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Smart Healthcare Monitoring System Using IoT

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ABSTRACT: Health is the fundamental element of every people to lead a better life, and it is characterized as a full state of physical, mental, and social well-being and not lack of illness. A healthcare system enables patients and doctors to communicate with each other and remotely exchange information that is monitored, collected, and analyzed from patients' daily activities via the IOT(Internet of Things). In our project we monitor the data of the patients such as heart rate, temperature and classify them using the different machine learning classification algorithms. Here we are using three classification algorithms such as KNN, SVM and RF.A relevant dataset is created by collecting the values from the patients and that dataset is used in our project and is acquired during the prediction of the accuracy of the classification algorithm.

KEYWORDS: IoT(Internet of Things), KNN (k-neighbours nearest algorithm), Smart Healthcare, Cloud & Fog Computing.

I. INTRODUCTION

Health is characterized as an important element in every one's life. In today's global world it has created a dilemma in lack of proper healthcare services and facilities to people as well as lack of physicians and unavailability of nurses.IOT is making any objects internally connected and it considered as an revolution in the recent decade technology. IOT is linking the computers to the internet via the sensors and networks. These components that are been connected can be used for healthcare monitoring.

[1]The most significant and the important factors indicating the human health are the heart rate as well as temperature. Tracking and optimizing them is a simple, efficient and smarter way for any healthcare related problems. These days the modern systems which are available here are providing a better and flexible interface in assisting devices which leads to a smarter life for the human beings. Smart devices that are available in recent days communicate with each other over a network called Internet of Things (IoT). Achieving the exchange of information and communicates between the things or smart objects such as people and different kinds of information services and applications is the core of the IoT. Integrating cognitive technologies into IoT based systems were recently developed and called as "Cognitive IoT". The main aim of this was to ensure smart management of IoT via cooperation and interaction between IoT and human being.

[2]The main aim of bringing IoT into the healthcare sector is that it helps in stronger, easier as well as healthier way in caring the patients via the medical devices and sensor implantation it has speeded up healthcare delivery by enabling the doctors spend less time in diagnosing illnesses, transportation and communicating with the patients. Classification algorithms have been used and predicting the accuracy of the accuracy of the classification algorithms.

II. LITERATURE SURVEY

The study by Prosanta Gope Tzonelih Hwang [1],proposed a system of "secure IOT based modern healthcare system" in which they used energy saving and lightweight wireless to monitor the fuctions of human body and environment surroundings. Biosensors are integrated with each sensor nodes like Electrocardiogram (ECG), Electroencephalography (EEG) and Blood Pressure (BP), etc. The sensors collect the physiological parameters and then forward these to the coordinators that are called Local Processing Unit(LPU). In IoT-based healthcare systems, the sensor nodes will be collecting data and forwards the sensitive data to the LPU. An adversary can be on this communication, and can overhear the critical information and also it will reduce the computational overheads.

The work by Udit Satija, Barathram Ramkumar, and M. Sabarimalai Manikandan [2], " Real time signal quality for IoT based healthcare monitoring" work which proposed a system which is developed for a light weight ECG signal quality assessment method and for automatically classifying the data acquired ECG signal in a real

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time based on IoT. It is a novelty based quality aware ECG telemetry system for IoT enabling cardiac healthcare monitoring systems in a wearable medical body are networks. The main objective was to present a light weight and real time signal quality assessments techniques for improving the battery and lifetime of IoT enabled wearable devices and thereby reducing the traffic load on the cloud servers, bandwidth and treatment costs. One of the drawbacks of this paper was that it cannot split in a way that decreases the connectivity cost.

The work proposed by Emna Mezghani and Ernesto Exposito and Khalil Drira[3], "A Model-Driven Methodology for the Design of Autonomic and Cognitive IoT-Based Systems-Application to Healthcare" this work proposed a generic and a reusable solutions for the elaboration of the flexible as well as smart IoT based systems which will be able to perceive the collected data as well as provide the decisions. The blackboard pattern here is the Cognitive Monitoring Management pattern will be enabling the interaction of the IoT with the humans. It is able to identify the bidirectional interactions and IoT Human interactions for visualizing the data and extract new insights and receive the notifications in case of the context changes and then the Human IoT interactions to manage the system through modifying its contexts as well as allowing the IoT based system learning from the experts and acquiring knowledge. One of the drawbacks of this paper was the heterogeneity of the knowledge representations and its distributions are identified as impediments of the integration.

