

REAL TIME HEALTH MONITORING USING IOT WITH INTEGRATION OF MACHINE LEARNING APPROACH

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Abstract- Healthiness is the base for every human being. It is directly or indirectly influencing the mental ability of the person. It gives them the confidence to each action of the human. Sound health is necessary to do all our day to day works with the fullest hope. Nowadays all people are having more health-conscious than in the past years. Because of these reasons, there are different types of health check-ups, monitoring clinics are evolved, and they do a lot of monitoring processes like daily, monthly, and master check-ups. To provide multiple services, options, and facilities to their clients the technologies play a vital role in the current era. The rapid development of information technology influences every person's life and health consciousness. These technologies are helping to monitor the status of a person and provide necessary tips then and there. Different methods of check-ups and monitoring process are available to get the information about a person. There are several IoT enabled sensors available to sense the patient complete details about a particular person's behavior, human anatomy, and physiology. This will lead the Big data. The Data gained over the sensors are uploaded to the internet, and connected to the cloud server. The affected person records could be saved in the web server and physicians can get right of entry to the data anywhere in the world. Any un expected variation in the data of the patient who is using the healthcare system, inevitably the data of the patient will be uploaded to the concerned doctor with immediate notification. This type of health care system will be most useful in rural and remote areas. In this chapter, discuss the Machine learning techniques which are important to the build analysis models. Then how this model is integrated with IoT Technology and provide accurate data of individual person and also discuss the Cardiovascular problems based on real-time input data.

Key words: Iot-Internet of Things, Monitoring, Sensors, Anatomy, Physiology, Cardiovascular

I. INTRODUCTION

When people go for physical check-up, the doctor has not only considered the conventional based static and metabolic state measurements, but also consider current health condition of the person. This type of data provided by the IoT technology, are used for making decision about patient diseases. This type of technology used by the physician for diagnosis for a patient's diseases and early intervention of diseases, mainly used in improving the human life time. This novel technology has influence on healthcare industry and extremely reduction medical costs and increase the speed and

accuracy of diagnoses. Based on up-to-date technological trends, one can voluntarily visualize repetitive physical investigation is preceded by a two-to three days of continuous biological one-to-one care using low-cost sensors. Over this pause, the electronic sensors were used to record the vital symptoms of biological constraints and send the report to the doctor /patient and all their information's are stored in cloud server.

Due to the progress of advanced healthcare systems, Nowadays, a massive quantity of data is created by healthcare industries (i.e. like disease identification, patients present condition., etc.). These data are used for build predictive analysis model. Machine learning (ML) technique is used for analyzing data from various perceptions and constricting into valuable information. The most emerging application of ML is finding and forecast of diseases which was discussed in numerous research works. Hence, in this chapter, discuss a various machine learning algorithm, then how they are predictable for the heart disease. Remaining part of this chapter arrangement is explaining the health monitoring system integrated with IoT with various functional sensors and Arduino microcontrollers. In this new technology, sensor are used to collect data from multiple place of body, analyze the data and afford two communication from patient to doctor anywhere in the world.

II LITERATURE SURVEY

Recent years, people have awareness in electronic sensors and devices which are commercially accessible for individual health care, capability, and movement. In addition to the part of capability provided to by current IoT technology, there are many research applications considered in the clinical area. one of the emerging applications is continues health monitoring, recording and communicate the data who is in the remote place also.

Mohammad Salah Uddinet. Al proposed an "intelligent based health monitoring system for patients' health condition through different types sensors connected networks". But the proposed system was developed for ICU patients in the hospital environment. Emergency information are sent to only clinical

persons like doctor, nursing assistance. Sindu Divakaran et al. the proposed diagnostic system which provides dynamic information of a patient report send to the medical professional who have the web enabled system. Priyanka Kakria et. al discuss the “Online telemedicine systems”, It is beneficial for the healthcare services and this system was based on advanced wireless and sensor technologies. But this system generates alert messages to the doctor in the critical situations. The advantages of the system are two-way communication is possible between doctor and patient. But patient record data security is not maintained in this work. T. M. Cheng et.al, in their work, projected nonlinear controller of feedforward and feedback mechanisms. It was implemented in electronic controlled treadmill system and it was very useful for design of individuals the exercise materials. But dynamic model may be needed to describe at higher intensity exercises.

Wan et .al developed WISE, which is used in the real-time personal health monitoring .The proposed system includes many sensors to identify the diseases. Farzad Samie et al represent the machine learning applications used in medical environment and they used in prediction and decision system of Internet of Things.

