Enhanced Health Care Monitoring System

Sumit Raj, Shubham Tiwari, Abhishek Vinod, N. Jeenath Shafana
Computer Science and Engineering
SRM Institute of Science and Technology
Chennai, Tamil Nadu 600089

Abstract

Internet has been the key to create the world a better place similarly Internet of Things has been the key to create a smarter world. Machine Learning and Internet of Things can together improve of the lives. By the means of this paper we are going to try and combine IoT and ML and use it for determining healthcare issues in an efficient way. We are going to keep a check on basic health aspects of an individual by using Temperature, Pulse and the ECG sensor combined with a Node MCU. The pre-processing and grouping of data is done using the SVM algorithm and K-means algorithm. This system would be useful for individuals to be aware of their own body functioning.

Keywords - *SVM(Support Vector Machine), K-Means Algorithm, Node MCU(Microcontroller Unit), SoC(System On Chip), IoT(Internet of Things).*

an early level. By using this monitoring system, we can keep track of our body at an regular interval and take preventive measures to protect ourselves.

Although healthcare Monitoring doesn't come up as a new idea. It has been thought upon and worked on by various people and organisations. We tried here to merge IoT and ML together in two phases namely Phase I and Phase II respectively.

In the Phase I the data of the patient or individual is recorded using various sensors such as temperature sensor, pulse sensor and ECG sensors. Then this data is compared in real time in the cloud with the threshold values and upon any abnormality it informs the doctor, nurses and relatives of the patient using MQTT.

In the phase II of our paper it analyzes the data collected using various machine algorithms like SVM and K means. This analysed data shows the result for the most probable disease which can occur to the individual.

I. INTRODUCTION

With the growing pace of development, every day we come across a lot of mutational and chemical changes in our body due to various physical factors present around us. To prevent ourselves from these changes we must go for regular check-ups. But in this developing world, we are running out of time and we don't take care of ourselves properly. Thus to protect ourselves and remain fit in this mutating world, we came up with this idea of an enhanced health care monitoring system using IoT and ML at an individual level.

As we are facing everyday a new disease in every couple of years like Ebola, Severe Acute Respiratory Syndrome (SARS), Covid-19 i.e. Novel Corona Virus and much more. Hence, it has become necessary for humans to take preventive measures at

II. RELATED WORK

Previously the systems which have been suggested by many journals had been focused on a particular section of patients and was only applicable to them. For instance one of them focuses on elderly citizens who are unable or more precisely incapable of visiting a doctor frequently for regular check-ups. Some other papers were concerned with patients having lung or pancreatic cancer. These were based on smart devices by using Internet of Things. To maximize the benefits of a system, there is a need for processing the data and use it in a more beneficial manner. Here comes the need for Machine Learning which we are trying to implement in our paper.

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In another study on this subject, there were comparisons of various existing algorithms and prediction accuracy has been discussed. In that study ADL in Internet of Things was analysed. It discussed about the algorithms such as SVM and Random Forest. These algorithms can only applied to data already stored i.e. offline data.

In another study, the integration of the various sensors attached to the objects was discussed. The to and fro relationship between the Internet and the objects was analysed and how it can be used for the betterment of the society. The main motive in that study was to give a comprehensive view of IoT usage in medical healthcare systems.

In one of the other studies related to this subject, the setup proposed by the system was particularly focusing on the heart related medical issues. It discussed a smart watch for detecting ECG and PPG signals for extracting the heart rate and the pulse rate. It also discussed about the emergency signals that could be used to alert the patient as well as the fellow relatives as a precautionary measure.

III. IMPLEMENTATION

PHASE I

Our paper proposes an enhanced health care monitoring system, which uses different non-invasive biomedical sensors to monitor health of the patient. Temperature sensor(LM 35), ECG sensor(AD8232), Pulse sensor(SEN-11574) are used to monitor the health of the patient which measures the body temperature, bio-potential generated by electrical signals and pulse respectively. All of the sensor is connected to the Node MCU**.** The Node Micro Controller Unit i.e. Node MCU is ESP8266 whose environment is developed in a SoC. This ESP8266 is an open ource hardware. It has a built-in support for WIFI connectivity and hence, makes IOT program development much simpler. Node MCU requires power supply for its working. Node MCU continuously reads input data from different sensors and then it sends this data to the cloud by sending this data to a particular URL address. After a particular interval of time the action of sending data to IP is repeated. ThingSpeak is an open source application used in IoT and API (Application Programming Interface) to keep and fetch data from things. This is done using the Message Queue Telemetry Transport and Hyper Text Transfer protocol over the internet. It allows the location tracking and creation of sensor logging application, and a social network of things with position update. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks which allows ThingSpeak users to ECGanalyze and visualize uploaded data using MATLAB.

