International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Real-Time Monitoring of Patient Activity Using IoT and Machine Learning in Healthcare

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Submitted:23/03/2023 **Revised:**25/05/2023 **Accepted:**13/06/2023

Abstract: This study of Cardiovascular disease at different hospitals has been used to predict the early detection of heart disease using automated intelligent practice. Moreover, research has extended the capability of bedside monitors and store the capture body parameters on cloud storage. It took into consideration age, gender, habit of tobacco, cholesterol, blood pressure, BMI, etc., which hit the chances of the possibility of heart disease. The study helps the various stakeholders in the health care sector to understand the key results The proposed research model is divided into three different phases. First phase is data capturing phases where the caretaker person creates the profile and gathers the patient information. In the secondary phase all the healthcare data uploaded on the cloud computing using Internet of Things(IoT) for further process. In the final stage the model is trained with the help of the existing healthcare records Using Machine Learning.

Keywords*: Internet of Things, Machine Learning, Cloud Computing, ICU, Real Time, Monitoring, Health parameters, Cardiovascular.*

1. Introduction

The doctor will take into account the patient's current health status in addition to the traditional static and metabolic state measures used in routine checkups. Medical diagnoses and treatment plans may benefit greatly from the information made available by the Internet of Things. This kind of technology is used by doctors to diagnose illnesses in patients and treat them at an early stage, with the goal of prolonging people's lives. This innovative technology has had a significant impact on the healthcare sector, contributing to the dramatic decrease in healthcare expenditures and the dramatic improvement in diagnostic speed and accuracy. The latest technical developments allow us to foresee low-cost sensors being used to provide continuous one-on-one biological care for two or three days before a recurrent physical inspection is performed. During this time, electronic sensors recorded crucial signs of biological restrictions, reported back to the doctor or patient, and saved their findings in the cloud. Modern healthcare sectors generate a vast amount of data (such as illness identification, patient status, etc.) as a result of the development of sophisticated healthcare systems. Predictive models are constructed using these data sets. Data from several sources may be analyzed and condensed using machine learning (ML) techniques. Disease detection and prognosis has been widely addressed in academic publications as one of ML's most promising new uses. In this chapter, we will explore the predictability of several machine learning algorithms with respect to cardiovascular disease. The next sections of this structure describe the IoT-integrated health monitoring system built using a wide variety of sensors and Arduino microcontrollers. Sensors in this innovative technology may be placed all over a patient's body, allowing for remote data collection, analysis, and two-way contact with a doctor. Healthcare is a fundamental need of existence. Health care focuses on keeping people healthy and treating them when they are sick. The use of diagnostic tools such as CT, MRI, PET, SPECT, etc. allows for the detection of any tears or abnormalities deep under the skin. Furthermore, pre-event detection of aberrant disorders like heart attack and epilepsy is possible. The demand for resources like hospital beds and physicians and nurses is extraordinarily high [2], putting a strain on current health care systems as the population continues to rise [3].Clearly, there must be a way to ease the burden on existing healthcare infrastructures without compromising the quality or quantity of treatment delivered.

Recent studies [3-7] have focused on the Internet of Things (IoT) as a possible way to relieve healthcare systems' burdens.Diabetic patients should be monitored on a periodic basis, as indicated in [5], and patients with