III. METHODOLOGY

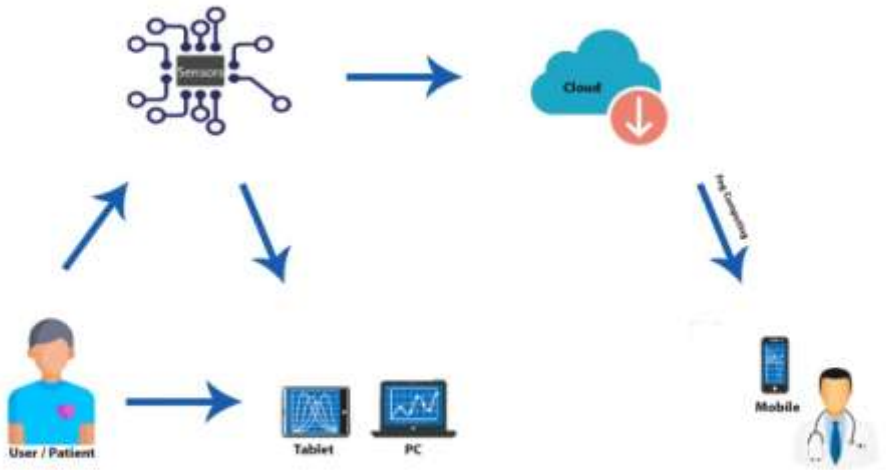

Figure.1 Methodology of Smart Healthcare Monitoring System

The project entitled as the smart healthcare monitoring system using IoT, mainly used IoT and machine learning classification algorithms to develop the system. Here we have the user or the patient where the patient will be monitored by using the sensors which are controlled by the Arduino UNO microcontroller. The sensors used here for monitoring the patient data are the temperature/humidity sensors, and heart rate sensors. These values are detected and then the readings will be displayed directly in the serial monitor/PC. And also an alert message regarding the detection of the patient readings will be sent to the receiver side i.e., the doctor. The detected readings or values will be sent as an alert message `via the Wi-Fi module by an SMS that the sensor values of the patient is been detected. And in case of any emergency the doctor can guide the patient to monitor his/her heart rate values and temperature values and thereby reducing the risk of

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getting ill. In this project we collected the data of patients from physicians and we used machine learning classification algorithms such as K Nearest Neighbours (KNN), Support Vector Machine(SVM) and Random Forest (RF). Different types of healthcare values of patients have been noted down and made into dataset. We have trained the data and then tested the data against the algorithm so that we get more accurate results.

DATASET USED IN CLASSIFICATION ALGORITHMS (KNN, SVM and RF):

The dataset consists of 303 values of individual's data. There exists 14 columns in the dataset andthey are:

1. Age: It displays the age of the individual in years.

2. Sex: This will display the gender of the individual in the following manner:

1 = Male

0 = Female

3. Chest-pain type (cp): It determines the chest pain and displays the type of chest-pain experienced by an individual by considering the following format:

1 = Typical Angina

2 = Atypical Angina

3 = Non-Anginal Pain

4 = Asymptomatic

4. Resting Blood Pressure (trestbp): Displays the resting blood pressure value the person in terms of mm/Hg (unit).

5. Serum Cholesterol (chol): Determines the serum cholesterol of a personand displays in mg/dl (unit).

6. FastingBlood Sugar (fbs): Determines and compares the fasting blood sugar level of a person with 120mg/dl. If the value determined is greater than 120mg/dl then it will be showing as:

1 = True

0 = False

In the actual dataset, there we had 76 features but for our preferences and study we are taking only those 14 features, we have chosen only the below 14 because:

1. Age: Age is the most significant and important factor for causing certain types of diseases, with an approximation of tripling the risk with each decade of life. Older adults may be more motivated to get health information because they are at higher risk than younger adults for causing the illness, both chronic and acute.It is estimated that around 82% of people who die of heart diseases are of 65age and above. Simultaneously, the age after 55 is the risk of stroke and it is doubling in today's decade.

2. Sex: Men are having higher risks of getting affected by heart diseases than that of the women. Men are at greater risk of heart disease than that of women. If a female is having diabetes, then she is more likely to develop heart problem than a male with diabetes.

