APPLICATION OF IOT IN HEALTH MANEGMENT

Taruna Chopra

Assistant professor

Department of Computer science and Engineering

Kalinga University, Naya Raipur, Chhattisgarh

ABSTRACT

Last ten years has seen broad examination in field of medical care administrations and their mechanical up gradation. To be more explicit, Internet of things (IoT) has shown likely application in interfacing different clinical gadgets, sensors, medical services experts to offer quality clinical types of assistance in a distant area. THis has worked on persistent wellbeing, decrease medical care costs, improved openness of medical services benefits, and expanded functional productivity in medical services industry current review surrenders a to-date synopsis of potential medical care uses of IoT-(HIoT-) based advancements. Thus, headway of use of HIoT has been accounted for according to viewpoint of empowering innovations, medical care administrations, and applications in addressing different medical care issues. In addition, expected difficulties and issues in HIoT framework are likewise examined. In aggregate, ongoing review gives an exhaustive wellspring of data in regards to various fields of use of HIoT expecting to assist future analysts, who with having interest to work and make headways in field to acquire understanding into theme.

KEY WORDS: IoT, medical, HIoT, wellbeing, industry, Internet.

INTRODUCTION

As of late, medical services industry has shown fast development and has been a significant supporter of income and business. A couple of years prior, finding of sicknesses what's more, anomaly in human body was just being conceivable in wake of having an actual investigation in clinic. greater part of patients needed to remain in medical clinic all through their therapy period. This is brought about an expanded medical services cost and furthermore stressed medical care office at provincial and remote areas. mechanical headway that has been accomplished during these times has now permitted finding of different sicknesses and wellbeing checking utilizing scaled down gadgets like smart watches. In addition, innovation has changed a clinic driven medical services framework into a patient-driven framework. For instance, a few clinical examinations, (for example, estimating circulatory strain, blood glucose level, pO2, level, etc) can be performed at home without assistance of a medical services proficient. Further, clinical information can be imparted to medical care habitats from far off regions with assistance of cutting edge media transmission administrations. Utilization of such correspondence administrations in combination with quickly developing innovations (e.g., AI, large information investigation, Internet of things (IoT), remote detecting, versatile figuring, and distributed computing) has worked on availability of medical services offices. IoT has improved autonomy as well as differentiated capacity of human to communicate with outer climate. IoT, with assistance of cutting edge convention furthermore, calculations, turned into a significant supporter of worldwide correspondence. It interfaces countless gadgets, remote sensors, home machines, and electronic gadgets to Internet. Utilization of IoT can be seen as in field of agribusiness, cars , home , and medical care . Developing fame of IoT is expected to its benefit of showing higher precision, lower cost, and its capacity to anticipate future occasions in a superior manner. Further, expanded information on programming and applications, with up gradation of portable and PC advancements, simple accessibility of remote innovation, and expanded advanced economy have added to quick IoT unrest. IoT gadgets (sensors, actuators, etc) have been incorporated with other actual gadgets to screen and trade data utilizing different correspondence. Conventions, for example, Bluetooth, Zigbee, IEEE 802.11 (Wi-Fi),etc. In medical services applications, sensors, by same token implanted or wearable on human body, are utilized to gather physiological data like temperature, pressure rate, electrocardiograph (ECG), electroencephalograph (EEG, etc. [11from patient's body. Moreover, ecological data like temperature, moistness, date, and time can likewise be recorded. These information help in making significant and exact deductions on medical issue of patients. Information capacity and availability likewise assume a significant part in IoT framework as a enormous measure of information are procured/recorded from an assortment of sources (sensors, cell phones, email, programming, and applications). information from aforementioned detecting gadgets is made accessible to specialists, guardians, and approved parties. sharing of this information with medical services suppliers through cloud/server permits fast determination of patients furthermore, clinical intercession if vital. participation between clients, patients, and correspondence module is kept up with for powerful and secure transmission. greater part of IoT frameworks utilize a UI that goes about as a dashboard for clinical parental figures and performs client control, information representation, and fear. An adequate measure of

exploration has been found in writing that has announced progress of IoT framework in medical care checking, control, security, and protection. These achievements outline adequacy and favorable fate of IoT in the

Medical services area. Nonetheless, fundamental worry while planning an IoT gadget is keeping up with nature of administration networks that incorporate protection of data sharing, security, cost, dependability, and accessibility. Proposing to expand employability of IoT in medical services frameworks, numerous nations have embraced new innovation and strategies. This changed momentum research in medical care area into a more gainful field to investigate. inspiration of this paper is to sum up progression of cutting edge investigations in IoT-based medical services frameworks and to give an orderly survey of its empowering innovations, administrations, and applications.

