Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 46 No. 2 (2025)

Hospital Automation and Patient Data Acquisition System

Shanmugapriya Subramaniyan [1*], Arjun V [2], Rahul Nair [3], Akshay Girish [4]

[1, 2, 3, 4] *Department of Electrical and Electronics Engineering, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu, India*

Abstract:- In this paper, digitalization of patient data acquisition along with analysis and processing of medical records using vitals collected and interfacing the same with mobile application, database and web app has been explained. A hardware to track the body vitals have been developed, which can communicate to database using MQTT protocol. The method also ensures the transfer of data from the hardware to mobile application, which uses apps script to establish a two-way communication between database and user's mobile application. First the hardware collects the user vital and monitor activities and generate a report from data collected from sensors and processed by ESP8266 via I2C bus. This is backed up to database and further used and displayed in mobile application and web app. Then this database is used as source of data for mobile application, band and web application.

Keywords*: Patient data, mobile application, medical data, Agami Arogya, sensor system, hardware implementation.*

1. Introduction

Technology plays a vital role in the medical field in helping and carving a healthy society. Technologies in the medical field can save many lives, improve the health of people in society and contribute a major role to attain sustainable healthcare through innovative technology, modules and diagnostics, the industry delivers value to patients, healthcare professionals, and healthcare systems and society. The major issue with the health of the patients within the hospital premises is severely affected if the patients are not cared for, studied and treated properly on time and there's a high risk of inflicting a lot of diseases. Hence there is a huge requirement for a solution to watch the patients anytime and anywhere for the medical staff. The availability of hospitals and medical care to help people is not adequate. Using proper technology, the medical field has made discoveries regarding treatments, data collection, symptom and disease research, cure research, and human aiding devices. Technology has made the field of medical care very accessible to people and easier for medical staff.

Introduction of IoT in the recent past has helped the modern era in every means. From transport to communication, the accessibility of data, resources and networking has never been easier with its help.

The Internet of Thing (IoT) is a worldwide concept of a connected networked set of anyone, anything, anytime, anyplace, any service, and any network and it establishes proper solutions for a huge range of applications and possibilities like many smart cities, security, waste management, traffic congestion, logistics, retail buildings, structural health centres, industrial control, emergency services and health care. The health care system is highlighting on the monitoring, storing, analysing and measurement various biological parameters and vitals of patient's body like rate of heart beat, oxygen saturation level in blood stream and body temperature using modern technology like a web server and a mobile or android or other operating system application where medical staff can constantly monitor the patient's condition on his smartphone using an Android application, the patient history will be stored on the database and medical staff can access the information remotely whenever needed from anywhere and need not be physically present. In this way, it simultaneously improves the quality of treatment through constant attention and lowers the cost of healthcare by eliminating the need for a medical staff to actively engage in data storage measuring and analysis.[1]

With the Electronic Health Record manual calculating, noting and writing mistakes are drastically declining. Recent studies and data have proven that using electronic health records has reduced manual nursing mistakes as well as improved patient treatment. Our people in society have improved as individuals over the years and have been introduced to electronic health records which have greatly improved our health care system. The project aims to analyse the potential of mobile computing, medical sensors and communication technologies for healthcare. The study deals with the health issues of patients within the hospital premises which are seriously affected if they are not treated on time and are at high risk of contracting a lot of infectious diseases. Hence there is a need for an answer for doctors from any place to see the patients at work or remotely. The people are suffering from different kinds of chronic and non-chronic diseases at a rate directly proportional to the increase in population. Thus, this project aims to accumulate admitted patient's health details, vitals, medical requirements, physical health details under a single display unit which will be remotely accessible to medical staff. The net flow must be maintained so that the patient's heart rate, blood pressure and oxygen levels in the blood run the risk of falling below the threshold level. The evaluation received from the patients is sent to the centralizer controller which is connected to the cloud. It is updated from time to time to avoid loss of report. With implementation of smart sensors, desk monitors and patient health monitoring devices the project aims to automate the monitoring of patients, provide constant care to patients and assist & support medical staff with patient vitals. In the context of this research project, we are addressing the issue of health of those patients within the hospital who are seriously affected if in any case they are not treated appropriately in time and are at high risk of such condition, where the patient is afflicted many diseases. Additionally, since current oxygen monitoring equipment does not have facilitiessuch as remote or mobile access through storage capacity, aid and support. With this project we introduce mobile application to do all the above mentioned.[2]

The aim of the paper is to research the possibilities of mobile computing, medical sensors and wireless communication technologies for healthcare. Additionally, it provides data storage facility and remote access of patient details to medical staff.

