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A Survey on: Internet of Things, it's Upcoming Obstacles and Implementations

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***Abstract*— With the Internet of Things (IoT) quickly developing as the following period of the Internet's development, it's turning out to be progressively essential to grasp the various potential regions for IoT applications, as well as the examination issues that accompany them. IoT is anticipated to enter for all intents and purposes each feature of day-to-day existence, from shrewd urban communities to medical care, savvy horticulture, coordinated operations and retail, and, surprisingly, brilliant living and savvy environments. Indeed, even while existing IoT enablement innovations have unfathomably progressed lately, there are as yet a large number of issues that should be tended to. Many exploration issues make certain to create since the IoT thought depends on heterogeneous innovation. Since the Internet of Things is so immense and contacts pretty much every part of our life, this makes it an important report point for concentrates on in spaces like data innovation and software engineering. Subsequently, the Internet of Things is preparing for new sorts of exploration to be directed. This article features future purposes and examination issues as well as the ongoing advancement of IoT innovation.**

Keywords—Internet of Things; IoT applications; IoT challenges; future technologies; smart cities; smart environment; smart agriculture; smart living

I. INTRODUCTION

The Internet is a correspondence network that interfaces individuals to data, while the Internet of Things (IoT) is an organization of remarkably addressable actual things with differing levels of handling, detecting, and incitation capacities that share the capacity to interoperate and convey involving the Internet as their normal stage [1]. Accordingly, the Internet of Things' basic objective is to empower things to associate with different items, people, whenever and from any area, through any organization, technique, or administration. The Internet of Things (IoT) is dynamically becoming perceived as the following stage in the development of the Internet. Conventional devices will actually want to interface with the web and play out an assortment of capacities, differentiating goals Only 0.6 percent of gadgets that can be connected to the Internet of Things have been associated so far [2]. associated with the web.As the internet continues to evolve, it has become more than a simple network of computers, but rather a network of various devices, while IoT serves as a network of various "connected" devices a network of networks [3], as shown in Fig. 1. Nowadays, devices like smartphones, vehicles, industrial systems, cameras, toys, buildings, home appliances, industrial systems and countless others can all share information over the Internet. Regardless of their sizes and functions, these devices can accomplish smart reorganizations, tracing, positioning, control, real-time monitoring and process control. In the past years, there has been an important propagation of Internet capable devices. Even though its most significant commercial effect has been observed in the consumer electronics field; i.e. particularly the revolution of smartphones and the interest in wearable devices (watches, headsets, etc.), connecting people has become merely a fragment of a bigger movement towards the association of the digital and physical worlds.

In light of this, the Internet of Things (IoT) is supposed to keep extending its span as relates the quantity of gadgets and capacities, which it can run. This is apparent from the uncertainty in the statement of "Things" which makes it challenging to frame the steadily developing constraints of the IoT [4]. While business achievement keeps on emerging, the IoT continually offers an essentially boundless stockpile of chances, in organizations as well as in research. Likewise, the student tends to the different expected regions for use of IoT spaces and the examination challenges that are related with these applications.

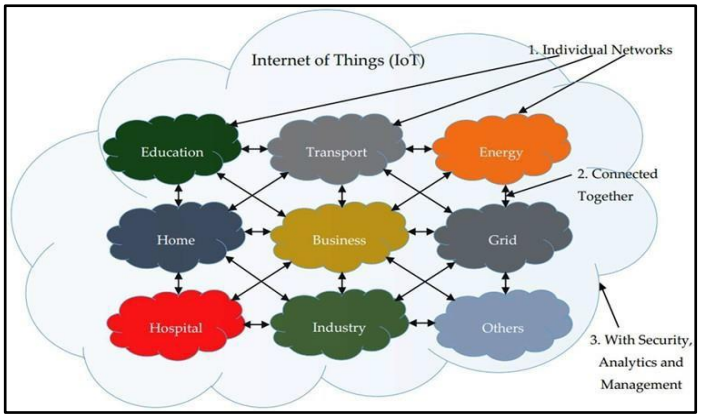

Fig. 1. IoT can be viewed as a Network of Networks [3].

