STORING AND COMPUTATION OF REAL-TIME DATA ON THE CLOUD THROUGH MEDICAL SENSORS

Dr. V. Santhi,
Associate Professor,
Dept. Of CSE,
PSG College Of Technology,
Coimbatore, India.
vsr.cse@psgtech.ac.in

V. Bhoovika
UG BE Student,
Dept. Of CSE,
PSG College Of Technology,
Coimbatore, India.
19z310@psgtech.ac.in

GK. Pavithra Yazhini
UG BE Student, Dept. Of CSE,
PSG College Of Technology,
Coimbatore, India.
19z337@psgtech.ac.in

***Abstract*—Healthcare is one of the sectors that all nations are working to grow sustainably. IoT, or the Internet of Things, is a young technology that offers advancements and improved medical solutions. A significant application of cloud computing is helping doctors perform faster diagnostic procedures. Obtaining real-time data from medical sensors is another one of the main applications. Here in this article, we have proposed a method in which we read patient data from the MySignals e-health platform, store it in the cloud, and conduct analysis on it. This project makes it possible for the doctor to monitor the patient's health from any location and provide recommendations for additional treatment by displaying that data in the cloud.**

Keywords— MySignals, healthcare, e-health, cloud computing.

I. INTRODUCTION

eHealth is of communication and information technology to enhance health and healthcare, where it provides rapid access to patient records and information for effective healthcare. The world's population is aging, healthcare costs are higher than ever, and the prevalence of chronic diseases is also rising. Thus, [10] e-health is preferred because it reduces paperwork and cost duplication, leading to lower healthcare costs. eHealth will produce fewer medical errors and helps in better clinical decision-making. The use of information and communication technology in healthcare significantly raises the standard of care. Today's evidence base demonstrates the (cost) effectiveness of online education, self-management support, and telemonitoring in several areas of health care. The new results are gradually providing more evidence of eHealth's impact on quality issues. With real-time health monitoring using a smart medical device connected to a smartphone app, medical devices can collect medical and other required data and use the smartphone's data connection to transmit the collected information to doctors or to a cloud platform. Various data such as blood pressure, oxygen, blood sugar, weight, and EKG can be transmitted. The doctor may review the data obtained regardless of the location, time, or device because it is kept in the cloud and can be shared with an authorized person, who can be a doctor or any other approved person who takes care of the patient.

MySignals is a platform for creating eHealth and medical device applications. [7] You can design new medical devices by adding your own sensors to MySignals to develop your own eHealth web applications. More than 20 biometric indicators, including blood pressure, pulse, respiration rate, oxygen saturation, ECG signals, and muscle electromyography signals, can be measured thanks to this. The most comprehensive eHealth platform available is MySignals thanks to its extensive sensing portfolio. Using a variety of hardware components, including the Arduino Uno, My Signal Hardware Kit, and a number of medical sensors, values can be recorded in real-time [9]. Additionally, the data will be captured and saved in the cloud for cloud-based analysis as well as display. Additionally, the cloud storage system is capable of accommodating various user needs. Additionally, the fundamental objective of cloud storage is to offer customers extremely dependable, low-cost, endlessly extendable, and storage platforms that can accommodate a variety of data storage needs. For a long time, research on collecting sensor cloud data has been largely constant and consistent.

II. LITERATURE SURVEY

In [1] This paper proposed a fog-based well-being checking system, which utilizes fog passages for clinical dynamics while considering the information gathered from the sensors like temperature sensor, ECG sensor, and pulse sensor, which are implanted into a wearable gadget to gauge the temperature, pulse, and systolic strain of a patient. This information is then gotten by watermarking and encryption processes and is briefly put away in the fog server until getting a legitimate organization network and sending them tothe specialists or parental figures by means of the cloud in any crisis circumstances. This builds the utility of the proposed framework. The colossal measure of information noted fromthese sensors is packed and put away in the cloud for future reference of clinics and analysts. At last, in this paper, the advantages of picking fog processing administrations in medical care checking and clinical navigation have been talked about.

In [2] It is very evident that C2F computing is conveying all the more actually contrasted with a cloud by meeting present prerequisites of arising models that require fast handling with less postponement. The two of them exist together, serving two unique areas and supplementing each other any place required. This paper analyzed key elements of Fog computing and how Fog adds and expands Cloud computing as well as proposed a C2F engineering for U-medical services observing for savvy home and emergency clinics with both arising standards by featuring the portrayal of various level important to accomplish the C2F vision key qualities progressively U-medical services observing. The further examination means to stretch out with elaboration of structure for C2F U-healthcare checking framework or other use instances of Internet of Things (IoT) with improved support and different components or innovations mixes.

