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Machine Learning for IoT HealthCare Applications: A Review

Chnar Mustafa Mohammed & Shavan Askar

Abstract:

Internet of Things and Machine Learning (ML) have wide applicability in many aspects of life, health care is one of them. With the rapid development and improvement of the internet, the conventional strategies for patient services diminished and supplanted with electronic healthcare systems. The use of IoT technology offers medical professionals and patients the most modern medical device environment. IoT things and Machine-Learning are valuable in various classifications from far off observing of the modern climate to mechanical mechanization. Moreover, medical care applications are principally indicating interest in IoT things in view of cost decrease, easy to understand and improve the personal satisfaction of patients. The latest applications for IoT medical treatment, investigated and still facing problems in the clinical environment, are needed for intellectual, creativity-based answers. In specific, portable, and implantable IoT model devices, investigated for calculating the data transmission. Implantable technologies lead to the natural substitution of the injured part of the human body. The creation of a wearable and implantable healthcare body area network faced several challenges that are illustrated in this study. In this paper, an overview of IoT and Machine Learning based on healthcare care demonstrated in detail, the applications that use in health care by incorporating Machine Learning (ML) for the Internet of Things (IoT) listed with all issues and challenges while using this application or devices for health care and their important usage. Also, algorithms used by Machine Learning in IoT for developing devices are indicated by showing previous work and classified each of them according to the used method.

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About Author (s)

Chnar Mustaf Mohammed, Information System Engineering, Erbil Polytechnic University, Erbil, Iraq.
Shavan Askar (Corresponding Author), Assistant Professor, Erbil Polytechnic University, Erbil, Iraq. Email: shavan.askar@epu.edu.iq

1. Introduction

Recently, the Internet of Things (IoT) and Machine Learning (ML) are produced another global view of data innovation to build a solid global structure by integrating a variety of physical and virtual 'things' with the emerging extensible and sensors. IoT was initially suggested to use methods of Radio-Frequency Identification (RFID) invention to incorporate particularly familiar articles (things) and their electronic portrayals in a web structure. Eventually, the IoT term came into operation in a range of sensors, including controllers, GPS apps, and cellphones, to cover all kinds of 'things.' (Qi et al, 2017). The continuous integration in an Internet-related stage and the supporting equipment of these sensors have raised a range of exploration concerns, from framework engineering and knowledge processing and implementations. Today in a large number of science and mechanical controls, particularly in the medical services, IoT innovation has made swift steps in multi-disciplinary research (Yadav and Jadhav, 2019). Therefore, the impact of IoT technology and machine learning development in healthcare today is the shift from hospital to home with regular medical tests and other health services as well as makes using of medical tools easier for doctors and patients. Particularly, in the cases of crisis, it would make health care simpler for patients. Furthermore, by transferring feasible and basic activities to home environments, hospitals can reduce the burden. Cost reductions are one of the main gains, any time they went to see the doctor, patients could escape hospital charges. Other obstacle includes the limitation of the current network structure that are incapable to handle real-time sensitive applications using IoT, therefore Software Defined Networking is expected to be a suitable network infrastructure for such applications (Askar, 2017; Fizi & Askar, 2016; Askar, 2016; Keti & Askar, 2015). For this reason, a trending technology in the health industry must be introduced in the near future to develop advanced medical technology and to use it to easily track patients from elsewhere. Monitoring of patients involves the physical circumstances and descriptions of the medicine of the patient (Reena and Parameswari, 2019). Embedded sensors, labels, etc. grown dramatically with the use of IoT. To obtain clearer data, portable sensors can be incorporated with IoT. A pharmacy container may be used to enhance the user-friendliness of the device using an android program. The implementation of various technologies like IoT will change significantly in any area in particular in the medical field at the right moment (Salah et al., 2014). IoT would improve the living conditions of the people. The implementation of integrated tools would bring about several positive improvements in electronic information management services, system processing, and managed communications (Aziz & Islam, 2020; Atiqur et al., 2020; Rakhmatulin, 2020). There are so many wearable systems and applications in various fields of healthcare need to be implemented (Aghdam, 2020). This paper will identify the main important points of personalized health care by applying IoT and Machine learning Besides, demonstrate some previous studies on IoT and ML for personalized health care also identifying related issues and challenges.