Design of Healthcare IoT (HIoT)

The system of IoT that is applied for medical care applications helps to incorporate upsides of IoT innovation and distributed computing with field of medication. It likewise spreads out conventions for transmission of patient's information from various sensors and clinical gadgets to a given medical care organization. geography of a HIoT is plan of various parts of an IoT medical services framework/network that are intelligently associated in a medical services climate. A fundamental HIoT framework contains mostly three parts (Figure 1) like distributer, agent, and endorser. Distributer addresses an organization of associated sensors and other clinical gadgets that might work separately or all while to record patient's essential data. This data might incorporate circulatory strain, Pulse, temperature, oxygen immersion, ECG, EEG, EMG, etc. distributer can send this data constantly through an organization to a specialist. merchant is liable for handling and stockpiling of obtained information in cloud. At long last, supporter enjoys ceaseless observing of patient's data that can be gotten to and envisioned through a cell phone, PC, tablet, and so on. Thus, distributer can process these information and give input after perception of any physiological oddity or corruption in patient's wellbeing condition. HIoT absorbs discrete parts into a half and half network where a particular intention is committed to each part on IoT organization and cloud in medical care network. Since geography for a HIoT relies upon medical care interest and application, it is difficult to recommend a widespread design for HIoT. Various primary changes have been taken on in past for a HIoT framework. It is critical to drill down completely related exercises connected with wanted wellbeing application while planning another IoT-based medical services framework for ongoing patient checking. progress of IoT framework relies on way things are fulfilling necessities of medical care suppliers. Since every infection needs an intricate technique of medical services exercises, geography should adhere to clinical guidelines and steps in finding system. HIoT Technologies innovations that are utilized to foster a HIoT framework is significant. This is on grounds that utilization of explicit innovation would be able Improve capacity of an IoT framework. Henceforth, to coordinate different medical care applications with an IoT framework, different cutting edge advancements have been embraced. These innovations can comprehensively be sorted into three gatherings, in particular, recognizable proof innovation, correspondence innovation, and area innovation

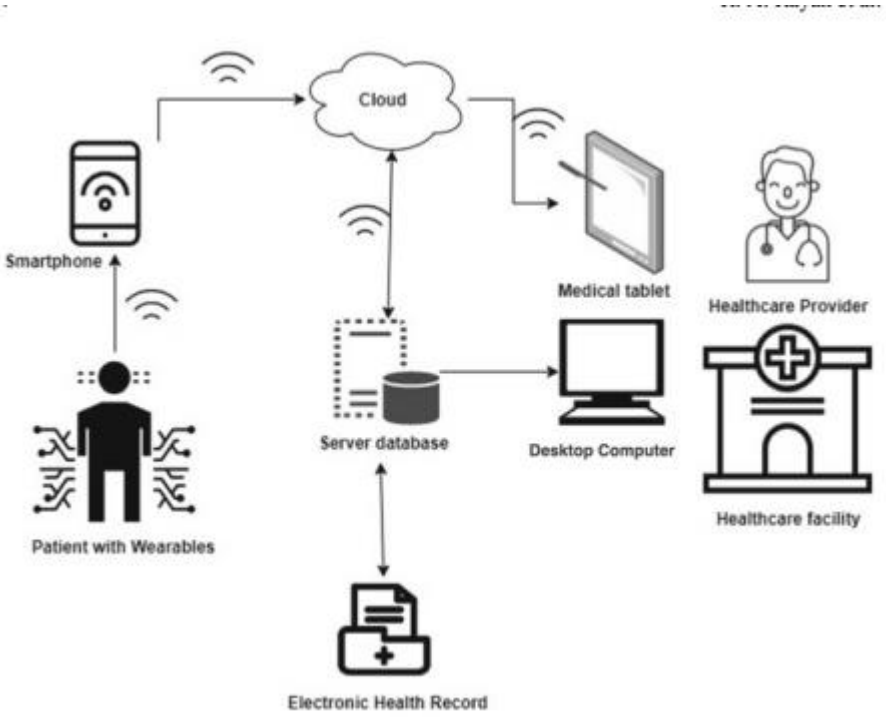

Figure 1: concept of health care.

ID Technology

A useful thought in planning a HIoT framework is openness of patient's information from approved hub (sensor), which may be available at distant areas. This can be completed with viable recognizable proof of hubs and sensors that are available in medical care organization. Recognizable proof follows most common way of appointing a remarkable identifier (UID) to each approved element with goal that it tends to be effortlessly distinguished furthermore; unambiguous information trade can be accomplished. In general, each asset related with medical services framework (clinic, specialist, attendants, guardians, clinical gadgets, etc) joined by an advanced UID. This guarantees recognizable proof of assets as well as association among assets in an advanced space. In writing, various norms for distinguishing proof have been accounted for. Open Software Foundation (OSF) has created two unique identifiers, to be specific, An all-around remarkable identifier (UUID) and an internationally evolved interesting identifier (GUID). UUID, a piece of Distributed Computing Environment (DCE), can be worked without necessity of concentrated coordination. In a medical care organization, sensors and actuators are distinguished and tended to independently which helps in legitimate working of framework.