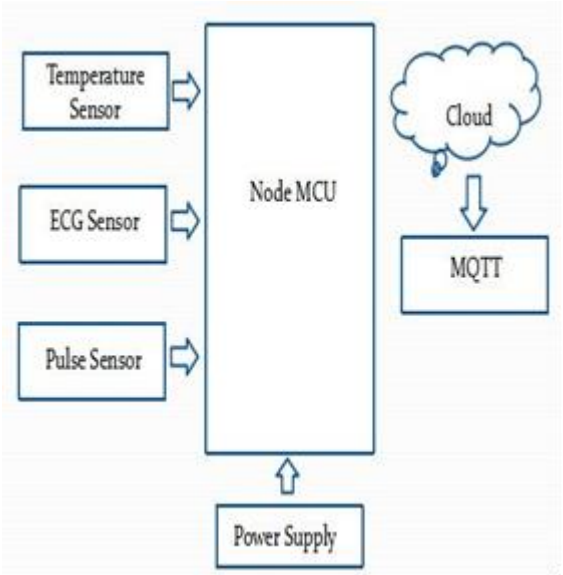

Fig 1. System Design (Phase I)

Here is the list of following components used in this enhanced health care system:

1) **Temperature Sensor(LM35):**
It is an integrated analog sensor which senses the temperature whose electrical output is proportional to degree centigrade It does not require any external calibration or trimming to provide accuracy. It has low output impedance, precise inherent calibration and linear output make interfacing to readout easy.

2) **ECG Sensor(AD8232):**
It is a circuit wich is used to measure the electrical activity(Electro Cardio Gram) of the heart. It outputs an analog reading. It works like an op amp to obtain a good signal from the PR and QT intervals. It is designed to amplify, extract, and clear out small bio potential signals in the presence of a noisy conditions.

3) **Pulse Sensor(SEN-11574):**
It gives digital output heat beat when a finger is placed on it. The Beats per minute (BPM) rate is measured by connecting the digital output to the microcontroller directly. It's working is based on the principle of light modulation by blood flow through finger at each pulse.

4) **Power Source:**
Nothing can work without electrical power. Depending upon the application type, several options for power are available. Battery charging controller can be designed using microcontrollers and softwares.

5) **Node MCU(Micro Controller Unit**):
It is an open source, low cost IoT platform. The main advantage of using Node MCU is that, it consists of an in-built WIFI module(ESP8266). Arduino IDE can also be used to program Node MCU. It also supports Bluetooth 4.2 and low power bluetooth. Node MCU features a 4 MB(32 Mb) flash memory organized in sectors of 4k each.

6) **ThingSpeak**:
ThingSpeak is an open source IoT application and API(Application Programming Interface) to store and retrieve data from things using the MQTT and HTTP protocol over the internet or a local area network. It enables the location tracking application, creation of sensor logging application, and a social network of things with status updates. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks which allows ThingSpeak users to ECGanalyze and visualize uploaded data using MATLAB.

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PHASE II

In the second phase of our paper we have analyzed the data collected in first phase using various Machine Learning algorithms. In today era each and every day we come across a number of new disease in our planet like Corona, Swine Flu, Ebola, Cancer, Tumors, etc. We see a lot of death due to these deadly diseases in our daily lives. But an early detection can prevent us from these life taking disease and can battle against these easily. Using certain Machine Learning algorithms we can predict the diseases which can occur to a person. The datasets from the first phase is analysed under various processes.

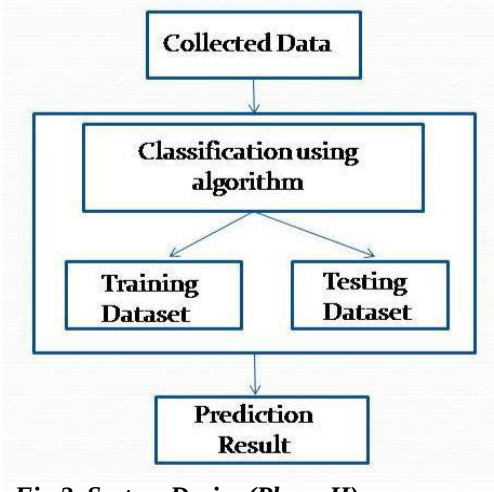

Fig 3. System Design(Phase II)

1. Data Accumulation

The data is collected from the first phase of the module where various sensors measure the various parameters like body temperature, pulse and Electrocardiogram (ECG) and certain other parameters. All these data are stored in the cloud and data is fetched for further processes.