2. Overview of IoT in the Healthcare System

Strong health and wellness alertness are the main factors that drive health care consumers' attention to IoT devices. This reduces the fear of repeated hospital appointments and expensive doctors. Health insurance customers in the medical sector the overall demand is increasing rapidly because of the renovation of the market. Business models must be redesigned in order to address the growing effects of many healthcare customers (Islam et al., 2015). The latest study reports that the consumer will recently take advantage of the 'Internet of Things' as a remarkable improvement in the use of IoT technology such as wearable and implantable systems. Personalized patient management, including data gathering and decision-making, was the main strength. This is the diagnostic information

collected through electronic clinical record books, visualization tools, screens, handsets that improve the decision-making method for doctors to play a significant role in ensuring the health of the patient.

At the end of the century, IoT-based customized health evaluation will become much more common. Health users would be more familiar with productive infection control techniques and intelligent technologies would help them. Moreover, keep them safe. With the data produced by connected devices, important decisions were taken immediately to improve the health of the patient. The problem for the healthcare sector is not the emergence of new products, innovations, although more focus needs to be paid to e-health consumers. The usage of connected devices designed to enhance human health and the associated climate with the intelligent use of data, such instruments may track the condition of the air in the environment, and physicians can examine patients remotely (Poongodi et al., 2019). There are also three key features to certify that the sensor has a 'thing' in the IoT healthcare System. First: the system shall identify and gather environmental data such as precipitation, temperature, light, etc. For the pulse: blood oxygen rates/monitoring, blood glucose regulation, electrocardiogram monitoring, and so forth. Second: the system can function autonomously in the transmission of collected data to the centralized controller. Dynamically or with some other system or whether any criteria are met. Third: this should be in an inactive state before the operation is ended. For example, whether the blood pressure of the patients or blood sugar levels are vital as well as notify information should be induced for urgent action (Selvaragj & Sundaravaradhan, 2020; Mohammad, 2020; Eti & Bari, 2020).

The abnormal pulse rhythm of the patient generates a message to the doctor and advises the patient to continue promptly with the recommended medication. Reconfiguration of the embedded device or skin spot for the monitoring of dose blood sugar, heat, and insulin (Fan et al., 2014). This method of surveillance not only serves to improve the health status of the patient but also allows the specialist to provide guidance until the situation becomes serious. Sensors in patients with heart problems help regulate the rhythm of the heart. Oxygen saturation levels may also be remotely monitored, for example, medical instruments such as CTs and MRIs (Wannenburg & Malekian, 2015). The patient activity has been successfully monitored using Radio-Frequency Identification [RFID] technology, sensor systems, System analysis for optimal process flow detection and regulation. In today's world, human wellbeing is largely affected by behavioral and environmental influences such as smoking, noise, etc. (Poongodi et al., 2019).

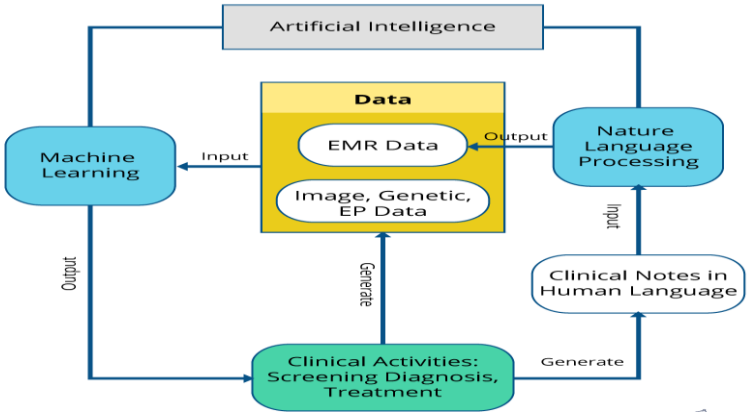

Figure 1. The architecture of IoT [11].