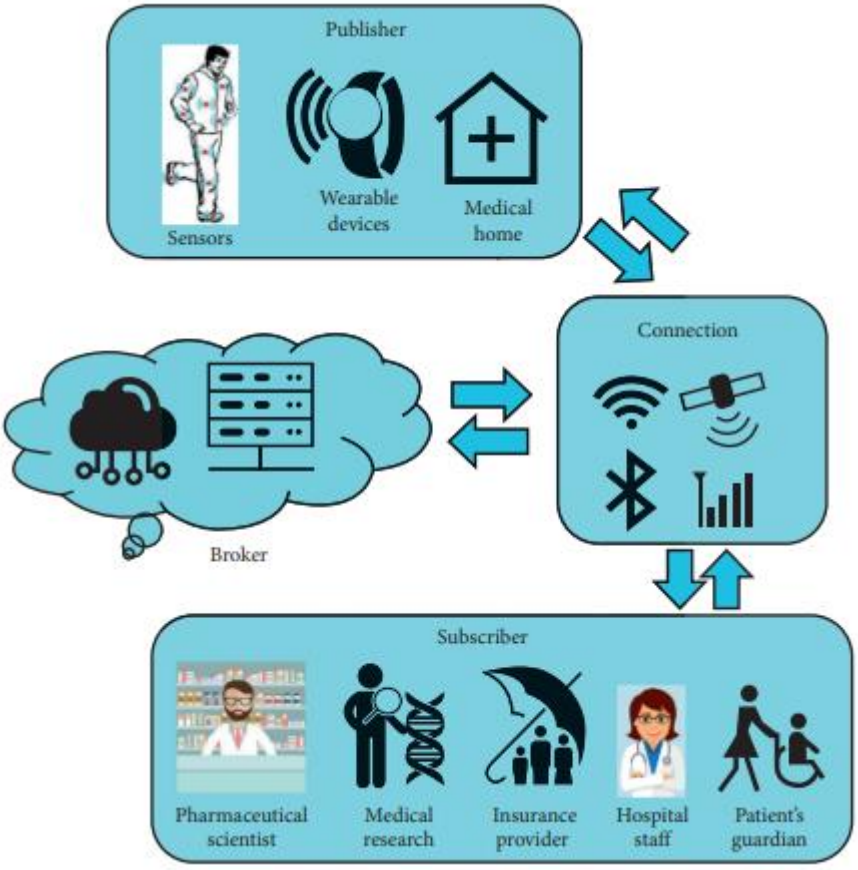

Figure 2: Architecture of an HIoT framework (reproduced from under Creative Commons License)

Chance that interesting distinguishing proof of a part may change all through existence pattern of IoT framework due to persistent up gradation of IoT-based advances. Thus, gadget should have an arrangement to refresh this data to keep up with uprightness of medical care gadget/framework. this can be contemplated to way that adjustment of design not just influences cycle of following organization component(s) yet additionally may bring about a defective conclusion. Moreover, utilization of IoT in medical care requests new advances that have capacity to (1) find things in light of a worldwide distinguishing proof number, (2) securely deal with character of parts utilizing different encryption and validation methods, and (3) form a worldwide index look for proficient revelation of IoT administrations under.

UUID plot Correspondence Technology.

Correspondence advances guarantee association among various substances in HIoT organization. These advancements can be comprehensively separated into short-reach and medium-range correspondence innovation. short-range correspondence innovations are conventions that are utilized to lay out an association among articles inside a restricted reach or a body region organization (Boycott), though medium-range correspondence advances as a rule support correspondence for a huge distance, e.g., correspondence between a base station and focal hub of a BAN. Distance of correspondence may change from a couple of centimeters to a few meters on account of short-range correspondence. In vast majority of HIoT applications, short-range correspondence innovation is liked. Absolute most generally utilized correspondence strategies incorporate RFID, Wi-Fi, Zigbee, Bluetooth, and so forth.

Radio-Frequency Identification (RFID). RFID is utilized for short-range correspondence (10 cm-200 m). It comprises of a tag and a peruse. tag is created utilizing a CPU and radio wire. It is utilized to remarkably distinguish an item/gadget (medical services gear) in IoT climate. peruse communicates or gets data from item by speaking with a label utilizing radio waves. On account of IoT, information utilized in tag are as an electronic item code (EPC). RFID empowers medical services suppliers to immediately find and track medical services gear. Primary benefit of RFID is that it needn't bother with an outside power source. Be that as it may, it is an exceptionally uncertain convention and may show similarity issues while associating with a cell phone. Bluetooth is likewise a brief distance remote correspondence innovation that utilizes UHF (super high recurrence) radio waves. This innovation permits remote association between at least two clinical gadgets. recurrence scope of Bluetooth is 2.4 GHz. Bluetooth convention presents a correspondence scope of up to 100 m. Bluetooth gives information assurance as validation what's more, encryption. benefit of Bluetooth lies in its low cost and energy productivity. It additionally guarantees a lower obstruction among associated gadgets during information transmission. Nonetheless, when medical services application requests long-range correspondence, this innovation comes up short to meet prerequisite. Zigbee is one of standard conventions that interconnects clinical gadgets and communicates data back also, forward. Recurrence scope of Zigbee is like Bluetooth (2.4 GHz). In any case, it has a higher correspondence range than that of Bluetooth gadgets. This innovation embraces cross section network geography. It comprises of end hubs, switches, and a handling community. Handling focus is liable for information examination and total. Network guarantees continuous association among different gadgets in any event, when there is an issue in a couple of gadgets. Benefits of Zigbee lies in its low power utilization, high transmission rate, and high organization limit.