3. Angina (Chest Pain): Angina is a chest pain or some sort of discomforts caused when your heart muscles are not able to get enough amount of oxygen-rich blood. It mostly develops a feeling like pressure or squeezing in our chest. The discomfort

7. Resting ECG (restecg): Displays the resting electrocardiographic results of an individual in the following format:

Values can be of (140, 173)

0 = Normal

1 = Having ST-T wave abnormality

2 = Left ventricular hypertrophy

8. Max heart rate achieved (thalach): Determines and displays the maximum heart rate occurredfor a patient.

9. Exercise induced angina (exang): Displayed as follows:

1 = Yes

0 = No

10. ST depression induced by exercise relative to rest (oldpeak): Displays the numeric value such as an integer or a float.

11.Peak exercise ST segment (slope): The values are displayed as follows:

1 = Upsloping

2 = Flat

3 = Down Sloping

12. Number of major vessels coloured by fluoroscopy (ca): It determines the values as integers or float. It can be of (0-3) vessels.

13.Thalssemia (thal): Displays the thalassemia in the following format:

3 = Normal

6 = Fixed Defect

7 = Reversible Defect

14. Diagnosis of heart disease (num): Determines and displays whether the person is suffering from any heart disease (angiographic disease status) or not:

0: <50% diameter narrowing

1: >50% diameter narrowing

0 = Absence

1, 2, 3, 4 = Present.

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also can occur in an individual shoulders, arms, neck, jaw, or back. The pain may even feel like indigestion.

4. Resting Blood Pressure: Over a time, it is observed that arteries that feed the heart can be damaged due to high blood pressure in an individual. High blood pressure willalso occur with certain other conditions like, obesity, high cholesterol or diabetes, and this which may increase the risk to even more.

5. Serum Cholesterol: Narrow artery is mostly caused by high level of low-density lipoprotein (LDL) cholesterol. A high level of triglycerides, a type of blood fat related to your diet, also increases the risk of a heart attack. However, a high level of high-density lipoprotein (HDL) cholesterol reduces the risk of a heart attack.

6. Fasting Blood Sugar: Not producing enough amount of hormone secreted by our pancreas (insulin) or not responding to the insulin properly will causethe body's blood sugar levels to increase in various numbers, which may further increases the risk of getting an heart attack.

7. Resting ECG: ECG (Electrocardiogram), for people having low risk of heart disease, the USPSTF summarised a moderate certainty that the potential harms of screening with resting or exercise ECG exceeds or maintains the potential benefits. For people having normal to high risk, current resourcesare insufficient to assess the balance of benefits as well as harms of screening.

8. Max heart rate achieved: With an increase in high blood pressure the increase in risk for cardiovascular, that is associated with the acceleration of heart rate and that was comparable to the increase in risk observed. It is observed that an increase in heart rate by 10bpm(beats per minute) is in turn directly related with an increase in the risk of heart attacks by at least 20%, and this increase in the risk of heart attack is somewhat similar to the one observed with an increase in therisk in blood pressure by 10mm/Hg.

9. Exercise induced angina: The discomfort or pain with angina usually feels like tight and gripping or squeezing, and can vary from low to high. Angina is usually felt in the centre of your chest but may spread to either or both of the shoulders, or back, neck, jaw or arm. It can even be felt in the hands of an individual.

10. Peak exercise ST segment: The normal ST segment during exercise therefore slopes sharply upwards. If there is a horizontal or down sloping ST-segment depression $\geq$ 1 mm at 60–80ms after the J point the treadmill ECG stress test is considered abnormal.

IV. SYSTEM DESIGN

The sensor nodes such as heart rate sensors (sensor 1) and temperature/humidity (sensor2) sensors are connected to the Arduino UNO Microcontroller. The value detected from the Arduino is sent to the software interface through hardware interface. And by using the Arduino IDE software, the detected values are displayed in the output terminal and then by using cloud computing technique detected value of patients are stored in the cloud storage.Cloud computing can be defined as delivery of computing services which includes storage, servers, networking, databases and security over the internet. Here the intention of using cloud computing was to offer a storage medium for the data and also for security, speed, scalability, and flexibility.

It is clear that this system is accurate in sensing values from sensors, clear view in monitoring, proper in decision making, classifying and reliable in communicating. Figure.2 represents the system architecture diagram.