2.1 The structure and use of IoT in Healthcare

IoT is a physical system and object network connection that allows detecting, analyzing, and managing remote devices. A computational architecture has been developed to link the edge computers so that wearable sensors and intelligent devices can communicate smoothly. For processing information, Smart devices are strongly reliant on the layer of IoT's middleware. Any IoT implementations include intelligent wellness, intelligent grid, intelligent towns, smart house, intelligent farming. Smart transit, and so forth. The three layers of IoT's fundamental architecture include perceiving, networking, and device layers. It then expands to cover more advanced architectures, middleware, and business layer. Besides some wearable and implantable devices use IoT technologies and Machine learning algorithms to be used for the health care system and personalize care manner (Poongodi et al., 2019). Below are two types of personalized healthcare devices that demonstrate the important points among them:

2.1.1. Wearable devices:

Products such as bracelets, pendants, pins, smartwatches, t-shirts, intelligent rings, shoes, workout trackers, and other public health equipment, portable systems may be fitted to the human bodily structure. The wearable device in direct contact is able to track the illness, the health of the individual, and the information obtained from the central research center. Three components include wearable technologies, such as sensors, computing, and screens. Usable devices can generate biological information such as calories used, walking, heart rate, blood pressure, workout time, etc. These devices have an important influence and it is very strong that the physical wellbeing of the customer gets a good deal (Poongodi et al., 2019; Aghdam 2020).

2.1.2. Implantable devices:

Implant instruments are inserted beneath the skin of the human body and aim to restore the whole or part of the biological system and its structure (Alam et al., 2018). Implants are indeed widely used for many applications, such as neurons, radiology, heart attack stent, microchips, etc., supporting a secure network for such services is crucial (Sulaiman & Askar, 2015). Any biological compounds, such as carbonates, silicon, titanium, etc. can be made from the inside of implantable devices. The content can also be selected according to human body section requirements and tools for the implant device (Al-Khafajiy et al., 2019). Some of the implantable devices are mentioned below:

Glucose Monitoring: A multi-layer receptor sensor in the abdominal skin cells would be implantable to perform the treatment. Every 30s bodily glucose levels can be tracked and data transfer every 5 minutes has been carried out. If the sensors are embedded, a variable amount of insulin will monitor the level of glucose.

Implantable Neural Stimulators: These forms of neural influences guide the human being's electrical signals. To reduce pressure from cell structure or brain.

3. An Overview of Machine Learning in Healthcare

Machine learning is also considered as one of our modern technology for transformation. The implementation of algorithms that can learn from the data is machine learning. Development in machine learning is motivated by big data and cheap computational availability. Machine learning is based on previous machines observations. algorithms are constructed. Machine learning in simplified terms is commonly derived from results. Master learning aims to recognize patterns from the data and to use learned patterns for useful inferences (Akhil et al., 2018). Machine learning can be a broad multidisciplinary approach focused on statistics, algebra, data collection, data analysis, etc. ML is an artificial intelligence fundamental methodology that extracts information through data training. In this analysis, we're not

telling machines where to look, because it's at the base of the tree, and it has several branches and sub-branches.

Machine learning is classified into the following groups (Shailaja et al., 2018), as seen in Figure 2