III EXISTING HEALTHCARE MONITORING SYSTEM

The electronic healthcare system needs a set of events consider to maintain the health monitoring system. Many sensors are required to provide real time data.so structural integrity valuations are need to integrated system. Yuehong et. al discuss the several survey in technologies specially medical environment. This is used to progress and support the present technologies of health care services. Among the various techniques IoT have played a vibrant role to communicate the available medical resources and provide smart health care services. They discuss the challenges of digital component and communication between the electronic device and human behavior. Liang et al. proposed problem of the sensor in an extensive sensor network and projected diagnostic and reconfiguration reasoning system. Shruti Jalalpur et.al., Implement the various machine learning techniques using Arduino based microcontroller. Using the IoT and machine learning techniques, they proposed the predication and detection of heart diseases.

IV METHODOLOGY AND DATA ANALYSIS

The novel healthcare monitoring system used to improve the traditional healthcare system in the patient information gathering which is from the digital sensor and IoT device. Artificial Intelligence (AI) techniques are used to implement in the large dataset, which is used to predict disease and clinical intervention. Machine Learning algorithm are used in this method to build analytic models. These analytic models are used in the health monitoring system.

Based on the previous research work, three different ML

$$b = \beta_0 + \beta_1 a$$

algorithms was implemented on the Heart Disease related dataset. R programming tool is used to detect the probability of heart diseases analysis. Then a continual monitoring system proposal has been planned with an Arduino. System design methods of the proposed system and the workflow as mentioned below:

Based on the different datasets to train several machine learning algorithms. Compare the performance of machine learning algorithms. Choose, best algorithm and develop an IoT based prediction and monitoring application. Patient details are get from the sensors, and through the IoT application, the details are send to the doctors. Based on the input values predicts the diseases present or not. Using Arduino microcontroller and sensors real-time patient physiological data (ie)Blood pressure, temperature, humidity, and heartbeat are collected and send to the predictive system. This is used to notice the serious condition of the patient.

After receiving an alert note, the doctor will communicate patient’s/ take care person cation through IoT.

V PROPOSED SYSTEM ARCHITECTURE

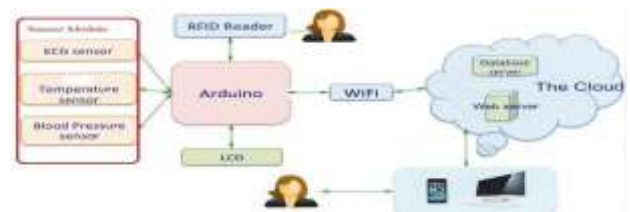


Figure 1 Block diagram of the proposed model

The block diagram of the proposed model is as exposed in Figure1. It explains all the digital components like the Arduino microcontroller, which is used to relate to the internet of the system. Also explain the techniques and tools are used for developing the complete arrangement. To develop a prediction system, a software tool is used to train with real-time datasets and analysis with many machine learning algorithms. The high accuracy ML algorithm is selected, and implemented in the predictive system for detecting and disease like heart disease risk level. In the system, different digital components like various biomedical sensors, IoT device LCD, buzzer, etc. are connected.

VI MACHINE LEARNING APPROACH

Machine learning leads to intelligent approaches used to improve performance of the system using example data or previous experience(s) through learning. More exactly, ML algorithms developed models of behaviors using mathematical techniques on huge data sets. There are many tools publicly available to implement machine learning algorithms. Some recent open source tools are WEKA tool for data mining applications, MATLAB for mathematical applications and R programming for data science application used. Based on the previous research work, the following machine learning algorithms, Multiple Linear Regression Algorithm, Random Forest, Support Vector Machine are considered in this chapter.

➤ Multiple Linear Regression Algorithm

This Algorithm is used to find the association between the variables and also find the predict the future. Predict the value of one dependent and predicted variable on the basis of other independent variables. The equation that denotes linear relationship between two variables a and b are:

When $a=0$, then the value of intercept is the value of b. When $\beta_0 = 0$, then the b is directly proportional to a.. When $\beta_1 = 0$: then Y is a constant, there is no relationship between b and a. Consider two or more quantitative and qualitative variable ($a_1, a_2, a_3 \dots a_n$) to predict a quantitative but dependent variable b. The output is the function model to predict the dependent variable with a new set of independent variables. A straight line is drawn, fit to the data. Find the relationship between the two or more quantitative and qualitative variable ($a_1, a_2, a_3 \dots X_n$) and the dependent variable b to generate a regression model for predict the future values of b.

➤ **Random Forest Algorithm:**

This is the one of the most powerful and well-known learning algorithm in ML. This algorithm is also called Bagging or Bootstrap Aggregation algorithm. In order to valuation the sample data such as mean, the bootstrap is a very powerful statistical method. Using training data, frequent models are measured and for every data sample the models are created. For the prediction model, each prediction model is averaged and get an improved the output value.