II. POTENTIAL APPLICATION DOMAINS OF IOT

Potential uses of the web of Things are not just various yet additionally very different as they saturate into for all intents and purposes all parts of day-to-day existence of people, foundations, and society. As indicated by [5], the utilizations of IoT cover wide regions including producing or the modern area, wellbeing area, agribusiness, savvy urban communities, security and crises among numerous others.

A. *Smart Cities*

As per [6], the IoT assumes a vital part in working on the savvy of urban communities and improving general framework. Some of IoT application regions in making savvy urban areas incorporate; keen transportation frameworks [7], shrewd structure, gridlock [7, 8] waste administration [9], brilliant lighting, brilliant stopping, and metropolitan guides. This might incorporate various functionalities, for example, checking accessible parking spots inside the city, observing vibrations as well as material states of extensions and structures, setting up sound observing gadgets in touchy pieces of urban areas, as well as checking the degrees of people on foot and vehicles. Computerized reasoning (AI) empowered IoT can be used to screen, control and diminish gridlocks in Smart Cities [6]. Additionally, IoT permits establishment of clever and climate versatile road lighting and identification endlessly squander holders by keeping tabs of waste assortment plans. Wise expressways can give cautioning messages and significant data, for example, admittance to redirections relying upon the climatic circumstances or startling events like gridlocks and mishaps. Use of IoT to accomplish shrewd urban areas would require utilizing radio recurrence recognizable proof 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, a few significant urban communities like Boston have anticipates how to carry out the Internet of Things in the greater part of their frameworks going from their stopping meters, streetlamps, sprinkler frameworks, and sewage grates are undeniably booked to be interlinked and associated with the web. Such applications will offer huge forward leaps regarding setting aside cash and energy.

B. *Healthcare*

Most medical care frameworks in numerous nations are wasteful, slow and unavoidably inclined to blunder. 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 improved through innovation. Extra innovation that can work with different tasks like report sharing to various people and areas, record keeping and administering drugs would go far in changing the medical services area [10]. A ton of advantages that IoT application offers in the medical services area is generally classified into following of patients, staff, and items, recognizing, as well 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 unsafe to patients, record upkeep and less instances of confusing newborn children. Moreover, programmed information assortment and transmission is essential in process mechanization, decrease of structure handling timetables, computerized system reviewing as well as clinical stock administration. Sensor gadgets permit capacities fixated on patients, especially, in diagnosing conditions and benefiting constant data about patients' wellbeing pointers [6].

Application spaces in this area incorporate; having the option to screen a patient's consistence with remedies, telemedicine arrangements, and cautions for patients' prosperity. Accordingly, sensors can be applied to short term and ongoing patients, dental Bluetooth gadgets and toothbrushes that can give data after they are utilized and patient's reconnaissance. Different components of IoT in this limit incorporate; RFID, Bluetooth, and Wi-Fi among others. These will incredibly upgrade estimation and observing procedures of basic capacities like circulatory strain, temperature, pulse, blood glucose, cholesterol levels, and numerous others.

The uses of Internet of Things (IoT) and Internet of Everything (IoE) are further being reached 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 different articles (things) utilizing Nano organizations. Clinical application, as displayed in Fig. 2, is one of the major focal points of IoNT executions. Utilization of IoNT in human body, for therapy purposes, works with admittance to information from in situ pieces of the body which were until recently in open to detect from or by utilizing those clinical instruments consolidated with cumbersome sensor size. Subsequently, IoNT will empower new clinical information to be gathered, prompting new revelations and better diagnostics.

C. *Smart Agriculture and Water Management*

As per [11], the IoT has the ability to fortify and improve the horticulture area through analyzing soil dampness and on account of grape plantations, checking the storage compartment distance across. IoT would permit to control and safeguard the amount of nutrients tracked down in farming items, and manage microclimate conditions to take full advantage of the development of vegetables and leafy foods quality. Besides, concentrating on weather patterns permits gauging of ice data, dry spell, wind changes, downpour or snow, accordingly controlling temperature and dampness levels to forestall parasite as well as other microbial pollutants.

With regards to dairy cattle, IoT can help with recognizing animals that munch in open areas, distinguishing impeding gases from animal fertilizers in ranches, as well as controlling development conditions in posterity to improve chances of wellbeing and endurance, etc. In addition, through IoT application in farming, a great deal of wastage and deterioration can be stayed away from through legitimate observing methods and the executives of the whole horticulture field. It likewise prompts better power and water control.