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particular diseases, such as Perkinson disease, should be monitored, as mentioned in [6]. Specifically, researchers are interested in finding ways to help with rehabilitation by keeping tabs on patients' development in real time [7]. Related studies [8, 9] have also recognized the possibilities of emergency healthcare, although this field has not seen much study as of yet. In the past, several studies have investigated various aspects and technologies of the IoT in healthcare. In [10], the author conducts a comprehensive review, focusing on existing commercial options, potential uses, and unanswered questions. Each element is examined alone, rather than in the context of the whole. Although data mining, storage, and analysis are all discussed in [11], the topic of system integration is hardly touched upon. In the United States, RFIDs were used to improve patient care and save healthcare expenses [12]. Healthcare monitoring systems aid in diagnosis by allowing doctors to keep an eye on things like a patient's heart rate. For secure wireless data transfer, many wearable devices have been suggested [13]. The Internet of Things has numerous opportunities in healthcare, but it also presents certain difficulties. Data security and the administration of IoT devices are major concerns for hospital administrators and IT [14]. Machine learning is a subfield of AI that has recently gained prominence. Using AI, we can create smarter and more capable machines. Machine learning is a strategy for acquiring knowledge automatically by observing and accumulating experience. The input is supplied into the generic algorithm, and the logic is constructed without the need for any coding. Machine learning is utilized in many different areas, such [15] internet search, spam filtering, ad placement, stock trading, and many more. By automatically analyzing those massive hunks of data and making the job of data scientists easier, Machine Learning has gained the same prominence and renown as big data and cloud computing. From the design sciences to interpersonal organizations, business, biomolecular research, and even security, massive data sets are collected and analyzed in many different fields [16]. Typical machine learning algorithms are designed to work with data that can fit totally into memory [17]. Learning from these vast datasets is anticipated to result in significant scientific and technical advancements, as well as improvements to the quality of our lives [18], but it also introduces enormous challenges. Since machine learning methods provide potential solutions to mine the knowledge buried in the data, they have found widespread adoption in a variety of data-intensive disciplines, including medicine, astronomy, biology, and so on.

2. IoT Architecture for Disease Detection

Using sensor networks, this technology facilitates patient monitoring and support. There are both hardware and software components to the design. Sensors for measuring heart rate, temperature, blood pressure, and a microcontroller board make up the hardware part. As indicated in Figure 1, the process begins with the collecting of sensor readings, continues with the storage of data in the cloud, and concludes with the analysis of cloud-stored data to check for irregularities in the patient's health.