In [3] The paper presents viewpoints in regard to the significance of utilizing distributed computing innovation for large information handling from biosensors. The remote sensors for the individual region have applications that have been utilized in medical care observing applications. There are a few restrictions of remote sensors as far as memory, energy, calculation, correspondence, versatility, and proficient administration of the huge information gathered from biosensors. In the medical services region is a need for strong and versatile superior execution computing and monstrous stockpiling foundation for ongoing handling, putting away, and breaking down (on the web or disconnected) of the biosensors information by involving complex calculations for separate required values from data set. The patients can associate with clinics or specialist disconnected or on the web, yet the information should be capacity by utilizing distributed computing innovation since this permit computing, stockpiling, and programming administrations (SaaS) with customization prospects and virtualization for minimal price. Cloud Computing can give an open, adaptable, and reconfigurable stage (PaaS) for checking and controlling applications.

In [4] The ability of Wireless Sensor Networks (WSNs) to handle information and scale up is increased by the combination of cloud computing and WSNs, known as Sensor/cloud. It has become difficult to obtain and upload physical data to the cloud in a timely manner given how fragile WSNs are in terms of correspondence capability. A number of research projects have recently been focused on and disseminated in the exploration sector due to growing interest from experts in the field. This study's main objective is to rigorously survey the current body of knowledge on information assortment in sensor clouds. As a result, the focus also emphasizes identifying, categorizing, and including noteworthy research on the topic of study. The same proof-based methodology is applied in this review. 43 relevant investigations were subsequently identified and located to address the intended exploratory questions. The systematic attitude gives an exact, reproducible, and deliberate examination, selection, and assessment process. The results demonstrate that analysis of information collection in Sensor-cloud is largely predictable, with stable results over the previous five years. The chosen studies used System, Framework, and Calculation the most frequently out of ten proposition commitments. Taking everything into consideration, the main research issues and areas for future research were identified and reviewed for experts to offer convincing solutions for the current problems.

In [5] The development and developing ubiquity of Cloud and IoT has turned into a great component for empowering consistent medical services applications influencing our day-to-day existence. The blend of Cloud and IoT in medical services frameworks is exceptionally energetic by the necessity for efficient computing foundations, a boundless stockroom for information logging, ideal organization execution, and accessibility. Too, "Cloud" gives an efficient stage and answer to beat a few innate issues (heterogeneity and asset limitations) looked at by IoT. Conversation and end 131 frameworks. A greater part of accessible examination papers has reviewed Cloud and IoT-based medical care frameworks independently, zeroing in on engineering, hidden innovation, and undertakings, but deficiency from definite assessment and top to bottom investigation. To fill this exploration hole, this part conveyed a profound and significant survey of the accessible examination papers and introduced a comprehensive vision of the Cloud IoT-based medical services mix parts. The section introduced consistent applications administered by the Cloud IoT stage and thought about the conversation on factors driving Cloud IoT wellbeing joining. The part likewise presents a reasonable building structure for medical care checking framework that considers the scope of perspectives including information assortment, transmission, and handlingincluding cloud capacity. The section presents a utilization case situation that identifies entertainers and informationflows liable for changing sensor information into the continuous transmission to the cloud. Likewise, a short conversation on plancontemplations for medical care design has been given. The work in this part additionally featured security issues influencing IoT layered engineering incorporating weaknesses inborn in the Cloud. These weaknesses could deliver medical care administrations nonfunctional and basic patient data can be mishandled by malicious clients. The part likewise introduced a short conversation on some potential moderation measures. A summed-up conversation on Cloud IoT stages is likewise introduced that targets settling heterogeneity issues between the Cloud and Things. At last, the part closes by recognizing some open exploration issues and difficulties hampering Cloud and IoT-based medical services reception.