2. Patient Data Acquisition System

2.1. Need For Data Acquisition System

Today the technology in health care centres lack wireless data transfer, storage to patient vital details and remote accessibility. This is due to the difficulty of achieving the operational compatibility between telecommunication, IoT (Internet of Things) networking and services and all the sensor data accumulating techniques used, device standards and the communicating protocols. This project thus fulfills the need of hardware to monitor patient body vitals (like SpO2, heart rate, calorie burned, body temperature, distance walked and cardiac output) and establishes a database to store all the vitals, medical history of patient, and entire medical data and prescriptions. It is updated periodically to avoid loss of reports. With implementation of smart sensors, desk monitors and patient health monitoring devices the project aims to automate the monitoring of patients, provide constant care to patients and assist & support medical staff with patient vitals. This acquired data is displayed in a mobile application in the form of an account, which can be shared to a doctor using dynamic generated ID or QR code. The medical staff can hence go paperless and get access to the entire medical history of the patient effortlessly. Also, the application (of medical staff) has the option to add a new prescription which will automatically be added to the patient's database.[3]

2.2. Principle of Patient Data Acquisition System

Data Acquisition (DAQ) system is used to process real world signals. We use it here to perform tasks like conversion of data, storage of data, transmission of data and processing of data. The patient data acquisition system used in this project can summarize and store data for the diagnosis of operation and record purpose and is flexible for any future requirement.[4]

2.2.1. Hardware

The wearable tracker constantly detects body movements on a 3-axis accelerometer. Data is recorded every time it is worn out and updated, enabling the tracker to track whether a person is moving forward, running fast, or

standing still. All this data is stored in the tracker for further processing. Processing occurs when data is transferred to software. Data related to the tracked data is sent to a smartphone or laptop computer via google sheets. Since the person has already shared personal information with the software, the collected data is processed through a personal algorithm. This makes it possible for the software to detect what various recorded movements mean. It divides movement into different functions and generates additional information based on these data. These are usually stored under different headings in the google sheets. When a person tapes an app or website a wide range of information is available from processed, readable data. The app allows a person to know how many steps have been taken, at what speed, individual speed, and the number of calories that may have been burned. The app allows a person to share information in a friendly way.[5]

2.2.2. Mobile Application

The mobile application is built for android devices only and has two different built models - one is dedicated and designed for patients and other supports medical staff. The application empowers digital and remote communication between doctor and patient, establishing a paperless working environment in hospitals. It has data Storage capacity per user (both patient and doctor) and is fault tolerant. Real time monitoring, storing and display of body vitals of the user. Also supports sharing of data to doctors. The application is built with a user-friendly GUI with trouble-free and undemanding login and sign-up procedure. Application communicates with the hardware build and has ability to store and display body vitals. Extended storage capacity of one month for body vitals.[6]

3. Digitalization of Medical Data

Current technology doesn't involve digital transmission of data between patient and medical staff. Conventional method is continued in practice, that is to use pen and paper for all details, vitals, prescription etc. But with digitalization one can experience stream less flow to data effortlessly with the medical staff. The key to make this happen is a strong and powerful database. Secondly, it requires a user- friendly application, easy to use and understand. Then to make body vital monitoring possible, digital factors must work hand in hand with hardware that monitors, Analise and communicates with the database and application.[7]

The hardware (band) here as a solution for monitoring are generally effective, however while implementing them it requires a key criterion of forming an idea with which the system can be built with the help of programming and other aspects.

Here the block diagram is made as the first aspect of the band to provide a path to achieve the effective result of a body vital monitoring band with ability to communicate with the application and to publish data to the database. The critical issue with databases is that the storage either must be locally in the user's device or should have support via cloud server. Using the user's local storage would end up consuming an enormous amount of space from the device and on the other hand servers are too costly. Thereby, this project uses google spreadsheet as its database. Once published to the database the application shows the data to the user. Now the challenge here is not every patient can afford a smartphone. Therefore, the application (of medical staff) can scan the QR code and get all the medical data. Hence the patient does not necessarily need to have a smartphone, rather just having an account is sufficient. For medical staff only relying on one mobile application would be unprofessional, hence this project consists of a desktop version for the medical staff.[8]

To achieve such a system which has real time human body vital monitoring modules and must be lightweight, comfortable, easy to wear and able to establish communication between database and android application gives rise to an enormous demand of IoT to establish networking and a compact microcontroller. This was achieved using NodeMCU with ESP8266 chipset. The sensors were connected to the microcontroller via I2C bus and data was collected and processed there. Then after securing an internet connection device can send the data to the database. The sensors were connected to the microcontroller via I2C bus and data was collected and processed there. Then after securing an internet connection device can send the data to the database.[9] The block diagram of the same is shown in Figure 1.