➤ **Support Vector Machine:**

SVM is a supervised learning algorithm, used to perform classification and regression analysis model. They analyses the large amount of data and perform classification by making parallel lines between data.[16,17] It splits the single line to generate flat and linear partitions also called hyperplane. These hyperplanes have the prime margin in a high-dimensional space to isolated given data into various classes. The margin between the two classes denotes the distance among the adjoining data points of the classes. So hyper-plane is used to create the classification of various the datapoints. Figure 2. Shows the sample Classification can be made by the hyper- plane among the two classes. Select the hyper-plane which is used to isolates the two classes. In the figure 2. Shows the various available hyper- planes A, B and C and these are used to classify the datapoints into various modules.

VII WORK FLOW OF THE PROPOSED SYSTEM

The Figure 2 illustrate the work flow of our planned health monitoring system. It contains the various modules like Data resource, Analysis of ML algorithm, Sensor system, integration of IoT devices with cloud service and automatic health monitoring system.

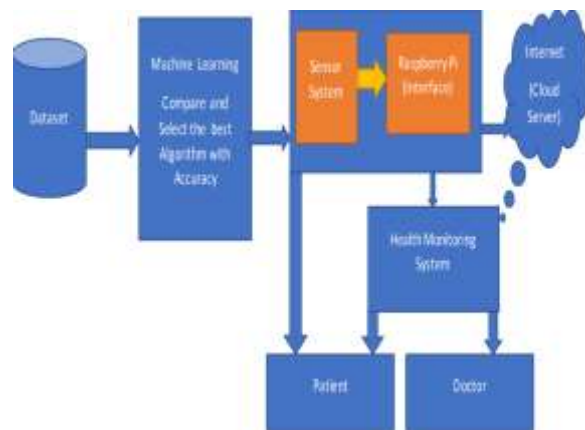


Figure 2 Work Flow of the Health Monitoring System

➤ **Data Source Module**

In this work two datasets heart disease databases and C level and Heart Disease dataset are used in this work because, they have same type of features. These datasets are combined to create new larger dataset. After the preprocessing implementation, 566 instances are used in this work for model validation. In this work, machine learning algorithm Multiple Linear Regression Algorithm, Random forest Algorithm and SVM Algorithms are used for classification of data and predictive model are created for the effective identification of Heart related diseases and the performance of algorithms were evaluated in terms of accuracy.

➤ **Attribute Documentation**

In this work, attributes like age, sex, chest pain type etc. are considered for the implementation of prediction system of heart diseases. Patient's mobile number is used as a key attribute (*i.e.* unique identifier). Attributes play an important role in analyzing the diseases.

➤ **Performance Analysis of Machine Learning Algorithms module**

Machine learning algorithm which mentioned above are implemented in the R programming Environment on new renewed dataset. Using 10-fold cross validation method, the performance of all the algorithms are analyzed. The best five experimental results have been displayed in figure 4, figure 5, figure 6 and figure 7. From the experimental, it has been observed that the SVM provides better results on the renewed dataset.