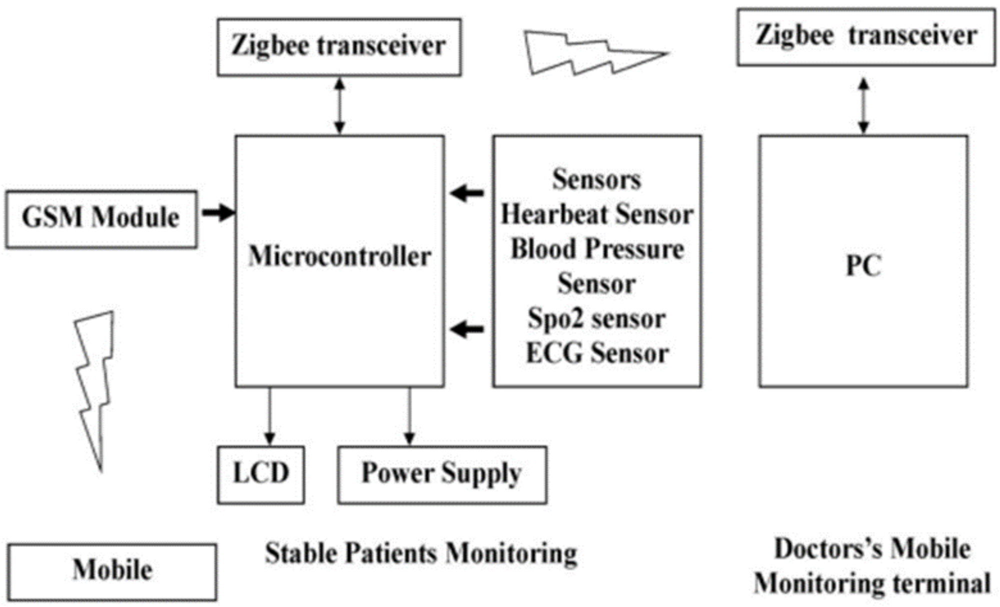

Fig.1 Remote System Block Diagram

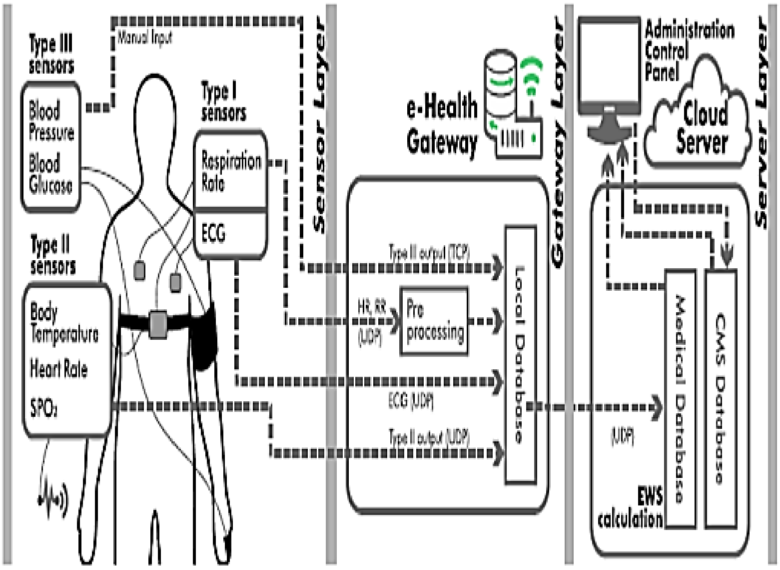

Fig 2 Medical IoT Architecture(MIoT)

This study describes a system that relies on pre-existing electrical infrastructure to transmit an alarm to the nearest hospital. Figure 2t depicts the overall design. To the MAoT

Unrecognized activity in bodily components is often what causes the anomalies. Heart rate may speed up when seizures strike the brain. A heart rate sensor may be used to monitor one's pulse rate. The heart rate may be monitored in real time. A Raspberry Pi board is connected to the sensor in order to display the data. You may see the numbers on a serial monitor or an LCD display that you connect to the board. All the data gets uploaded to the cloud because of the sheer magnitude of it. Cloud data is examined locally before being uploaded. In the presence of any pathological circumstances, the heart rate tends to rise gradually. Raspberry Pi boards are supported by a number of open source cloud systems, one of which being Raspbian jessi. It's free and open-source software that stores information acquired online once users sign up with their real-world addresses. Using machine learning techniques, the gathered data is examined for the existence of anomalies. The cloud-stored data are brought in for further study. Training the system to make predictions from sample data is recommended. Large amounts of data are required for training in order to get reliable results in prediction. When training on more data, accuracy improves. Data from many different people in many different situations should make up the training dataset. The collection should also include information on people of varying ages, as well as information on people in both good health and poor health. Both the data acquired at the present time and the data tested up to the previous session should be included in the training dataset. Prediction is achieved by using both the training data and the additional practical data.

3. Literature Review

Amit Sundas et.al (2023) An IoT Tiered Architecture (IoTTA) for translating sensor output data into immediate clinical input is presented, as well as the potential of IoT applications in healthcare settings is analyzed. Multiple processes are taken into account in this plan of action, from sensing to transmitting to processing to storing to mining to learning. This approach might be utilized to create effective solutions in the field of Internet of Things (IoT) healthcare application development. The analysis finds that the fastest-growing areas of internet of things applications in healthcare include data mining, self-care, and neural networks.

Afzaal Hussain et.al (2021) Both the potential of IoT applications in healthcare settings and a tiered architecture for transforming sensor output data into direct clinical input are given and discussed. This strategy takes into consideration a number of procedures, including as sensing, sending, processing, storing, mining, and learning. This strategy has the potential to be used to provide efficient answers in the area of IoT healthcare app creation. Data mining, self-care, and neural networks are identified as the most rapidly developing fields of internet internet of things applications in healthcare.