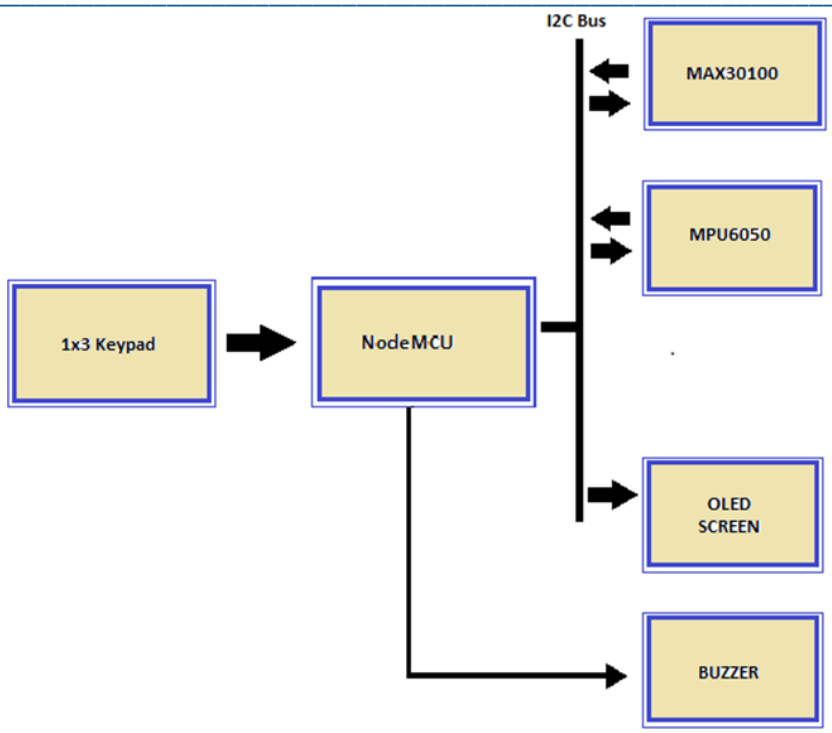


Figure 1. Block Diagram of Band

The implementation of these elements successfully via the mentioned communication protocol is the task that has been taken up on hand to provide a precise transfer of the data with excellent reliability and accuracy of storing of data.[10]

4. Proposed System - Agami Arogya

Agami Arogya is a cluster of software and hardware components working together to establish a paperless and digital transmission of data between medical staff and patient. It comprises of Agami Arogya application (one for patients and other for doctors), Arogya band (hardware) that enables monitoring of body vitals of the user, and the data is transmitted to database and android application where the user can interpret his data and can securely share the medical data with his doctor and then seek for remote consultation. Then finally the desktop version of Agami Arogya enables the doctors to work from PC/laptops at the workplace or remotely. The medical staff have the freedom to choose the software according to their comfort since Agami Arogya is available in both mobile and desktop versions.[11]

4.1 Hardware Architecture

Hardware architecture is an embedded system which runs on NodeMCU ESP8266 at its core. The system consists of various levels of sub-systems such as power system, sensor system, display system, control and IOT system. The power system consists of USB power. Sensor systems consist of MAX30100 and LM35, MAX30100is a heart rate sensor with spo2 detection, LM35 is used to measure body temperature.[12] The smart band has served many main purposes like tracking eligibility or a few notification alerts. However, in today's interconnected world we want more and more reliable wearables, leading to stronger health control features and even bigger displays with longer battery life. While some of these features are common in smartwatches, smart bands tend to have less difficulty here. This means you can view all your alerts, health and fitness warnings and more at your smart band itself, all of which one need not spend extra money to get a full smart band.[13]