Close Field Communication (NFC). Fundamental idea of NFC is electromagnetic enlistment between two-circle radio wires that are put close to one another. This innovation is like RFID that likewise utilizes electromagnetic enlistment for information transmission. NFC gadgets can be worked in two modes: dynamic and detached. On account of aloof mode, just a single gadget produces radiofrequency while other gadget goes about as a recipient. On account of dynamic mode, both gadgets can create radiofrequency at same time and can communicate information without matching. Primary benefits of NFC are its simple operability and an effective remote correspondence organization. Be that as it may, it is material for a very short scope of correspondence. Remote Fidelity (Wi-Fi) is a remote neighborhood network (WLAN) that observes IEEE 802.11 guideline. It gives a higher transmission range (inside 70 ft.) as contrasted with Bluetooth. Wi-Fi constructs an organization rapidly also, without any problem. Consequently, it is for most part utilized in medical clinics. Wide utilization of Wi-Fi lies in its simple similarity with cell phones and its arrangement to help vigorous security also, control. Be that as it may, it shows a somewhat higher power use and organization performs conflictingly. Satellite correspondence is viewed as additional compelling and valuable in remote and generally isolated geological regions (like provincial regions, mountains, tops, seas, etc) where different methods of correspondence can't reach without any problem. Satellite gets signals from land, intensifies those signs, and afterward resends them to Earth.

Figure 3: Selected cases of IOT implementation in healthcare.

In excess of 2000 satellites are circling around Earth. benefit of satellite correspondence innovation incorporates high velocity information move, moment broadband access, soundness, what's more, similarity of innovation. Nonetheless, power utilization related with satellite correspondence is extremely high when contrasted with other correspondence methods.

Area Technology.

Constant area framework (RTLS) or area advancements are utilized to recognize and track place of an article inside medical care organization. It additionally tracks treatment interaction in view of circulation of accessible assets. Quite possibly most broadly utilized innovation is Global Positioning System, which is regularly known as GPS. It utilizes satellites for following purposes. An item can be distinguished through GPS as long as there exists an unmistakable view between article and four various satellites. In HIoT, it very well may be utilized to identify position of rescue vehicle, medical services supplier, guardians, patients, and so on. In any case, use of GPS is just restricted to outside applications as encompassing frameworks can go about as a deterrent to correspondence between object and satellite. In such cases, a nearby situating (LPS) organization can be really utilized. LPS can follow an object by detecting radio transmission that is produced from making a trip object to a variety of redeployed recipients. Different brief distance correspondence advancements, for example, RFID, Wi-Fi, Zigbee, etc can likewise be utilized to utilize LPS. Notwithstanding, super wideband (UWB) radio is liked because of its benefit of higher fleeting goal. This empowers beneficiary to precisely gauge appearance time. Youthful and Zetik have utilized UWB-based restriction framework that utilizes time distinction of appearance (TDOA) for following. In writing, other estimating boundaries have likewise been accounted for in planning a UWB based restriction framework like family member and differential season of arrival , full circle season of flight, etc. GPS, alongside different high transfer speed correspondence advancements, might be investigated in future to create savvy medical care organizations.