A. M. Keerthi et.al (2020) In this study, we offer a sensor- and Internet-enabled, cost-effective, and user-friendly app-based method for gathering real-time data. After conducting a poll of persons over the age of 50 about their experiences with fever, we use Machine

Learning analysis to identify the most effective model. As a result, the proposed system has as one of its primary goals the maintenance of accurate family member information.

Parampreet Kaur et.al (2018) In this research, we suggest and describe a Cloud IoT-based system for diabetes prognosis. It uses a network of sensors embedded in smart wearable devices to continuously monitor and gather data on a patient's blood glucose levels. This information is then stored in the cloud and fed into an ensemble model to estimate the likelihood that the patient will develop diabetes. The authors conduct a series of experiments using 10 Ensemble models, each of which is created by combining two of five distinct machine learning techniques.

4. Proposed System

According to the suggested concept, the microntroller would be responsible for collecting and analyzing data from the sensor network. Proposed outcomes are saved in the cloud for easy access. The final results of the processing may be accessed and analyzed directly from the cloud. The cloud is then used to save the results of the analysis, from which physicians may later access the data. The results and patient status are posted on the hospital's website. There are primarily three distinct elements to the system. The idea focuses on three main areas: a health monitoring system, a health condition prediction system, and an emergency alarm system. Since this method is concerned with medical matters, all information and procedures must be kept secret. The implementation of encryption technologies lends credibility to the designed system by guaranteeing its privacy and safety. The hardware that enables the Internet of Things and is used to record the patient's health characteristics using a variety of sensors make up the health monitoring module. Since the Raspberry Pi can only process digital signals, all of the sensors must be linked to it by its GPIO pins or an MCP3008 analog-to-digital convertor. The suggested system's health condition prediction module is very promising. Patients' health information is gathered from the sensory nodes and saved to a database in this section. The KNN classifier, which categorizes health statuses, is put to the test on the data saved in the database. The classifier's determinations are accurate and need little human oversight. The idea of using a machine learning method is what gives this subject its broad focus. In terms of illness prediction, the suggested system's use of machine learning algorithms and data mining approaches effectively mimics the capabilities of expert physicians.

Predicting Health Conditions With Machine Learning

Machine learning methods may be used to the dataset for analysis. The purpose of any classification approach (or classifier) is to generate classification models from an input data set. Decision trees, rules, adaboosts, support vector machines, least squares regression, kernel neural networks, and naive bayes classifiers are all examples of typical machine learning techniques. Each technique takes a somewhat different tack when it comes to learning how to find a model that fits the input data's correlation between characteristics and classes. New records' grouping labels should be reliably predicted by the model generated by a learning process. Models with high generalization skills are the pinnacle of machine learning. Machine learning algorithms are used to train on the health monitoring dataset, and then that dataset is analyzed further on the basis of what was learned through the training. K-Nearest Neighbor is used as a classifier in this approach.

K-Nearest Neighbour (KNN) classifier

Using a training set, KNN is a non-parametric in supervised learning algorithm that classifies input into a predetermined category. A new instance (x) may be predicted by summing the output variables from the K most similar examples (neighbors) in the complete training set. This is the most common grouping in the set of categories. Its goal is to forecast how a new sample point will be classified by using the database's existing categorization scheme. The categorization procedure includes the following phases.:

1. In the training phase, data from the training instances are used to build a model. The categorization method establishes connections between variables and their respective goals. A model is presented as a summary of the connections..

2. Phase 2: Test the model using data that was not used to train it but whose class labels are known..

3. In the application stage, you'll put the model to work by classifying fresh data for which the class labels are unknown.

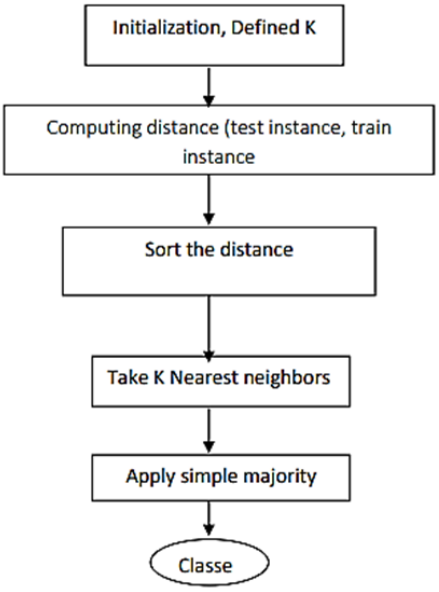

Fig 3 depicts a typical KNN classification process.