III. System Flowchart

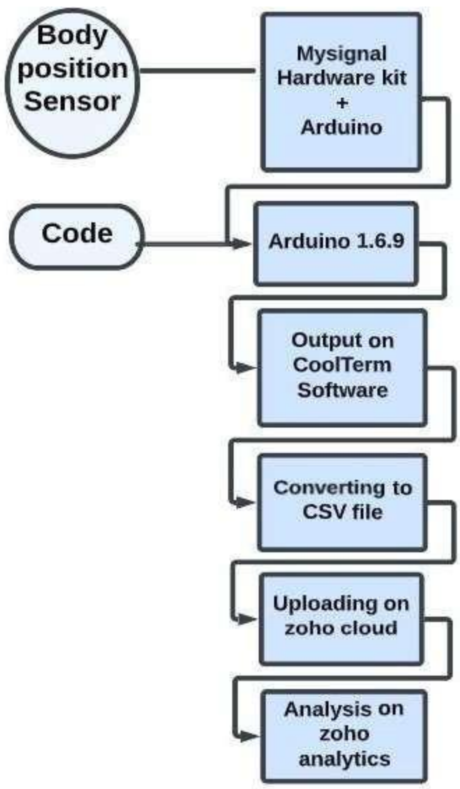

Fig. 1. Flowchart of the proposed model

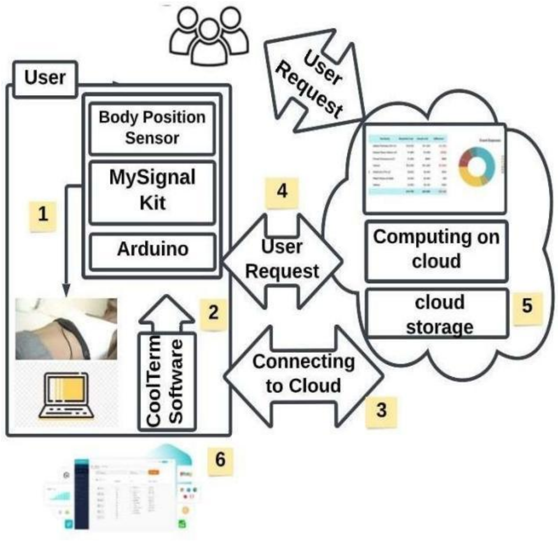

Fig. 2. Workflow of the proposed model

IV. System Design

- MySignals must be placed on top of the Arduino. MySignals can either have an external power supply or can be connected to a laptop. Once we see the green light ensuring active power, we need to connect the body position sensor to the appropriate port where we have several ports toconnect different sensors.
- After downloading, and installing Arduino 1.6.9, [8] we need to add all the necessary libraries to work with.
- Then we have to compile the code and upload that to the Arduino, then we will receive the output to the serial monitor.
- We need to go to Zoho creator [6] and upload a file containing data in .csv format. Then we are supposed to create a web application for which we need to click "OK". Then the data in the file (CSV) will be displayed in table format.
- Now we have to click on SHEET 1, where new data can be added and press submit. Then this added new data will be added to the existing record. This added data can be deleted or modified at any time.
- In Zoho analytics [6] we should upload the CSV file. according to our requirement, we have to choose an option between a graph, pie chart, etc. Then we have to choose our X-axis and Y-axis with respect to our requirements.
- MySignal [7] - The Products are not intended for use in medical diagnosis, cure, mitigation, treatment, guidance, or prevention of disease and neither are they medical devices or healthcare services. Since MySignals Products are not finished goods, End Users are not supposed to buy them.

V. Implementation

A. Hardware Setup

MySignals Hardware Kit will be linked to the Arduino UNO. At most 10 wired sensors can be connected to the MySignals Hardware Kit. The hardware kit will be placedon top of the Arduino board [8].The kit will be connected to the power supply using a cable. The values detected from the sensors can be viewed either on the hardware kit or on the serial monitor.

B. Connecting Sensors

1. Body Position sensor

Here we are connecting the Body Position Sensor [11] to the kit to read the values from the sensor. Body Position Sensor will be worn by the patient as shown in *figure 3* to detect his position. The Body Position Sensor senses five different patient positions (standing/sitting, left and right posture, supine, prone). It detects it by using a triple-axis accelerometer. The data here refers to the body position and its value in the x, y, and z axes. The unit and range of the body position sensor are mentioned in *Table 1* and the body position includes supine, prone, sit or stand, left lateral and right lateral.

Fig. 3. Body Position sensor

Connection: Connect the sensor to the right connector pin marked on the MySignals hardware board. Place the sensor around the chest and add the code to the Arduino.

TABLE I.
Name and Values of Body Position Sensor

Name of the Sensor	*Values*
Body Position	Five different Positions (Supine, prone, Left lateral, Right lateral, Sit or stand)

2. Spirometer

The amount of air breathed and exhaled as well as the total time required for inhalation and exhalation are measured using a spirometer. The data here refers to the time taken for the amount of air blown in and out. A new disposable mouthpiece should be placed in the spirometer for each user. hen press the ON button. The patient should place the spirometer in an upright position in his mouth and cover it tightly. Then the patient should breathe faster. It takes a short while to detect the readings from the spirometer. The unit and range of the Spirometer are given in *Table 2.*

Connection: The patient should place the disposable mouthpiece in his mouth and he should breathe faster. To turn on the spirometer, press the ON button. To read the data from the glucometer, connect the spirometer to MySignals.