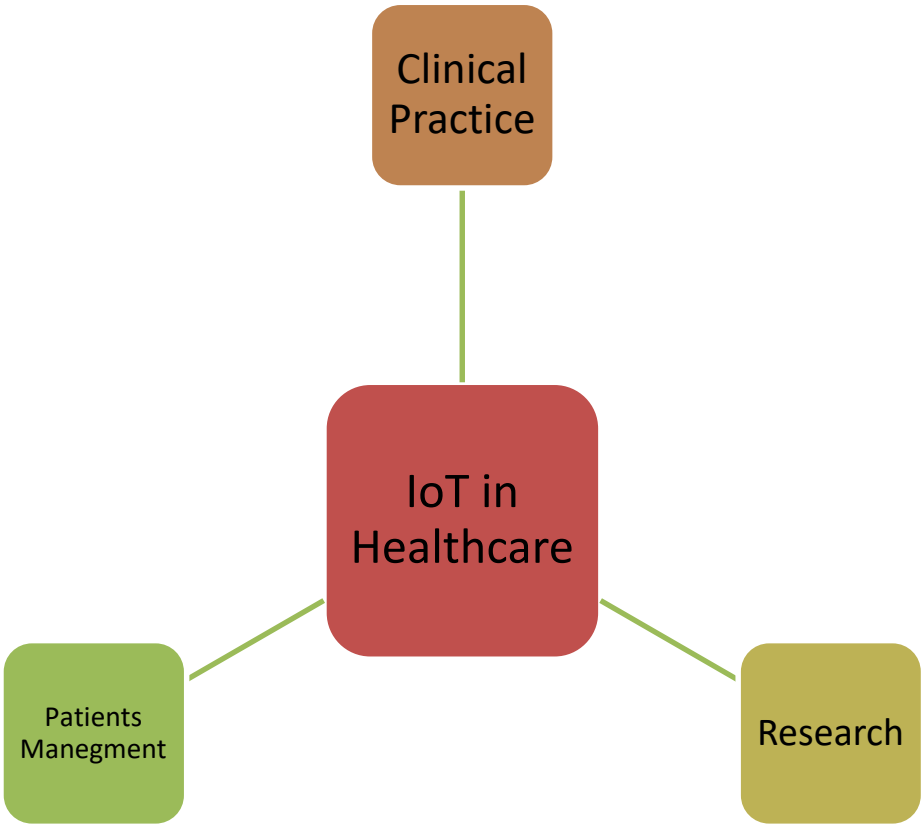

Figure 3: Key Application of IoT in health care.

Administrations and Application of HIoT

Late progression in IoT innovation has empowered clinical gadgets to make continuous examination that was not workable for specialists a couple of years prior. It has additionally upheld Journal of Healthcare Engineering medical care communities to contact more individuals all at once and convey brilliant medical care administration at an insignificant expense. Utilization of enormous information and distributed computing has additionally made correspondence between patient and specialists more solid and simpler. This brought about an improved patient's commitment to treatment cycle with a diminished monetary weight on patient. Significant effect of IoT, which has been seen as of late, is adding to development of HIoT applications that incorporates infection conclusion, individual consideration for pediatric and old patients, wellbeing and wellness board, and oversight of ongoing sicknesses. For a superior handle of these applications, it has been partitioned into two fundamental classifications, in particular, administrations furthermore, applications. Previous incorporates ideas that are being utilized while fostering a HIoT gadget and last option remembers medical services applications for one or other finding of a

explicit medical issue or estimations of wellbeing boundaries. Following segments have incorporated an itemized portrayal of administrations and uses of HIoT.

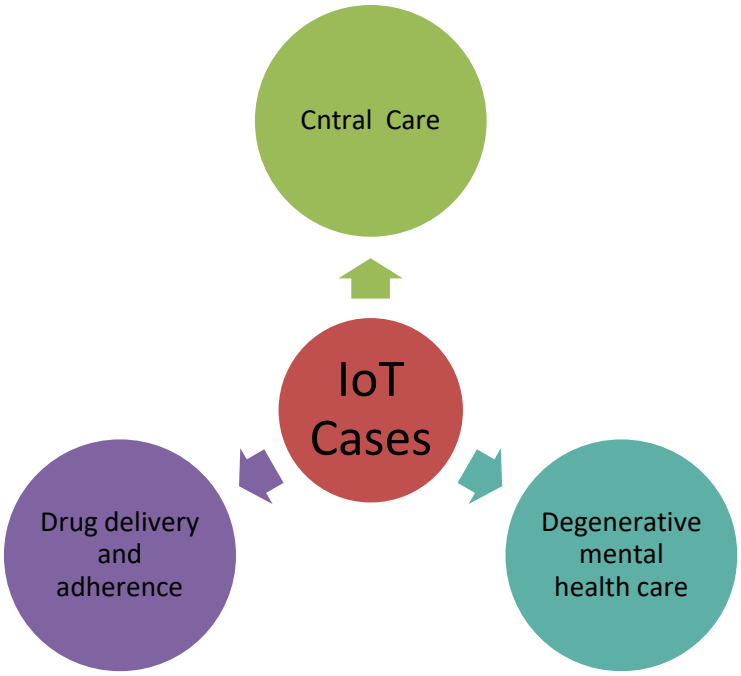

Figure 3: Selected cases of IoT implementation in healthcare.