4.1.1 Working

The Arogya band constantly detects body movements on a 3-axis accelerometer. Data is recorded every time it is worn out and updated, enabling the tracker to track whether a person is moving forward, running fast, or standing

still. All this data is stored in the tracker for further processing. Processing occurs when data is transferred to software. Data related to the tracked data is sent to a smartphone or laptop computer via google sheets. The app allows a person to know how many steps have been taken, at what speed, individual speed, and the number of calories that may have been burned. The app allows a person to share information in a friendly way.[14]

NodeMCU uses a basic polling system which waits for user input, The system boots to the time screen. In time screen various multiple tasks happen where activity of the user is monitored, time fetching, idle alert checking and medicine alert checking. In heart screen heart rate, Sp02 and temperature of person is measured and published to the server.[15] Every screen is connected in round robin fashion so that bidirectional access to the screen is enabled. Screen 1 fetches time from NTP timer and updates the screen with the current time after that the library keeps internal tracking of the time, so that even after disconnecting Wi-Fi the band will continue to show exact time. screen-1 also check person activity for after 2 seconds and recognize the activity. Screen 2 reads MAX30100 and LM35 to measure Spo2, heart rate and human body temperature and then publishes this data to the server via MQTT protocol. The data read from the sensor is then published to the screen via I2C protocol. Screen 3 reads MPU6050 and updates the user activity using a machine learning classifier, the classifier used is random forest classifier.[16]

4.1.2 Circuit Diagram

See Figure 2.