TABLE II. MEASURES AND RANGE OF SPIROMETER

Measures	*Range Of Values*
Expiratory Volume	0.01 - 9.99 (L)
Amount of Air Flows	50 - 900 (L/min)

3. Pulse and Oxygen in Blood (SPO2)

Pulse Oximeter is a bluetooth device. It can be connected to the MySignals Hardware kit using the Bluetooth module. BLE112 Blue Giga module is integrated into the hardware board.

A pulse oximeter is used to indicate the pulse rate and oxygen saturation of the blood. The patient should insert his finger into the sensorand press the ON button. It will take a few seconds to recordthe pulse rate and saturation level.

Connection: After inserting your finger into the sensor, pushthe ON button. The blood saturation level and pulse rate aremeasured a short while afterward. Additionally, Table 3 provides the Pulse Oximeter's unit and range.

TABLE III. MEASURES AND RANGE OF PULSE OXIMETER

Measures	*Range Of Value*
Pulse rate	25 - 250 (ppm)
Oxygen level	35 - 100 (%)

4. Glucometer

Glucometer is a device used for determining the approximate concentration of glucose level in the blood. A small drop of blood is placed on the test strip. The meter reads the value and uses it to calculate the blood glucose level. The meter then displays the level in mg/dl or mmol/l. It can be connected to the MySignals Hardware kit using theBluetooth module. BLE112 Blue Giga module is integrated into the hardware board.

Connection: Place a test strip inside the device. Wait until the sign instructs you to put in a blood drop. your fingertip fora price. Put the blood droplet on the strip.

5. Temperature

The temperature depends upon the place and the time of day and the level of activity of the person. Different parts of our body will have different temperatures and the unit and range of the temperature sensor are givenin *Table 4*. The commonly accepted body temperature is 37.0°C (98.6°F).

Connection: Place your sensor and let make a contact with the skin and the metallic part. Stick a small piece of adhesive tape to hold the sensor.

TABLE IV. MEASURES AND RANGE OF TEMPERATURE

Measures	*Range Of Values*
Temperature of the body	0 - 50 (°C)

C. DataCollection

By creating an Arduino program in C++, the data from the sensor may be gathered. Either the serial monitor or the hardware kit will display the data. For data collection, we used the Arduino 1.6.9 version. To receive the data from various sensors, we must first add the libraries, compile the code, and then run it.

D. Conversion of Arduino output to CSV file

To convert the serial monitor output to a CSV file, we used the coolterm software. The output will be displayed on the coolterm software instead of displaying on the Arduino serial monitor. [8] Then the output displayed in the coolterm software will be converted to a CSV file. The various output values will be collected and added to the CSV file and get updated. The generated CSV file will be stored on the cloud.

E. Upload data to the “Zoho”cloud

[6] A CSV file is posted to the cloud using the output from the Arduino serial monitor. The "Zoho" cloud computing platform is used here. We can have a single repository for everything we're working on because of Zoho cloud, which helps us stay more organised. Both easier and more trustworthy. We must first register for a Zoho account for our process. After that, we must use our login information to access the Zoho creator website. When prompted, upload the CSV file. Then it invites us to develop a Web application. Select OK. The information included in the CSV file will then be shown in table format. On clicking sheet 1 on the left column, it allows us to add new data. Once we add new data, we have to click submit to update the data in the web app through the cloud. It allows us to edit or delete the existing data. In the navigation bar, if we click the mobile symbol, it shows how the data will be displayed on android. In addition to that, we can give our e-mail id in the prompted text- field to which we will get a play-store app link. Once we install the app, we can view the real-time data on our phones. It isadvantageous because now we can edit in both the web app and the android app and both will be updated accordingly via the cloud. For this to work, an internet connection is necessaryas we use an online cloud.

F. Analyze the data

In Zoho analytics [6], upload the CSV file. Choose the option among the graph, pie chart, etc. according to your requirement. Then we have to choose our X-axis and Y- axis according to our requirements.

V. RESULTS AND DISCUSSION

Here we have displayed the output we got for each sensor. For hardware setup as shown in figure 4, MySignals has to be placed on top of Arduino. MySignals can have either an external power supply or it can be connected to a laptop.