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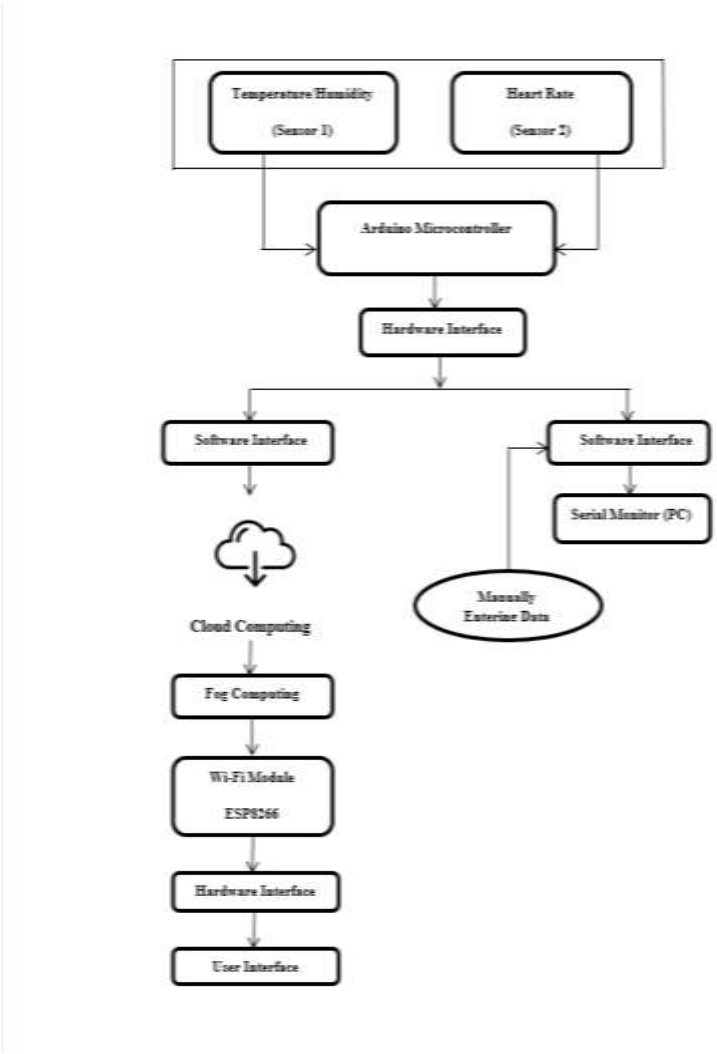

Figure.2 System Design of Healthcare Monitoring System

In this proposed system, we use the Arduino microcontroller. The Arduino microcontroller is an open source and also user friendly device. The proposed system consists of Arduino, Heart Beat Sensor, Temperature/Humidity Sensor, and ESP8266 Wi-fi Module (IoT). We monitor the patients' healthcare by using Heart Beat Sensor and Temperature/Humidity Sensor. The sensor values have been given to the microcontroller. The microcontroller will display the sensor values that can be monitored in the webpage widely using IoT. An ESP8266 Wi-Fi module is used for the communication purpose. Thereby, the monitored sensor values can be communicated worldwide. All the values that are monitored can be stored in the corresponding web link and the doctors are given notification in the form of physical activity and illnesses via SMS in telegram. Some of the features present in the Arduino software which makes the coding easy and fast when compared to other microcontrollers. The dynamic changes that occur in the communication range are given by Wi-Fi module ESP8266 through which communication is done widely. This will provide a better communication and self-management of diseases.

V. SYSTEM REQUIREMENTS AND SPECIFICATIONS

Software requirements and hardware requirements are given mentioned below:

- Software Requirements:

Operating system : windows 10
Software : Telegram, PyCharm
Languages : Python

- Hardware Requirement:

➢ NodeMCU:The NodeMCU (Node MicroController Unit) is an open source software for IoT platform and hardware development environment that was built around a very

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inexpensive System-on-a-Chip (SoC) called the ESP8266.

LM 35:the LM35 sensors are precision integrated-circuit temperature sensors, in which output voltage is linearly proportional to the centigrade temperature. It can be easily interfaced with any Microcontroller that has an ADC functionor any development platforms like Arduino.

- ESP8266 Wi-Fi module:The ESP8266 Wi-Fi module is a complete Wi-Fi network where you can easily connect it as a serving Wi- Fi adapter as well as wireless internet access.
- Heart Rate Sensor: A heart rate monitor or HRM is a personal monitoring device which allows an individual to measure/display heart rate in real time and record the heart rates for further study.

VI. SYSTEM IMPLEMENTATION

1. Arduino Uno Microcontroller: The Arduino IDE is open source software used to write code on the sketch and uploaded on the arduino board. Arduino will collect the information from those 14 digital both input/output pins and Analog PORT pins. Compiling of the code is done before uploading the code. For displaying the output of the sensors, the arduino boards have been featured with serial communication or COM port. After the compilation and uploading of the code is verified, the output can be displayed through the serial monitor/PC.