Application

HIoT administrations/ideas are utilized for improvement of various IoT-based applications. Scientists working in said fields have proposed different ideas to assistance of humanity. In straightforward words, ideas are more engineers driven, while applications are client driven. quick improvement in IoT-innovation has prompted advancement of additional reasonable and user-friendly wearable sensors, convenient contraptions, and clinical gadgets. These frameworks can be utilized to gather patient's data, analyze sicknesses, screen wellbeing of patients, and create alarms if there should be an occurrence of a health related crisis. In accompanying area, absolute latest economically accessible gadgets have been examined. Further, different HIoT-based applications have been tended to including both single condition and various circumstances

DISCUSSION

IoT innovation assists with guaranteeing reception and execution of choices in appropriate time in light of assortment and handling of a colossal measure of information. Besides, to deal with such huge measures of data, which is powerfully changing, individuals have created AI innovation. Cycle of a wide utilization of IoT is one of basic advantages of innovative insurgency. IoT will become among biggest developments of mankind. Fame of IoT is a reaction to fast development in beyond two centuries. It is realized that settling on significant choices requires thinking about all broad measures of data regarding a few subjects and articles digression to processes in regard of which a choice is made. Essentially, choice ought to be accepted in a mode as near continuous. Due to specific physiological and mental impediments, individuals are not generally capable in that frame of mind to go with speedy and informed choices. Thus, IoT and AI innovations are significant. levelheaded utilization of these innovations can carry many advantages to clinical area. current medical care industry is a field where IoT turns out to be more predominant. IoT straightforwardly influences individuals' lives and shows significance of medication as a circle of movement in present day culture. Clinical frameworks are one of most encouraging key regions that consume enormous numeric information. huge progression of data and its change to a particular finished result and its utilization is incomprehensible utilizing intelligent data and imaginative innovations. As indicated by logical investigations, the vast majority of heads of wellbeing area accept that IoT will prompt a transformation in medication in following couple of years. This will include for the most part following three regions: far off wellbeing checking of patients, avoidance of intensifications of constant sicknesses, and assortment of data. Wellbeing is quickest developing portion of IoT. As indicated by conjectures of researchers, number of associated clinical gadgets in next 10 years will increment by multiple times. A few examinations anticipate that number of individual wearable sensors 12 R. A. Rayan et al. for clinical bearing in next two years will ascend to 92.1 million units. In 2016, their number was just 2.4 million. At same time, an assortment of gadgets and shrewd frameworks are not expected to substitute specialists and attendants, it works with and advances their work. Specialists can help individuals remotely utilizing Internet advancements, which is particularly significant in time of crumbling of epidemiological system. Subsequently, IoT permits finding way to deal with every patient independently, to perform state of his wellbeing and compute individual treatment. Moreover, IoT can work with training in clinical consideration on account of: robotization of information assortment in clinical establishments, enhancement of clinical staff, giving more precise finding of infections, checking patient's condition and course of sickness progressively, separately. Likewise, IoT can further

develop adequacy of forecast and avoidance of infections. It is conceivable that with a sensible and lucid use of AI and IoT, number of blunders in clinical practice should be altogether decreased, which will assist with saving more patients. rise and far and wide utilization of AI in different circles of human exercises have caused in this time many discussions. There are sure obstructions and dangers to innovation improvement of IoT. Primary foundational hindrances incorporate an absence of comprehension of upsides of IoT. Consequently, there is a nonappearance or defective condition of its improvement system. Additionally, huge hindrances and dangers incorporate political; innovative; lawful guideline; training and inspiration; monetary and financial; security; protection; similarity of advances and normalization. These obstructions require further examination to decide program of measures for beating them since they are wellspring of a scope of dangers during utilizing IoT.

CONCLUTION

The current survey researched various parts of HIoT Framework. Far reaching information about engineering of a HIoT framework, their part, and correspondence among these parts has been examined in this. Furthermore, this paper gives data about current medical care administrations where IoT-based advances have been investigated. By utilizing these ideas, IoT technology has helped medical services experts to screen what's more, analyze a few medical problems, measure numerous wellbeing boundaries, and give indicative offices at far off areas. This has changed medical care industry from a clinic driven to a more understanding driven framework. We have additionally examined different uses of HIoT framework and their new patterns. Further, difficulties and issues related with plan, assembling, and utilization of HIoT framework have been given. these difficulties will frame a base for future progression and exploration center in forthcoming years. In addition, an extensive cutting-edge information on HIoT gadgets has been accommodated peruses who will start their exploration as well as additionally make headways in said field.