A. Supervised Learning.

C. Unsupervised Learning.

D. Reinforcement Learning

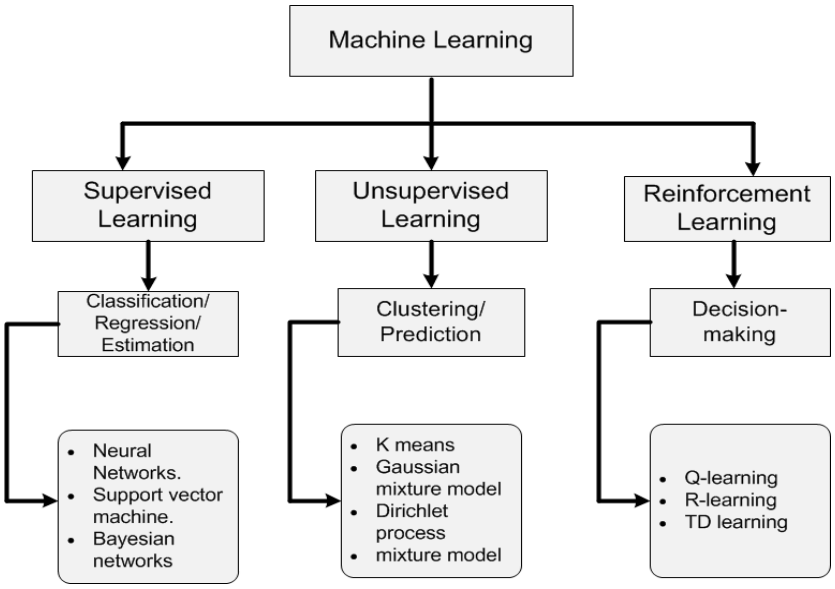

Figure 2. Machine Learning Classification Techniques (Shailaja et al., 2018).

3.1. Application of Machine Learning in Healthcare

Algorithms for machine learning help distinguish difficult and broad patterns of information and records. This technique is particularly suited for clinical purposes, especially for people with advanced genomics and proteomics. It is also used for diagnosing and identifying other diseases. Deep-learning algorithms are used in medical technology to create a preferential patient treatment plan by recommending the incorporation of beneficial care plans (Shailaja et al., 2018). Pharmaceutical machine learning can be carried out in multiple ways (Akhil et al., 2018) such as (1) disease identifying and diagnosing, (2) personalized change of treatment/conduct, (3) drug discovery/manufacture, (4) medical test review, (5) treatment with radiology and radiation, (6) smart electronic reports of health (HER), and (7) epidemic outbreak forecast

4. Machine Learning Algorithms in IoT

4.1 Technologies and Methods used in Healthcare for Elderly People

Alex et al. (2016) discussed and described an intelligent home-based wireless-connecting Medicine Box with an android (Health-IoT) application that allows patients and physicians to communicate more closely. A smart medicine box is provided on the proposed platform which warns patients to take their treatment on time. The box has wireless internet connectivity to ensure timely notifications of medicines that are informed with the patient's mobile in the android program. The machine automatically warns the patient so that the correct medication is received at the right time. And if vital signs occur, the preconfigured protector receives SMS warnings. While (Kinthada et al., 2016) in their study suggests a method/framework for tracking the medical consumption of patients. It offers frameworks for the dissemination of prescription drugs and the monitoring of the history of prescriptions

like the International Journal of Pure and Applied Mathematics. The system advises the patient of the use of warnings. The lost injection is often found by medical professionals in case of errors as well as the eMedicare suggested overcomes traditional device disadvantages. This smarter system is smaller cheaper, more precise, lightweight, and less complex in operation. The system recommended may help all elderly patients, particularly analphabets, to take their medication on time. Pinto et al. (2017) mentioned concerning the number of older people in the world is increasing; there is a growing need to provide ways to support the elderly in their lives. It may be said in this respect that the Internet of Things will give a more customized, preventive, and cooperative type of treatment a new aspect to contemporary healthcare. This investigation provided a live IoT solution for elderly people to monitor and record their patients' vital information and promoting emergency alert systems. The research proposed a way to monitor and assist elderly people with a bracelet that can be connected to the cloud server. It is meant to become a cost-effective wireless networking solution.