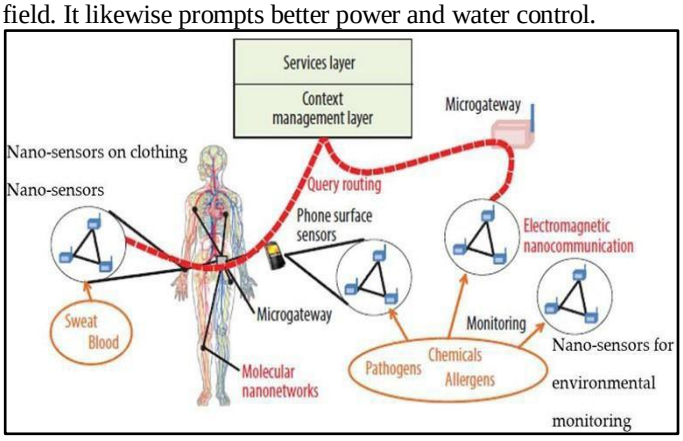

Fig. 2. The Internet of Nano-Things [3].

According to [11] make sense of, in water the executives, the job of IoT remembers reading up water reasonableness for oceans and streams for both drinking and agribusiness use, recognizing pressure varieties in lines, and fluid presence outside tanks as well as checking levels of water variety in dams, streams and supplies. These IoT applications use Wireless sensor organizations. Instances of existing IoT applications in this space incorporate; SEMAT, GBROOS, SiSviA

D. Retail and Logistics

Executing the IoT in Supply Chain or retail Management has many advantages. Some incorporate; noticing capacity conditions all through the store network, item following to empower follow capacity purposes, installment handling relying upon the area or movement period out in the open vehicle, amusement parks, rec centers, and others. Inside the retail premises, IoT can be applied to different applications, for example, course in the shop in light of a preselected list, quick installment processes like consequently looking at with the guide of biometrics, recognizing potential allergen items and controlling the revolution of items on racks and distribution centers to robotize restocking methods [12].

The IoT components generally utilized in this setting incorporate; remote sensor organizations and radio recurrence distinguishing proof. In retail, there is an ongoing utilization of SAP (Systems Applications and Products), while in operations various models incorporate quality transfer conditions, thing area, identifying capacity contrariness issues, armada following among others. In the business space, IoT helps in distinguishing levels of gas and spillages inside the business and its environs, monitoring harmful gases as well as the oxygen levels inside the limits of synthetic plants to guarantee the security of merchandise and laborers and noticing levels of oil, gases and water in reservoirs and capacity tanks. Use of IoT likewise aids support and fix since frameworks can be set up to foresee hardware glitches and at the equivalent consequently plan occasional upkeep administrations before there is a disappointment in the gear. This can be accomplished through the establishment of sensors inside gear or apparatus to screen their usefulness and infrequently send reports.

E. Smart Living

Inside this space, IoT can be applied in controller gadgets by which one can remotely turn machines on and off consequently forestalling mishaps as well as saving energy [1, 3]. Other savvy home apparatuses incorporate coolers fitted inside LCD (Liquid Crystal Display) screens, empowering one to know what is accessible inside, what has over remained and is nearly lapsing as well as the need might arise to be restocked. This data can likewise be connected to a cell phone application empowering one to get to it when outside the house and subsequently purchase what is required. Moreover, clothes washers can permit one to screen clothing from a distance. What's more, a wide scope of kitchen gadgets can be connected through a cell phone, consequently making it conceivable to change temperature, as on account of a stove. A few stoves which have a self-cleaning element can be effectively observed too. As far as wellbeing in the home, IoT can be applied through caution frameworks and cameras can be introduced to screen and recognize window or entryway openings consequently forestalling gatecrashers [3].

F. Smart Environment

The climate plays an imperative part inside all parts of life, from individuals, to creatures, birds and furthermore plants, are undeniably impacted by an undesirable climate somehow. There have been various endeavors to establish a sound climate as far as wiping out contamination and decreasing wastage of assets, yet the presence of businesses, as well as transportations squanders combined with foolish and unsafe human activities are normal spot components which reliably harm the climate. Thusly, the climate requires brilliant and creative ways of assisting in observing and overseeing waste, which with providing a lot of information that powers legislatures to set up frameworks that will safeguard the climate.