References

- Agrafioti, F., Bui, F.M., Hatzinakos, D.: Medical biometrics in mobile health monitoring. Secur. Commun. Netw. 4, 525–539 (2011). https://doi.org/10.1002/sec.227 45. Brey, P.: Freedom and privacy in ambient intelligence. Ethics Inf. Technol. 7, 157–166 (2005). https://doi.org/10.1007/s10676-006-0005-3
- Allied Market Research: Internet of things (IoT) Healthcare Market 2014–2021 (2016) 42. Cirillo, F., Wu, F.-J., Solmaz, G., Kovacs, E.: Embracing Future Internet Of Things. Sensors 19 (2019). https://doi.org/10.3390/s19020351
- Baker, S.E., Xiang, W., Atkinson, I.M.: Internet of things for smart healthcare: technologies, challenges, and opportunities. IEEE Access (2017). https://doi.org/10.1109/ACCESS.2017. 2775180
- Baldini, G., Botterman, M., Neisse, R., Tallacchini, M.: Ethical design in internet of things. Sci. Eng. Ethics 24, 905–925 (2018). https://doi.org/10.1007/s11948-016-9754-5
- Bandyopadhyay, D., Sen, J.: Internet of things: applications and challenges in technology and standardization. Wirel. Pers. Commun. 58, 49–69 (2011). https://doi.org/10.1007/s11277-011- 0288-5
- Bowes, A., Dawson, A., Bell, D.: Ethical implications of lifestyle monitoring data in ageing research. Inf. Commun. Soc. 15, 5–22 (2012). https://doi.org/10.1080/1369118X.2010.530673
- Chai, P.R., Zhang, H., Jambaulikar, G.D., Boyer, E.W., Shrestha, L., Kitmitto, L., Wickner, P.G., Salmasian, H., Landman, A.B.: An Internet of Things buttons to measure and respond to restroom cleanliness in a hospital setting: descriptive study. J. Med. Internet Res. 21 (2019). https://doi.org/10.2196/13588
- Coeckelbergh, M.: E-care as craftsmanship: virtuous work, skilled engagement, and information technology in health care. Med. Health Care Philos. 16, 807–816 (2013). https://doi.org/ 10.1007/s11019-013-9463.
- Ergen, O., Belcastro, K.D.: Ai driven advanced internet of things (Iotx2): future seems irreversibly connected in medicine. Anatol. J. Cardiol. 22, 15–17 (2019). https://doi.org/10. 14744/AnatolJCardiol.2019.73466
- European Commission: Ethics Guidelines for Trustworthy AI (2019)
- European Commission: G20 Trade and Digital Economy Ministers Adopt Statement in Tsukuba. Brussels (2019)
- Fullerton, K.: Coordinated Plan on Artificial Intelligence (COM(2018) 795 final) (2018)
- Garcia-Morchon, O., Falck, T., Wehrle, K.: Sensor network security for pervasive e-health. Secur. Commun. Netw. 4, 1257–1273 (2011). https://doi.org/10.1002/sec.247 38. Backman, W., Bendel, D., Rakhit, R.: telecardiology revolution: improving management of cardiac disease in primary care. J. R. Soc. Med. 103, 442–446 (2010). https://doi.org/ 10.1258/jrsm.2010.100301
- Gomes, B. de T.P., Muniz, L.C.M., da Silva E Silva, F.J., Dos Santos, D.V., Lopes, R.F., Coutinho, L.R., Carvalho, F.O., Endler, M.: A middleware with comprehensive quality of context support for internet of things applications. Sensors 17 (2017). https://doi.org/10. 3390/s17122853
- Gopal, G., Suter-Crazzolara, C., Toldo, L., Eberhardt, W.: Digital transformation in healthcare—architectures of present and future information technologies. Clin. Chem. Lab. Med. 57, 328–335 (2019). https://doi.org/10.1515/cclm-2018-0658
- Gope, P., Hwang, T.: BSN-Care: a secure IoT-based modern healthcare system using body sensor network. IEEE Sens. J. 16, 1 (2016)
- Greengard, S.: Internet of Things. MIT Press, Cambridge, MA (2015) .
- Gruson, D.: Ethics and artificial intelligence in healthcare, towards positive regulation. Soins Rev. Ref. Infirm. 64, 54–57 (2019). https://doi.org/10.1016/j.soin.2018.12.015
- Joyia, G.J., Liaqat, R.M., Farooq, A., Rehman, S.: Internet of medical things (IOMT): applications, benefits and future challenges in healthcare domain. JCM (2017). https://doi.org/10. 12720/jcm.12.4.240-247