2. Data Preprocessing

The data preprocessing steps involves a number of sequential steps and methods to handle the collected data. The disabled or faulty datasets are removed. Here we are taking two steps. They are data enhacement and data cleaning.

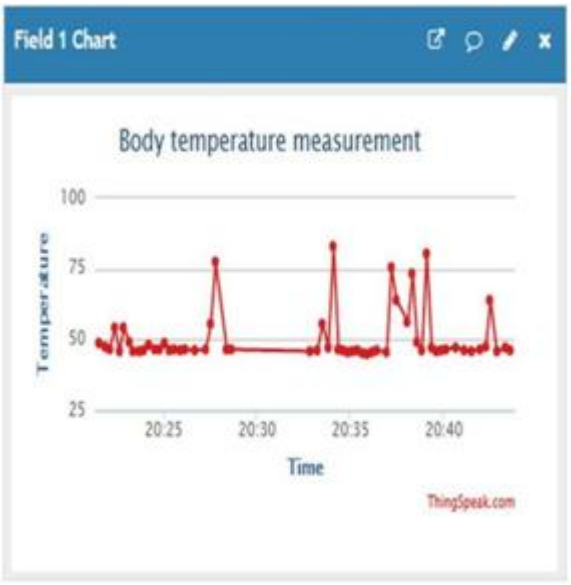

Fig 2. Temperature report in ThingSpeak

A) Data Enhacement

In the data enhacement step, we transform the data into the format as required by the analysis algorithms.

B) Data Cleaning

Data Cleaning is used to fill incomplete data and remove duplicate datasets. This data cleaning step is done with the help of Newton polynomial in order to perform the data interpolation.

3. Initialization stage

In this stage, K means algorithm is used for the partitioning of the datasets into k predefined distinct non-overlapping clusters where each data point belongs to a single cluster only. It makes the inter cluster data points quite similar as possible and then assigns data points to the cluster such that the sum of the squared distance between the data points and the centroid of the cluster is at the minimum distance. In this algorithm firstly number of clusters is specified. Then, centroids are initialized by shuffling the dataset and then K data points are randomly selected without replacement. After that data points are iterated until there is no change in centroids. Then Euclidean distance is calculated and data point to the clusters are assigned. Controids are computed by calculating average of all the data points in a cluster.

4. Assignment Stage

In this stage, discriminator is used to determine whether the learning process in the cluster should be halted or not. In accordance with the operation time and operation state, data point are assigned to the clusters with the minimum euclidean distance.

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5. Evaluation stage

In this stage, the model is trained on various folds of data and it's rechecked to evaluate the consistency. The dataset from the data assignment phase is transferred to this to re-train the model. It will also improve the accuracy and the prediction capability of the system. Then, test dataset is evaluated and the output gets generated after this. Hence during this stage Support vector Machine algorithm is used. It finds a hyperplane in an N dimensional space that classifies the data point. Here a plane with the maximum margin of data points of various classes. These data points are basically support vectors which are close to hyperplane and they influence the position of the hyperplane. Support vectors help to maximize the data points.

6. Analysis Generation

This stage shows the final result and notifies us with the abnormalities if any persists in the analyzed datasets. This will get triggered at time when the analyzed results shows any risk of disease.

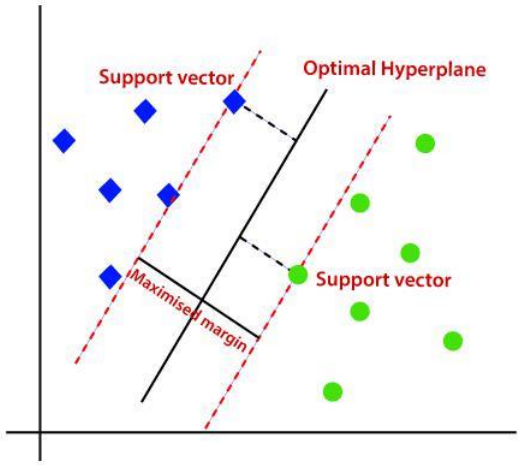

Fig 4. SVM algorithm Data Points

IV. CONCLUSION

A proper wellbeing of an individual is an important part of an individual. The health of an individual can't be compromised, it should be maintained to the highest order. By utilizing the proposed system through this paper we try to provide everyone a door to have a constant record of their wellbeing and an chance to maintain it in cheaper and efficient way. Even WHO(World health Organisation) appeals to the citizens of the world to keep a track of their basic health conditions even if one feels healthy as there is common saying- "Health is Wealth". We are trying to play our part by suggesting methods using which everyone can be benefitted.

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