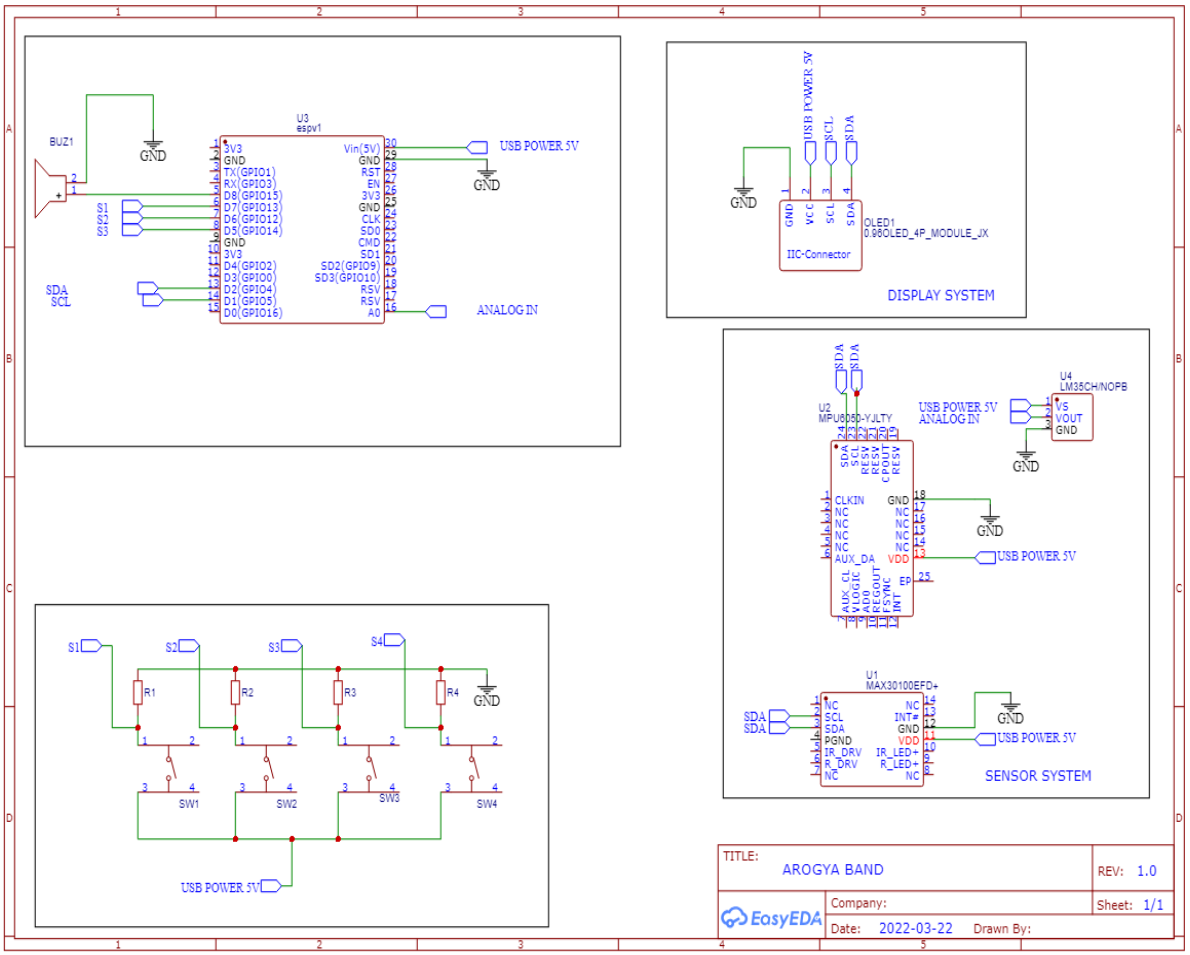


Figure 2 Circuit Diagram of Band

5. Control and Sensor System

Sensor structures for calculating the life of the affected person mainly include the MAX30100 and LM35.

5.1 MAX30100

The MAX30100 is an incorporated pulse oximetry and coronary heart charge display sensor solution. It combines LEDs, photodetectors, optimized optics and low-noise analog sine charge processing to detect pulse oximetry and coronary heart-signals. The MAX30100 operates from 1.8V and 3.3V power materials and can be operated with negligible standby current via a software program, allowing the power delivery to remain related at any time. The MAX30100 is saved in a personal enclosure.[17]

The enclosure plays a critical role to capture the data, the enclosure holds the finger firm which reduces the error in measurement. Nodemcu communicates with the MAX30100 with I2C protocol, which is a serial communication protocol with MAX30100 as slave. In this prototype we are using VIN, SCL, SDA, GND pin, VIN and GND are used to power the module SDA and SCL are used for communication with the module. In this prototype we are using VIN, SCL, SDA, GND pin, VIN and GND are used to power the module, SDA and SCL are used for communication with the module.[18]

5.2 LM35

Temperature can be calculated by the output voltage from the analog input given, the voltage is measured against the adcs of Arduino to get temperature (Figures 3 and 4).

V_{OUT} = 10 mv/°C × T

where

- V_{OUT} is the LM35 output voltage
- T is the temperature in °C

Figure 3 V_{out} formula

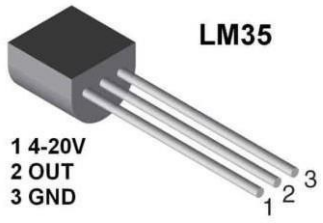


Figure 4 LM35

That is, avoid short-circuiting the output. By connecting a fixed resistor between the adjustment pin and output, the LM117 and LM317-N can be also used as precision current regulators. Supplies with electronic shutdown can be achieved by clamping adjustment terminal to ground, which programs the output to 1.25 V.

5.3 MPU6050

The MPU6050 sensor module is a complete tool to track 6-axis movements. It contains a 3-axis gyroscope, 3-axis accelerometer and digital motion processor in a small pocket. In addition, it has the additional function of an on-chip temperature sensor. With the I2C bus interface to talk to the microcontrollers, the data from the mpu6050 is collected directly from the buffer which is transferred to the classifier. The separator uses a machine that receives translation information to classify the work into categories.

5.4 Microcontroller

NodeMCU ESP8266 Serial WIFI Transceiver Module is the bridge between the server and the standalone embedded system. The data which is fetched from the sensor is processed, ESP then takes this data and publishes it to a specific topic in which the receiver is subscribed. The protocol used to communicate between server and target is MQTT protocol.[19]

Control system at its core is also NodeMCU ESP8266 which manages the data incoming from the sensor, and it processes the raw data from the sensor. Nodemcu updates the display system via I2C protocol.

5.5 Display System

Display system consists of an OLED 1.3 inch. OLED displays various system screens and updates the user about the states. NodeMCU runs on Arduino framework. There are few screens.

- Displaying time and updating background activity.
- Reads MAX30100 and LM35.

- Reads MPU6050 and updates activity.
- Screen used to set up band settings. AROGYA BAND ALERT SCREEN

Band checks for background activity in the Time screen, if it finds idle activity for 30 min it will make buzz sound and show notification to the user. Band check for medicine alerts from the database and update the user on time. Morning medicine alert happens at 8AM, afternoon alert at 1PM and night at 8PM.

5.6 Machine Learning Classifier

The hardware uses machine learning to understand various activities such as idle, standing, handwave, sleep wave and walking activity. The sample model data which is collected from mpu6050 is given to the classifier and trained, later the trained model is implemented in the hardware as a C file. Random forest is the classifier used to detect the pattern.