2. Heart Rate Sensor: An optical heart rate sensor measures the pulse waves of the heart, which are changes in volume of the blood vessels that occur when heart pumps blood. It works by measuring the electrical signals from our heart. And they are transmitted to a data centre. Many of the models allow us to analyse the data via a computer. The sensor is connected to the Arduino microcontroller using the port.

3. Temperature/Humidity Sensor: Humidity sensors work by detecting the changes that will alter the temperature in air. This sensor is directly connected to the Arduino microcontroller via the port.

4. IoT Monitoring and Connection Details: The IoT monitoring is a run application based on the communication protocol operations. Arduino microcontroller collects all the sensor values via the analog input and converted into digital. These values are stored in the Ardunio and sent to the ESP8266 Wi-Fi module through certain operations of communication protocol.

5. Classification Algorithms: The data obtained from the Arduino microcontroller are converted into text file which is taken as an input to the classifiers. The data are classified and output is obtained. Three algorithms are used to obtain the accuracy of the dataset. The three algorithms used here are KNN, SVM, and RF. In KNN, the input consists of k closest training examples. The output depends on whether k-NN is used for classification.

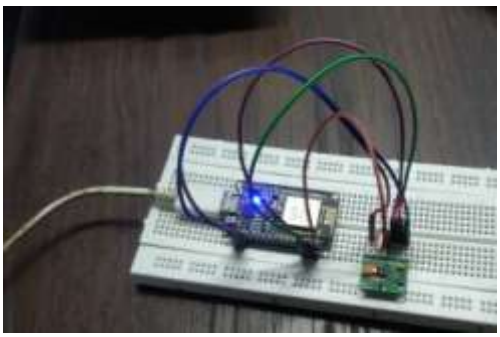

Figure.3 Monitoring Kit

The program code in the Arduino IDE is uploaded in the Arduino board. Figure.5 represents the Arduino IDE in which verification and uploading of code is done.

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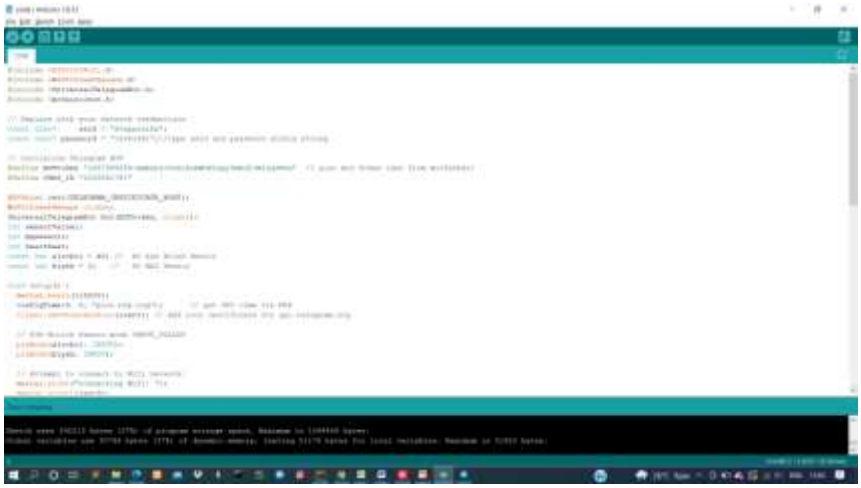

Figure.4 Arduino IDE

To display the predictions and accuracy of the classification algorithms we use flask web interface so that it will be displayed in a web interface format. This is the page for adding the values manually as well as by fetching details from the hardware. Then it displays the accuracy of the three classification algorithms such as KNN, SVM nd RF.

Figure.5 Home Page and Prediction Page of Healthcare System

This is the results page in which accuracy of the classification algorithms is displayed and we can also display individual accuracy of graphs of classification algorithms.

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Figure.6 Results of Accuracy

VII.CONCLUSION

One of the disadvantages in hospitals is that in treatment they try to reduce the rate of hospital admissions and increases the workload on employees and thereby producing dissatisfaction. In this system we have two sensors that monitor patients' data and store it in a cloud storage medium and actively send an alert message to the doctor. So, the doctor will be able to know the activities of patient and could reduce the risk of illness. Each time when the value of a patient is detected, the doctor will be able to know whether the patient is having any issues related to health and can guide for further treatment.

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