Shrewd climate procedures mix with IoT innovation ought to be made for detecting, following and evaluation of objects of the climate that offer expected benefits in accomplishing a reasonable life and a green world. The IoT innovation permits noticing and overseeing of air quality through information assortment from far off sensors across urban areas and giving nonstop geographic inclusion to achieve better approaches to overseeing gridlocks in significant urban communities. Also, IoT innovation can be applied in estimating contamination levels in water and thusly illuminate choices on water utilization. In squander the executives, which comprises of different sorts of waste, similar to synthetics and contaminations being hindering to the climate and to individuals, creatures, and plants too, IoT can likewise be applied. This can be accomplished by natural security through controlling modern contamination through quick checking and the executives frameworks joined with management notwithstanding dynamic organizations. This decreases squander [13].

As mentioned in the weather conditions gauging, IoT is implemented to convey a critical precision and high goal for observing the climate by data sharing and information trade. Through IoT innovation, climate frameworks can gather data like barometric strain, mugginess, temperature, light, movement and other data, from vehicles moving and communicate the data remotely to weather conditions stations. The data is accomplished by introducing sensors on the vehicles and, surprisingly, on structures after which aiding weather conditions forecasting is put away and dissected. Radiation is likewise a danger to the climate, human and creature wellbeing as well as horticultural efficiency. IoT sensor organizations have some control over radiation through consistent observing of its levels, especially around atomic plant premises for recognizing spillage and spreading prevention..

III. Research Challenges

For every one of the above likely uses of IoT, there must be appropriate practicality into the various areas to learn the progress of certain applications and their usefulness. Similarly as with some other type of innovation or advancement, IoT has difficulties and suggestions should be figured on a mission to empower mass reception. Despite the fact that the momentum IoT empowering advances have significantly worked on in the new years, there are as yet various issues that require consideration, consequently making ready for new components of examination to be completed. Futhermore, the IoT idea results from heterogeneous

advances that are utilized in detecting, gathering, activity, handling, construing, sending, telling, making due, and putting away of information, a ton of examination challenges will undoubtedly emerge. These examination challenges that require consideration have subsequently spread over various exploration regions [14].

A. *Privacy and Security*

Inferable from the way that IoT has turned into an imperative component as respects the eventual fate of the web with its expanded use, it requires a need to sufficiently address security and trust capacities. Specialists know about the shortcomings which by and by exist in numerous IoT gadgets. Besides, the groundwork of IoT is laid on the current remote sensor organizations (WSN), IoT accordingly 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 running security plans which will shield information and frameworks from one finish to another. Many goes after by and large adventure shortcomings in unambiguous gadgets in this manner getting entrance into their frameworks and subsequently making secure gadgets helpless [16, 17] . This security hole further propels extensive security arrangements that comprise of exploration that is effective in applied cryptography for information and framework security, non-cryptographic security strategies as well as structures that help designers to think of safe frameworks on gadgets that are heterogeneous.

It is a requirement for more exploration to be led on cryptographic security benefits that have the capacity to work on asset obliged IoT gadgets. This would empower different gifted clients to safely utilize and convey IoT frameworks no matter what the deficient UIs that are accessible with practically all IoT gadgets. Notwithstanding the assurance and security parts of the IoT, extra regions like classification in correspondence, dependability, and genuineness of correspondence gatherings, and message uprightness, and strengthening wellbeing necessities ought to likewise be consolidated. These may incorporate highlights like having the option to forestall correspondence of different gatherings. For instance, in deals, savvy objects should be kept from working with contenders' admittance to secret data in the gadgets and hence utilizing this data vindictively.

B. *Processing, Analysis and Management of Data*

It is the technique for handling, examination and information the board is immensely difficult due to the heterogeneous idea of IoT, and the enormous size of information gathered, especially in this time of Big Data [18]. Right now, most situation use unified frameworks in offloading information and doing computationally serious undertakings on a worldwide cloud stage. In any case, there is a steady worry about customary cloud models not being viable as far as moving the enormous volumes of information that are delivered and consumed by IoT empowered gadgets and to be capable further help the going with computational burden and all the while meet timing imperatives [19]. Most frameworks are consequently depending on current arrangements, for example, versatile distributed computing and haze registering which are both in view of edge handling, to moderate this test..