5.6.1 Excel Pattern for Various Activity

The Graph of various activities is plotted with respect to time, acceleration of x, y, z axis and angle of displacement in x, y, z with respect to time is plotted. The graph shows specific patterns for every activity which then can be used by an ML classifier to identify the activity based on the graph (Figures 5-7).

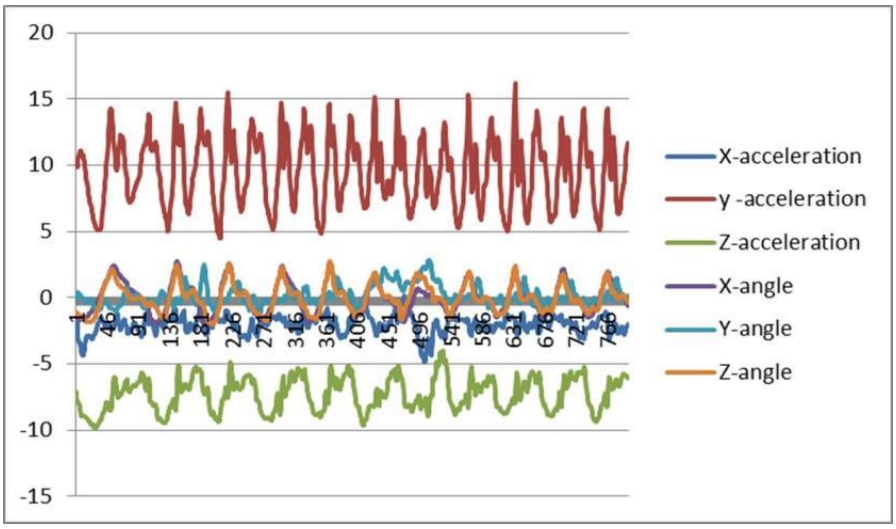


Figure 5 Walking Plot

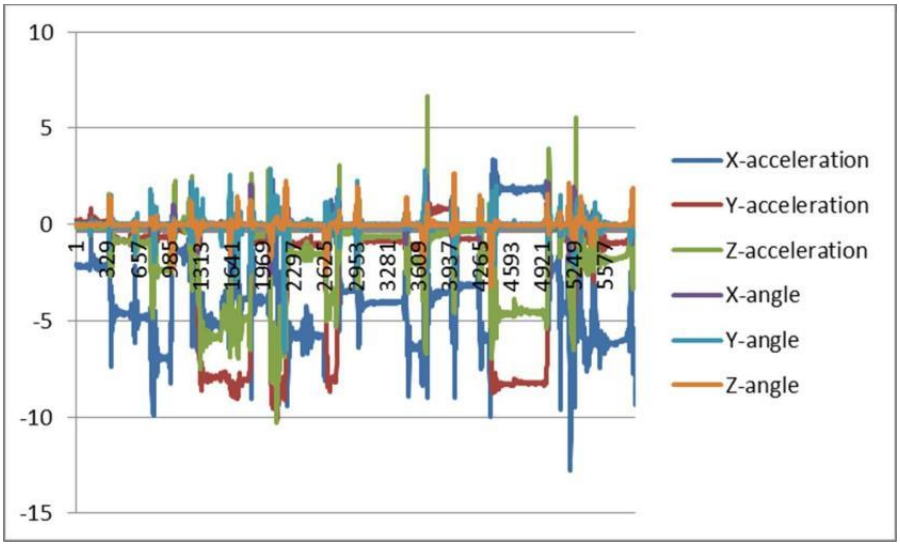


Figure 6 Idle Plot

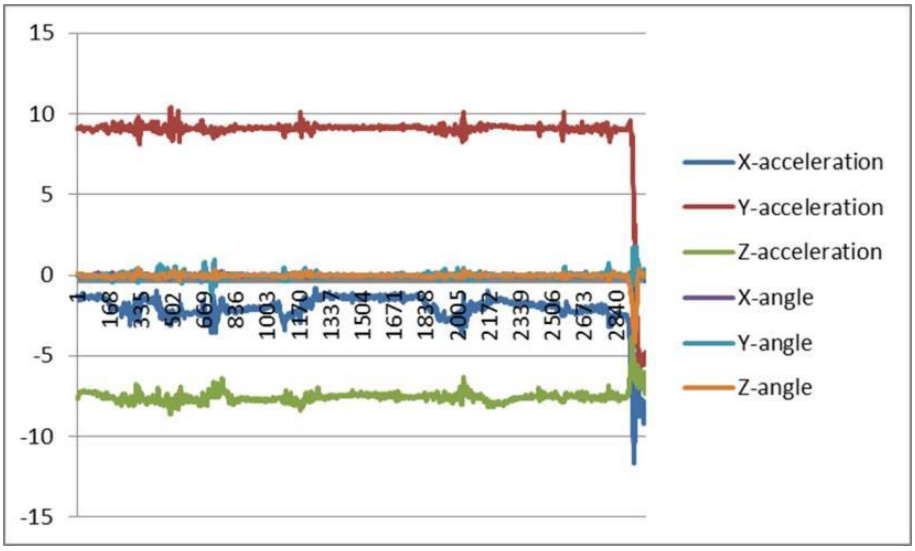


Figure 7 Standing Plot

5.7 Model Recording

NodeMCU relates to an SD card to read data from MPU6050, a sample of 1000 data of x, y, z axis acceleration and angle is measured real-time and then saved as a csv file, then this csv file is fed to the ML classifier.

5.8 Plotter / Graph

Arduino IDE comes with a serial plotter integrated with the following graph sorted using Arduino serial plotter (x -axis no of sample taken). The graph shows the change in rhythm change at work level; The x-axis shows the number of samples taken in the y-axis showing the rate of heartbeat. The graph shows the change in Sp02 of the change in activity level. The x-axis shows the number of samples taken and the y axis indicates the heartbeat. In the case of our computer system the loops are almost rented for 1 second (Figure 8).

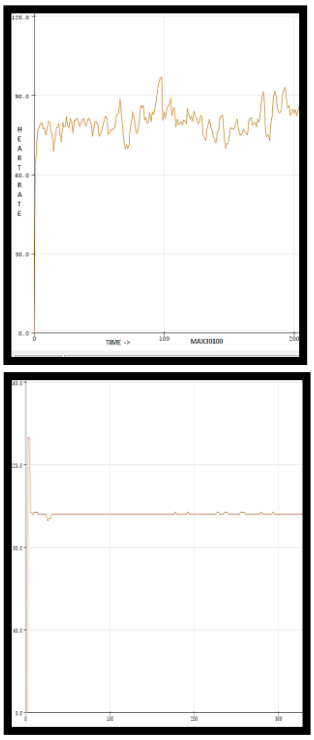


Figure 8 Heart rate vs time (top), Sp02 change with time (bottom)

6. Mobile Application

The mobile application is built using Kodular community. The application supports all SDKs and Android above 4.1 Jelly Bean to latest Android 11. Kodular formerly known as Makeroid is an open-source online suite for development of mobile application. It has an amazing innovative and user-friendly component and block design which provides a simple and free drag-and-drop Android app creator.