K- Nearest neighbour algorithm:

An example is provided to illustrate the KNN classifier's algorithm. Take a look at Figure 4; there are two distinct groups represented by the white and orange circles. There are a total of 26 exemplars used for training. For blue circles, the forecast must be made. Using a K-value of 3, we may determine the degree of distance similarity by resorting to established metrics such the Euclidean distance..

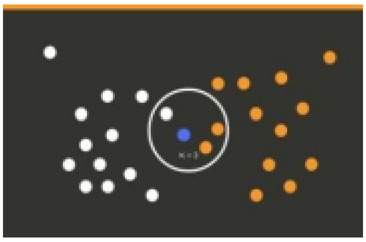

Fig 4. KNN Classifier

If the scores are near, then the courses are comparable. The picture is used to determine distance, and smaller circles with less distances are positioned within the larger one. Let's assume we have a training set of "n" samples, where each sample represents a single data point. The "c" classes are used to organize the training data points. The goal of KNN is to make a classification prediction for an unlabeled data point. The new data point is compared to all the training data points, and the average Euclidean distance is then calculated. The distances should be sorted such that they do not decrease. Assuming that K is an integer greater than zero, we may exclude the least "K" values from the ranked set. We now have access to the K-point distances. Among the classes of "k-nearest neighbors," "nearest neighbor" is a particular instance. In this case, k equals 1 (k = 1). In this scenario, the nearest neighbor will become the new target class for this data point.

Performance Analysis & Discussion

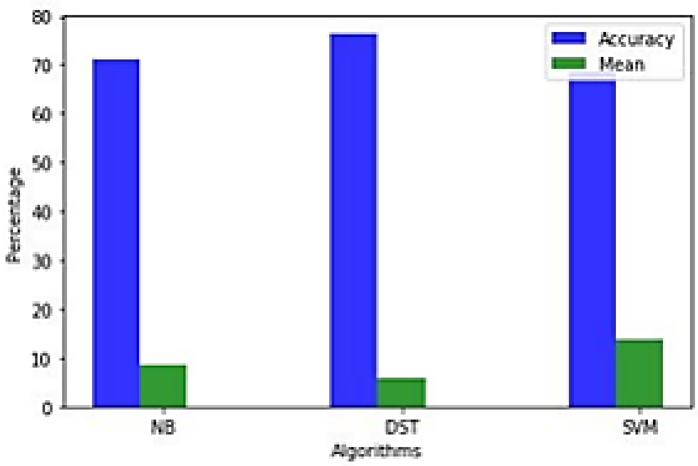

Fig 5: Using a train/test split of 8:2, we evaluate the efficacy of several machine learning algorithms for spotting cases of epilepsy.

Depending on the information they have to work with, various machine learning algorithms will achieve varying degrees of success. Decision tree analysis, naive Bayes classification, and support vector machine analysis are the three approaches employed to analyze the dataset. Figure 5 shows that decision trees outperform other methods in terms of accuracy. The number of accurate predictions made by a model is proportional to the number of training samples it receives. One factor that significantly affects an algorithm's accuracy is the mean. If a certain value in the dataset is inappropriate, the mean might be used as an alternative. As the mean rises, accuracy declines. The higher the accuracy, the smaller the mean value. Figure 5 displays the correlation between accuracy and the mean. Because the dataset is of higher quality, the decision tree approach also increases precision. The decision tree method surpasses the naïve bayes and support vector machine algorithms by 5.3 and 7.8 percentage points, respectively, with an accuracy of 76.4%.

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