One more examination heading as respects information the executives is applying Information Centric Networking (ICN) in the IoT. Since these data driven frameworks offer help in the proficient substance recovery and admittance to administrations, they have all the earmarks of being very significant in getting to as well as moving as well as overseeing created content and its transmission. This arrangement, in any case, achieves different difficulties, for example, how to expand the ICN worldview capability over the proper organization edge, how to take in IoTs static and cell phones as well as how to allocate the usefulness of ICN on asset compelled gadgets [19].

Information examination and its setting not just assumes a critical part in the progress of IoT, it likewise presents significant difficulties. Whenever information has been gathered it must be utilized shrewdly to accomplish savvy IoT capacities. In like manner, the advancement of AI strategies and man-made consciousness calculations, resultant from brain works, hereditary calculations, developmental calculations, and numerous other computerized reasoning frameworks are fundamental in accomplishing robotized navigation.

C. *Monitoring and Sensing*

Regardless of whether advancements worried about observing and detecting have gained huge headway, they are continually developing especially zeroing in on the energy effectiveness and structure angle. Sensors and labels are typically expected to be dynamic continually to get immediate information, this viewpoint makes it fundamental for energy effectiveness particularly in lifetime augmentation. At the same time, new advances in nanotechnology/biotechnology and scaling down have permitted the improvement of actuators and sensors at the Nano-scale.

D. *M2M (Machine to Machine) Communication and Communication Protocols*

Meanwhile, as of now present IoT situated correspondence conventions like Constrained Application Protocol (CoAP) and Message Queuing Telemetry Transport (MQTT), there is still no norm for an open IoT. Albeit all items require network, it isn't required for each item to be made web competent since they just have to have a specific capacity to put their information on a specific entryway. Moreover, there are a great deal of choices as far as reasonable remote innovations, for example, LoRa, IEEE 802.15.4, and Bluetooth despite the fact that it isn't certain if these accessible remote innovations have the required ability to keep covering the broad scope of IoT network from now on.

The correspondence conventions for gadgets are the main thrust in realizing IoT applications, and they structure the principal backing of information stream among sensors and the actual articles or external world. Meanwhile, different MAC conventions have been anticipated for a few spaces with Frequency Division Multiple Access, Time Division Multiple Access and Carrier Sense Multiple Access (TDMA, FDMA and CSMA) for low traffic effectiveness that is sans crash, more hardware in hubs are required separately. The primary goals of the vehicle layer incorporate ensuring a start to finish unwavering quality as well as performing start to finish control of clog. In this perspective, most conventions can't collaborate fitting start to finish dependability [20]..

E. *Blockchain of Things (BCoT): Fusion of Blockchainand Internet of Things*

Like IoT, blockchain advances have additionally acquired huge ubiquity since its presentation in 2018. Despite the fact that blockchain was first executed as a hidden innovation of Bitcoin digital currency, it is currently being utilized in diverse nonmonetary applications [21]. Miraz contends that both IoT and Blockchain can fortify one another, in an equal way, by wiping out their particular inborn engineering impediments [22]. The fundamental innovation of IoT is WSN. Accordingly, comparable to WSN, IoT additionally experiences security and protection issues. In actuality, the essential purposes behind blockchain's execution pattern in non-money related applications is because of its inbuilt security, unchanging nature, trust and straightforwardness. The properties are fueled by blockchain's agreement impact and use of Distributed Ledger Technologies (DLTs) in broad reliance on taking an interest hubs. Thusly, the combination of these two innovations Blockchain and Internet of Things (IoT) considers another thought for example the Blockchain of Things (BCoT) where blockchain reinforces IoT by giving additional layer of safety while the "things" of IoT can act as taking an interest hubs for blockchain environments [22]. Subsequently, blockchain empowered IoT biological systems will give improved in general security [23] as well as advantage from one another.