VIII SYSTEM DESIGN OF HEALTH MONITORING SYSTEM

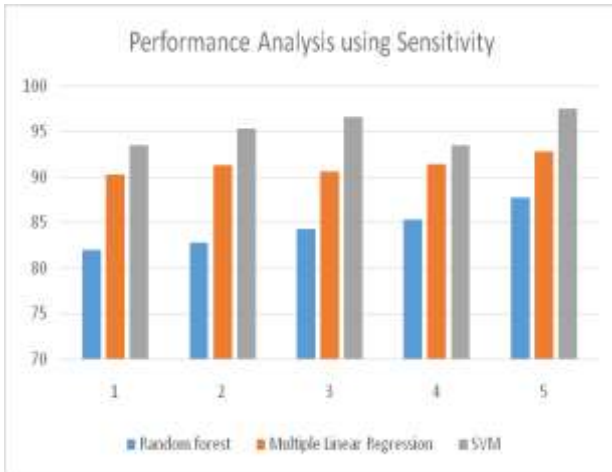


Figure 3 Performance Analysis using Sensitivity

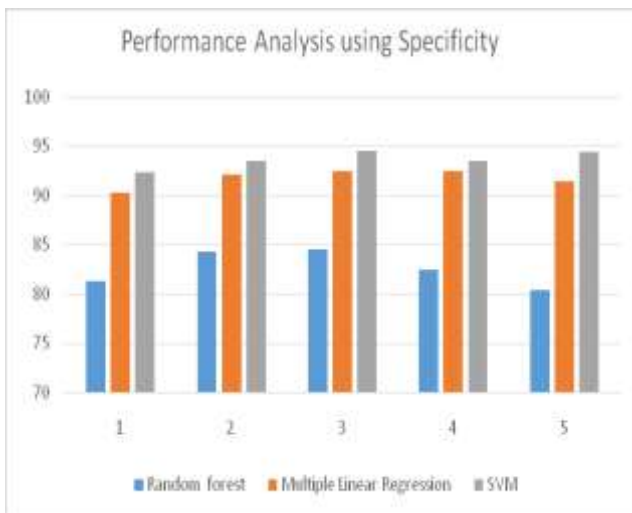


Figure 4 Performance Analysis using Specificity

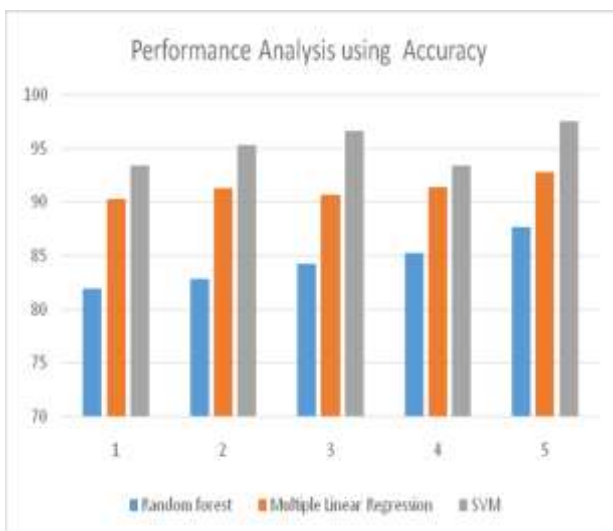


Figure 5 Performance Analysis based on Accuracy (%)



Figure 8 Overview of architecture and interfaces of a system

Systems design is explaining the overview of proposed architecture and interfaces of the application and UML (Unified Modelling Language) is used to model system designs.

Figure.8 shows the complete hardware setup includes sensors like Heartbeat sensor etc. The microcontroller board Arduino/raspberry pi and GPRS modules are used to communicate with cloud server. For information sharing between patient and doctors, electronic device like mobile, LCD display are used. Any abnormal value found in the data immediate notification communicate to the doctor and patient via communication media. Table 1 shows the some of the example of about the condition of patient which is used to make the decision about the heat diseases.

Table.1 Patient's condition for decisionmaking

Temperature	Humidity	Human awareness	Pulse rate	Action taken	Risk Level
<37°C	41%-46%	Normal	60-100	NotNeed	Normal
>38°C	41% - 46%	Abnormal for above 50 age persons	40-60 or 100-120	Notify to caretakers	Medium
>38°C	46% - >52 %	Abnormal body condition	40- 60 or 100- 120	Inform to doctor	High
>38°C	46% - >52 %	Abnormal body condition	40- 60 or 100- 120	Need Emergence care	Emergency

➤ **Use Case Diagram**

Use Case Diagram includes actors, instances and their relationships. It represents all the scenarios, related to the application cooperates with users and other external systems related to application. Figure.9 shows the use case diagram of system design.

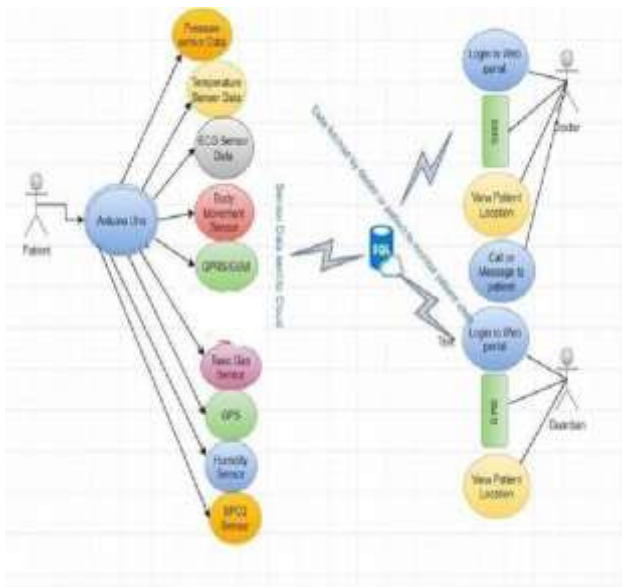


Figure 6 Use case diagram of system design

CONCLUSION

In the current pandemic COVID-19, effective and dynamic healthcare data analysis and decision is needed on patients' health record. ML Techniques are used to develop the analytic models and these models are integrated to IoT based health monitoring system to improve the performance of the healthcare system. From the above analysis SVM algorithm, exposed better accuracy rates of more than 90 percent, this algorithm may be considered for medical applications to disease detection and prediction purpose. Normally the attributes will influence on the classification and prediction performance. But Compare to the previous research work, even though the number of features is reduced, the SVM algorithm performance was good with renewed dataset. Therefore, it is significant that SVM is the most effective ML algorithm to be implemented on medical application system. Table 1 explains patient's condition for making decision of heart disease and risk level. The normal and abnormal values of temperature, pluses, Humidity can be implemented to the proposed real-time IoT based Health Monitoring system. Based on the real time data, it will send the alert message to the concern patient and doctor.

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