- Kounoudes, A.D., Kapitsaki, G.M.: A mapping of IoT user-centric privacy preserving approaches to GDPR. Internet Things 11, 100179 (2020). https://doi.org/10.1016/j.iot. 2020.100179
- Latif, S., Qadir, J., Farooq, S., Imran, M.A.: How 5G wireless (and concomitant technologies) will revolutionize healthcare? Future Internet 9, 93 (2017). https://doi.org/10.3390/fi9040093
- Li, D.: 5G and intelligence medicine—how next generation of wireless technology will reconstruct healthcare? Precis. Clin. Med. 2, 205–208 (2019). https://doi.org/10.1093/pcmedi/ pbz020
- Li, S., Li, M., Xu, H., Zhou, X.: Searchable encryption scheme for personalized privacy in IoT-based big data. Sensors 19 (2019). https://doi.org/10.3390/s19051059
- Li, S., Xu, L.D., Zhao, S.: internet of things: a survey (2015). https://doi.org/10.1007/s10 796-014-9492-7
- Mittelstadt, B.: Ethics of health-related internet of things: a narrative review. Ethics Inf. Technol. 19, 157–175 (2017). https://doi.org/10.1007/s10676-017-9426-4
- Nayak, R.: Radio Frequency Identification (RFID): Technology and Application in Garment Manufacturing and Supply Chain. CRC Press, Cambridge, MA (2019). https://doi.org/10.1201/ 9781351238250
- Nikus, K., Lähteenmäki, J., Lehto, P., Eskola, M.: role of continuous monitoring in a 24/7 telecardiology consultation service–a feasibility study. J. Electrocardiol. 42, 473–480 (2009). https://doi.org/10.1016/j.jelectrocard.2009.07.005
- O'Brolcháin, F., de Colle, S., Gordijn, B.: ethics of smart stadia: a stakeholder analysis of Croke Park project. Sci. Eng. Ethics 25, 737–769 (2019). https://doi.org/10.1007/s11948- 018-0033-5
- Panwar, N., Sharma, S., Singh, A.K.: A survey on 5G: next generation of mobile communication. arXiv:151101643 Cs Math (2015) Internet of Things for Healthcare … 15
- Paranjape, K., Schinkel, M., Nanayakkara, P.: Short keynote paper: mainstreaming personalized healthcare-transforming healthcare through new era of artificial intelligence. IEEE J. Biomed. Health Inform. 1 (2020). https://doi.org/10.1109/JBHI.2020.2970807
- Parmentier, F.: [Healthcare data and artificial intelligence: a geostrategic vision]. Soins Rev. Ref. Infirm. 64, 53–55 (2019). https://doi.org/10.1016/j.soin.2019.06.013
- Psiha, M.M., Vlamos, P.: IoT applications with 5G connectivity in medical tourism sector management: third-party service scenarios. Adv. Exp. Med. Biol. 989, 141–154 (2017). https:// doi.org/10.1007/978-3-319-57348-9_12
- R. A. Rayan et al. 19. Özdemir, V., Hekim, N.: Birth of industry 5.0: making sense of big data with artificial intelligence, "The Internet of Things" and next-generation technology policy. OMICS J. Integr. Biol. 22, 65–76 (2018). https://doi.org/10.1089/omi.2017.0194
- Report linker: Global Internet of Things (IoT) in Healthcare Market Size to Grow at a CAGR of 27.6%. https://www.prnewswire.com/news-releases/the-global-internet-of-thingsiot-in-healthcare-market-size-to-grow-at-a-cagr-of-27-6-300979377.html. Accessed 19 Apr 2020
- Russell, C.L.: 5 G wireless telecommunications expansion: public health and environmental implications. Environ. Res. 165, 484–495 (2018). https://doi.org/10.1016/j.envres.2018.01.016
- Sadoughi, F., Behmanesh, A., Sayfouri, N.: Internet of things in medicine: a systematic mapping study. J. Biomed. Inform. 103, 103383 (2020). https://doi.org/10.1016/j.jbi.2020.103383
- Schüz, J., Espina, C., Villain, P., Herrero, R., Leon, M.E., Minozzi, S., Romieu, I., Segnan, N., Wardle, J., Wiseman, M., Belardelli, F., Bettcher, D., Cavalli, F., Galea, G., Lenoir, G., Martin-Moreno, J.M., Nicula, F.A., Olsen, J.H., Patnick, J., Primic-Zakelj, M., Puska, P., van Leeuwen, F.E., Wiestler, O., Zatonski, W.: Working groups of scientific experts: European code against cancer 4th edition: 12 ways to reduce your cancer risk. Cancer Epidemiol.
- Sharma, M., Singh, G., Singh, R.: An advanced conceptual diagnostic healthcare framework for diabetes and cardiovascular disorders. ICST Trans. Scalable Inf. Syst. 5, 154828 (2018). https://doi.org/10.4108/eai.19-6-2018.154828
- Solanki, M.R.: Application of RFID technology in libraries and role of librarians. Indian J. Agric. Libr. Inf. Serv. 35 (2019)
- Stefano, G.B., Kream, R.M.: micro-hospital: 5G telemedicine-based care. Med. Sci. Monit. Basic Res. 24, 103–104 (2018). https://doi.org/10.12659/MSMBR.911436
- Tyagi, S., Agarwal, A., Maheshwari, P.: A conceptual framework for IoT-based healthcare system using cloud computing. In: 2016 6th International Conference—Cloud System and Big Data Engineering, Conflu (2016). https://doi.org/10.1109/CONFLUENCE.2016.7508172
- Yang, J., Luo, J., Lin, F.,Wang, J.: Content-sensing based resource allocation for delay-sensitive VR video uploading in 5G H-CRAN. Sensors 19 (2019). https://doi.org/10.3390/s19030697
- Zhang, P., Schmidt, D.C., White, J., Mulvaney, S.: Towards precision behavioral medicine with IoT: iterative design and optimization of a self-management tool for type 1 diabetes. In: 2018 IEEE International Conference on Healthcare Informatics (ICHI) (2018). https://doi.org/10. 1109/ICHI.2018.00015