Once we see the green light ensuring the active power supply, we have to connect the body position sensor to the appropriate port where we have multiple ports for various sensors to connect with.

Fig. 4. Hardware Setup

We must add the necessary libraries to Arduino 1.6.9. Library modules may include Adafruit-GFX-AS,Adafruit-ILI9341-AS,MySignals,MySignals-BLE,aUTouch.Program for for Arduino has been written using these libraries and after running the code the output is then displayed on the serial monitor after the code has been assembled and sent to the Arduino. We'll use the cloud platform to store the data we gathered.

VI. OUTPUT

A. Body Position Sensor

1) *Supine position* –Lying flat on the back

Fig. 5. Supine position

When we get the x, y, and z values as mentioned in Table 5,it indicates a supine position in the body position sensor.

TABLE V. VALUES OF THE SUPINE POSITION

Values of the Supine Position	
Current position	***Supine position***
X	0.56
Y	0.13
Z	-0.88

2) *Prone Position* - Lying flat on the stomach

Fig. 6. Prone position

When we get the x, y, and z values as mentioned in Table 6, it indicates a prone position in the body position sensor.

TABLE VI. VALUES OF PRONE POSITION

Values of the Prone Position	
Current position	***Prone position***
X	-0.50
Y	-0.13
Z	0.88

3) *Left lateral recumbent*

Fig. 7. Left lateral recumbent position

When we obtain the x, y, and z values shown in Table 7, the body position sensor is in a left lateral recumbent posture.

TABLE VII. VALUES OF LEFT LATERAL RECUMBENT POSITION

Values of the Left lateral recumbent Position	
Current position	***Left lateral recumbent***
X	0.00
Y	1.00
Z	0.06

4) *Right lateral recumbent*

Fig. 8. Right Lateral recumbent position

When we get the x, y, and z values as mentioned in Table 8, it indicates a right lateral recumbent position of the body position sensor.

TABLE VIII. VALUES OF RIGHT LATERAL RECUMBENT POSITION

Values of the Right lateral recumbent Position	
Current position	***Right lateral recumbent***
X	0.00
Y	1.00
Z	0.06

5) *Sit or stand position*

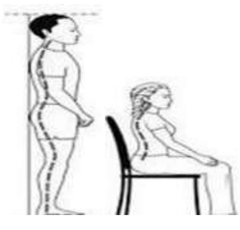

Fig. 9. Stand or Sit Position

When we get the x, y, and z values as mentioned in Table 9, it indicates a sit or stand position in the body position sensor.

TABLE IX. VALUES OF SIT/ STAND POSITION

Values of the Sit/Stand Position	
Current position	***Sit/Stand position***
X	-0.94
Y	-0.06
Z	-0.19

B. Spirometer

The volume of air breathed in and out is measured using a spirometer. Additionally, it counts the overall amount of time spent inhaling and exhaling. The sample value for Peakexpiratory flow as in Table 10.

TABLE X. READINGS OF SPIROMETER

PEF	555 (l/mn)
FEV	5.50 (l)
Date	11/02/2022 11:35

C. Pulse and Oxygen in Blood (SPO2)

The pulse oximeter is used to indicate the pulse rate and oxygen saturation in the blood. Oxygen saturation indicates the amount of O2 carried in the bloodstream. Table 11 shows the oxygen level for the corresponding pulse rate.

TABLE XI. VALUES OF PULSE OXIMETER

SPO2	98%
Pulse	63 bpm

D. Glucometer

A Glucometer is a tool used in medicine to measure blood glucose levels. The meter reads and uses a little drop ofblood on a test strip to determine the blood glucose level.The blood sugar reading from the glucometer will be calculated over a few minutes. The level will then be shown on the meter in mg/dl or mmol/l. BLE is used by this sensor to connect to the MySignals system.

E. Temperature

It is crucial for medical purposes to measure body temperature. The cause is that several disorders are characterized by alterations in body temperature. A sample temperature value that was examined is shown in Table 12.

TABLE XII. VALUE OF TEMPERATURE

Temperature	37.10

VI CONCLUSION

In this paper, we have discussed the process of implementing the MySignal hardware setup and collecting real-time input data using medical sensors.We are storing the data in the cloud platform and doing analyses over the recorded data, such as in body position sensors, which continuously monitor the position of the paralyzed patient and alert the appropriate doctors or authorized persons to take corrective actions once the position of the patient changes.Our future works are to implement a notification system where if any abnormal activities are noticed then the appropriate doctors will get notified.

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