F. *Interoperability*

Generally as respects the web, interoperability has forever been and keeps on being an essential thing esteem in light of the fact that the underlying essential in Internet network requires that "associated" frameworks can "communicate in a comparative language" with regards to encodings and conventions. Presently, different businesses utilize an assortment of guidelines in supporting their applications. Because of the huge amounts and kinds of information, as well as heterogeneous gadgets, involving standard connection points in such different substances is vital and, surprisingly, more critical for applications which backing cross hierarchical, notwithstanding a wide scope of framework impediments. Thusly, the IoT frameworks are implied towards being intended to deal with considerably higher levels of operations[24].

IV. Conclusion

To conclude, IoT can best be depicted as a CAS (Complex Adaptive System) which will keep on developing subsequently requiring new and inventive types of programming, frameworks designing, project the executives, as well as various different disciplines to foster it further and oversee it the next few years. The application areas of IoT are very assorted to empower it to serve various clients, who thus have various requirements. The innovation serves three classifications of clients, people, the general public or networks and establishments. As examined in the application part of this examination paper, the IoT has point of fact a gigantic capacity to be a colossally groundbreaking power, which will, and somewhat does as of now, decidedly influence a huge number of lives around the world. As per [25], this has become much more obvious, as various legislatures all over the planet have shown an interest in the IoT idea by giving seriously subsidizing in the field that is intended to work with additional examination. A genuine model is the Chinese Government. Endless examination bunches have been, and keep on being, started from various areas of the planet, and their primary goal is to completely finish IoT related explores. As increasingly more examination studies are directed, new aspects to the IoT processes, innovations included and the items that can be associated, keep on arising, further clearing way for substantially more application functionalities of IoT. The way that IoT is so far reaching and influences basically all parts of our lives, makes it a critical exploration point for concentrates on in different related fields like data innovation and software engineering. The paper features different potential application spaces of the web of things and the connected exploration 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. Zanjal 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, }dzanie, 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.

[18] Z. Alansari, N. B. Anuar, A. Kamsin, S. Soomro, M. R. Belgaum, M. H. Miraz, and J. Alshaer, "Challenges of Internet of Things and Big Data Integration", in Emerging Technologies in Computing (M. H. Miraz, P. Ex- cell, A. Ware, S. Soomro, and M. Ali, eds.), (Cham), pp. 47–55, Springer International Publishing, 2018, DOI: 10.1007/978-3-319-95450-9_4.

[19] J. Cooper and A. James, "Challenges for database management in the internet of things" IETE Technical Review, vol.26, no.5, pp.320–329, 2009.

[20] D. B. Ansari, A.-U. Rehman, and R. Ali, "Internet of Things (IoT) Proto- cols: A Brief Exploration of MQTT and CoAP," International Journal of Computer Applications, vol. 179, pp. 9–14, 03 2018.

[21] M. H. Miraz and M. Ali, "Applications of Blockchain Technology beyond Cryptocurrency", Annals of Emerging Technologies in Computing (AETiC), vol. 2, no. 1, pp. 1–6, 2018, DOI: 10.33166/AETiC.2018.01.001.

[22] Miraz, M.H., "Blockchain of Things (BCoT): The Fusion of Blockchain and IoT Technologies", Advanced Applications of Blockchain Technology, Studies in Big Data 60, 2019, DOI: 10.1007/978-981-13-8775-3_7, https://doi.org/10.1007/978-981-13-8775-3_7.

[23] Miraz, M. H. and Ali, M., 2018. Blockchain Enabled Enhanced IoT Ecosystem Security, Proceedings of the International Conference on Emerging Technologies in Computing 2018, London Metropolitan University, UK, Part of the Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering (LNICST), vol. 200, pp. 38-46, Online ISBN: 978-3-319-95450-9, Print ISBN: 978-3-319-95449-3, Series Print ISSN: 1867-8211, Series Online ISSN: 1867-822X, DOI: 10.1007/978-3-319-95450-9_3, Springer-Verlag, https://link.springer.com/chapter/10.1007/978-3-319-95450-9_3.

[24] A. Mazayev, J. A. Martins, and N. Correia, "Interoperability in IoT Through the Semantic Profiling of Objects," IEEE Access, vol. 6, pp. 19379–19385, 2018.

[25] R. Porkodi and V. Bhuvaneswari, "The Internet of Things (IoT) Applications and Communication Enabling Technology Standards: An Overview," in 2014 International Conference on Intelligent Computing Applications, pp. 324–329, March 2014.