4.2. Methods used in Bigdata and Artificial Intelligence for Healthcare

In (Hosseini et al.,2017) study dealt with the features of a Brain Machine interface using different sensors like electro-encephalography (EEG). Visualize with diffusion tensor (rs-fMRI) and imagery for extracting information from an epileptic brain with a diffusion tensor. The proposed approach incorporates state-of-the-art computation to offer a context-aware approach in real-time utilizing intrusive and non-invasive methods to follow, analyze and monitor the brain. This helps to find and to treat epilepsy in a timely way (operative or otherwise to arise). The key aim of this research is to forecast an "ictal start". Healthcare systems require a network structure that can support QoS provisioning for video and real-time sensitive applications, therefore, intensive research has to be conducted to support these special requirements (Askar et al., 2011). In (Akhil et al.,2018) paper addressed machine learning use in medical care. In a couple of years, machine learning will transform healthcare. In the future ML and AI will be transforming healthcare, but ML and AI Decision Support Systems (DSS) performance should be predictive solutions to patients' and doctors' problems. Major firms such as Enclitic, MedAware, and Google have initiated huge programs to develop healthcare system machinery and artificial intelligence systems. Effective healthcare providers cannot be expanded spontaneously. The use of machine learning and technology for artificial intelligence will improve current efficiency and precision. The use of such technology would enhance health services and reduce health care costs in a less time period for more patients. In (Yadav et al.,2020) article, concentrated mainly on two broad data technologies (Healthcare analytics and the Internet of Things. Big data (BDA) has been provided two related computer science divisions, Big Data and Analytics, are together developed to provide a common approach for data management. Most of the big data are represented in business professionals, as an entity can carry, produce, and exchange extremely large volumes of unstructured, organized data. The Internet of things (IoT) is the arrangement for the storage and sharing of information between multiple physical, electronic, and sensor-based devices linked together.

4.3. Methods used in Devices for Disease Recording such as Cancer and Covid-19 and other Heart Diseases

Dhillon et al. (2019) demonstrated that healthcare offers a different form of data. Different master learning algorithms such as supervised, unsupervised, and enhanced algorithms are used for analyzing this variety of data to increase prediction that can be analyzed using different performance parameters such as exactness, sensitivity, specificity, precision, F1 scoring, and Curve region. In this paper, algorithms for machine learning are described and

machine learning algorithms are used to analyze various types of health care data, such as clinical data, omic data, and sensors. The study concluded that various machine learning algorithms and feature extraction techniques for the prediction of survival of cancer patients were suggested by different authors for the analysis of different types of information in health care. Additionally, Kaur et al. (2019) suggested a method that increased patient-physician interactivity. K-NN, Vector Machine, Decision Trees, Random Forest, and MLP are all machine learning techniques used in this work. The Random Forest machine learning methodology has achieved maximum accuracy of 97.26 % on dermatology data collection. Different samples of illnesses are used to assess the efficacy of the planned work to test the experimental outcomes, such as breast cancer and heart disease, coronary problems, spectral heart failure, thyroid, surgery, dermatologist, and liver disorders. On average, the random forest has been evaluated for good reliable outcomes for each of the considered datasets.

In a study, Otoom et al. (2020) proposed to minimize the IoT-based structure incidence of transmissible diseases. The structure suggested was using the utilization of future cases and health records of COVID-19. COVID-19 confirmed cases for the creation of a statistical machine for learning disease model and medication response study. The machine also transmits the results to doctors who will easily respond to the suspicious cases to confirm the case. This makes it easier to confirm isolation and proper healthcare should be provided. An experiment was performed to test a true COVID-19 data set for eight machine learning algorithms. (1) Support Vector Machine, (2) Neural Network, (3) Naïve Bayes, (4) K-Nearest Neighbor (K-NN), (5) Decision Table, (6) Decision Stump, (7) OneR, and (8) ZeroR. All these algorithms, with the exception of Stump, OneR and ZeroR decisions, have been found to have reached accuracies of over 90%. With the five best algorithms, the possible causes of COVID-19 will be efficiently and reliably defined. Using the proposed re-time framework, the effect of transmissible diseases and mortality rates could be minimized by early case identification. This system will also provide an understanding of the disease and the potential to track recovered cases.