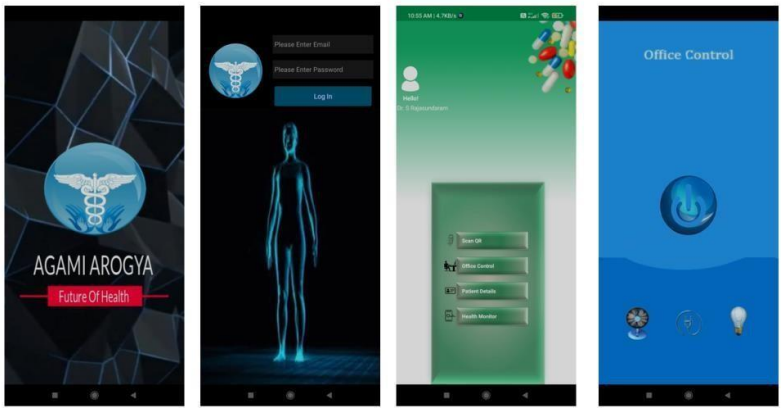
Kodular provides an unbound online suite for development of mobile applications. It's popular for the easy online drag-and-drop block coding environment for Android app creators, on which everyone can create any kind of mobile application. The mobile application introduces innovative replacements for the long queues in hospitals for registration, and the need for pen and paper methods to keep track of medical records, prescriptions and data of patients. Here through this application, we introduce digital processing and cloud storage for both medical staff and patients. Registration in the administrative office of hospital, consulting, and safe data storing is introduced via the android application supporting complete digitalization of hospital needs of patients and medical staff. Through this project we introduce two mobile applications, one for the patients and other for the medical staff. The application for medical staff requires a specific User Id and password, linked with the hospital, which will verify the authenticity of the user (doctor) and will allow access to the database only after verification. The patient can download and create his/her new account in the application and after which the user (patient) will be allocated with a random generated precise seven-digit number which can be used as patient Id for future reference. Patient is also provided with a secured dynamic generated QR code which the doctor can scan to access the medical history of that patient. With the help of this application, both doctors and patients can digitize their hospital related needs with secure server communication and protocol. Also, the application helps to reduce fraud cases & fake medical reports/certificate.

