. V. Sundareswaran and M. S. null, "Survey on Smart Agriculture Using IoT," *International Journal of Innovative Research in Engineering & Management (IJIREM)*, vol. 5, no. 2, pp. 62–66, 2018.

[12]. P. Tadejko, "Application of Internet of Things in logistics-current challenges," *Ekonomia i Zarz{a}dzenie*, vol. 7, no. 4, pp. 54–64, 2015.

[13]. S. Rajguru, S. Kinhekar, and S. Pati, "Analysis of internet of things in a smart environment," *International Journal of Enhanced Research in Man-agement and Computer Applications*, vol. 4, no. 4, pp. 40–43, 2015.

[14]. H. U. Rehman, M. Asif, and M. Ahmad, "Future applications and research challenges of IOT," in *2017 International Conference on Informa-tion and Communication Technologies (ICICT)*, pp. 68–74, Dec 2017.

[15]. Z. Alansari, N. B. Anuar, A. Kamsin, M. R. Belgaum, J. Alshaer, S. Soomro, and M. H. Miraz, "Internet of Things: Infrastructure, Architecture, Security and Privacy", in *2018 International Conference on Com- puting, Electronics Communications Engineering (iCCECE)*, pp. 150– 155, Aug 2018, DOI: 10.1109/iCCECOME.2018.8658516.

[16]. J. A. Chaudhry, K. Saleem, P. S. Haskell-Dowland, and M. H. Miraz, "A Survey of Distributed Certificate Authorities in MANETs," *Annals of Emerging Technologies in Computing (AETiC)*, vol. 2, no. 3, pp. 11– 18, 2018, DOI: 10.33166/AETiC.2018.03.002.

[17]. A. S. A. Daia, R. A. Ramadan, and M. B. Fayek, "Sensor Networks Attacks Classifications and Mitigation", *Annals of Emerging Technologies in Computing (AETiC)*, vol. 2, no. 4, pp. 28–43, 2018, DOI: 10.33166/AETiC.2018.04.003.