5. Open Research Issues and Future Direction for ML and IoT in healthcare

Machine learning is closely connected to mathematical comparison, to decision-making based on current evidence, and forecasts found through past knowledge. In the case of patient monitoring, the ML-based approach can evaluate the condition according to the data collection. Learning datasets play an important role in accurately predicting the new problem's future trend. The data collection can be distorted often and not unique to a wide range of situations. Noisy data, messy data, and incomplete information will lead to less chance of diagnosis and advice on health detection and prediction. In the case of controlling sleep and heart problems, the patterns and routines of sleep can vary by person, age, and health. Therefore, a complete list of the cases of sleep cycles cannot be obtained, which may lead to inaccurate PH calculations. If IoT and ML are used, permit PH, for detection, estimation, and alerting of the patient, the machine might need to determine. Any circumstances may lead to a mistake of an ML-based judgment, and it is difficult to indicate that a specific decision is made. Few crashes have occurred because of an autonomous car's incorrect decision. The essential issue is how to interpret a machine's decision (Ahamed and Farid, 2018). Disadvantages can restrict the use of ML in PH insensitive use such as custom medicine. It is important to consider how an unattended computer Diagnostics Assistive Monitoring operates. The predictive analysis may benefit hospital-released patients who may require re-accommodation in the hospital. This initiative requires additional tracking instruments and continuous monitoring. These models are also built on historical experience

and claims. It is important to tackle data leaks, data noise, and missing data issues. Using health conditions and vital signs in the diagnosis can be helpful (Zeadally et al., 2019).

5.1. Issues and challenges

Customized electronic medical treatment is not open to challenges and weaknesses. It takes into account the fundamental problems of IoT and ML This offers an example in which an elderly individual uses a Personalized Healthcare (PH) system based on a sensor. The sensor gathers different details, for example, heart rate, Environmental supplement, blood sugar, pressure, etc. The data is processed for use by the participating parties. The database also uses some computer training algorithms to interpret the data obtained to determine the risk factor for patients, improve their health, and recommend potential strategies on this basis (Ahamed & Farid, 2018). The main matters and challenges around IoT and ML in PH solutions are (Yadav et al., 2020):

The volume of data produced by the sensors is massive. The retrieval of the correct information from the data gathered is a challenge. This initiative involves the creation of an algorithm that can extract patterns in collected data from body sensor networks. Major research scopes arise in the area of machine learning and sampling algorithms.

In view of the fact that computer-intensive processes are being held back, the efficiency of Real-Time Response is an area of development. Optimizing the volume of data transmission is a matter of concern.

Privatization of computing. With more and more IoT-enabled computers, one-point computing would create a limitation in network power. The algorithm needs to be shared and the parallel processing of the task stage needs to be accomplished. Computational and resource allocation algorithms are areas of significant research importance in this field.

IoT and devices safety.

End Point Applications Energy Consumption. The battery used in IoT devices is one of the main issues, so it may not be convenient to charge these devices. Generally, discharges to a back-end processor and saves battery capacity, which would otherwise have been sufficient for internal computing, resolves this issue.

6. Conclusion

Healthcare is one of the fastest expanding markets of today's economy; more people require care, and it is becoming more costly. Government expenditure on health care has hit an all-time peak, while the essential need for improved patient-physicist ties has become visible.

Technologies such as big data and artificial learning have the ability to provide both patents and providers of improved treatment and reduced costs. A number of businesses and organizations have already taken the first step in this field. Which helped promote the transition to patient and evidence-based care. The data is there; we just need to work out how to view it. In addition, the learning of the system depends largely on the data and algorithms available to categorize data in certain classes through supervised learning or unregulated learning. People take wrong decisions and sometimes we human beings rely on facts to take any action. The choice we make often includes feeling, but machines won't. We human beings can select based on our decent values, our global observation, political and religious value, and our identity. The data collection available to train computers for decision making will include these factors. These factors It is also a challenge to ensure that the data collection used to learn is free from machinery so far as possible human prejudices. Overcoming IoT and ML weaknesses will increase the health of the client more. This paper focused to discuss the general view on IoT and ML which are applied in the health care system, the application used for personalized health care and demonstrated some other related works and their opinions

with their finding of this field also the challenges and issues which faced electronic health care for the future direction of these issues.

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