The patient application also has the feature to establish communication to the hardware (Fitbit band) of the project which constantly provides the patient with the following data: Steps Covered, Minutes Passed, Calories Burned, Total Distance walked. Medical vitals include Heart Rate, Cardiac Output, Body temperature and SpO2 (oxygen saturation)**.** The application also allows the user to set daily goals, where the user can decide the number of steps he/she plans to cover on that day.

7. Doctor's Mobile Application

The Agami Arogya (for doctor) application first will verify the user (doctors) then displays the option to scan the QR code of the patient. Once scanned the doctor will have access to the patient's medical record. Here after reading required medical

documents or records of the patient the doctor can add the current symptoms, prescription and medications, which will be added to the patient's database. After adding the required medication, the medical staff also has an option to edit the prescription if required. The application also has an added feature to automate and control the electrical gadgets present in his/her office through the app. It provides the user a safe passage to control all connected electrical gadgets remotely from mobile applications. Hence the application also helps in achieving smart energy management and automation of electric gadget via remote controlling option (Figure 9).



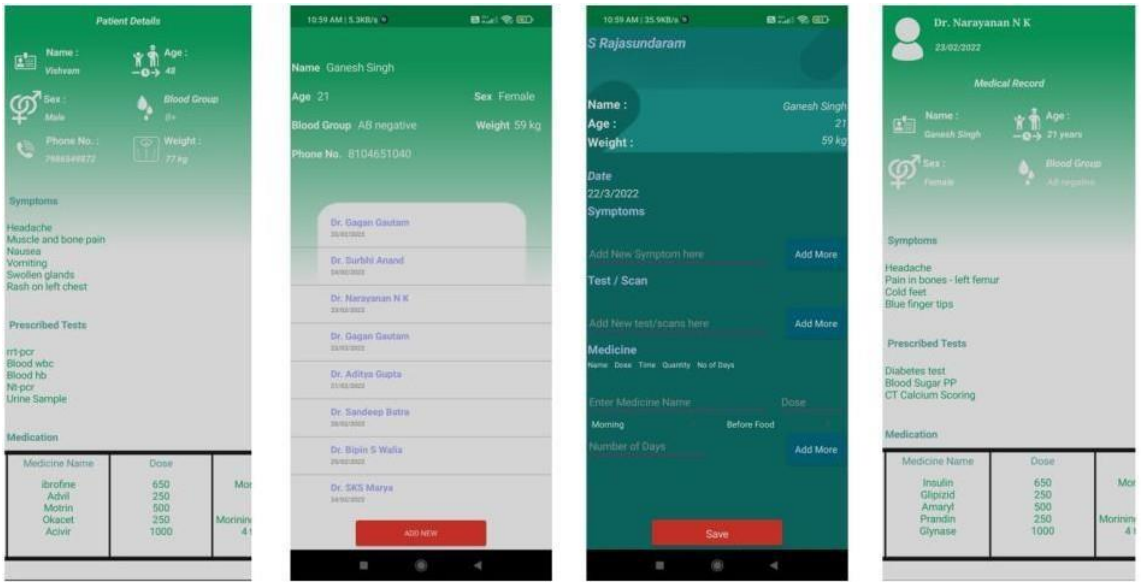


Figure 9 Doctor's Application

8. Patient's Application

The patient application starts with a login page where the user can register himself/herself and have access to the database to store the medical history / prescription. Then the user gets an option to display his unique QR code. This QR code is dynamically generated which is used by doctors to establish communication with the server and database to access the medical history / prescription and to add the present prescription and medication. The application also has an option to

display the body vitals of the user from the band in the application. There are two options to view the vitals. Primarily it displays current reading from the band and the second option is where the user can view recorded data stored in the database. The vitals are stored for a period of one month. It is a user friendly and interactive interface. The user can view heart rate, SpO2, Cardiac output, body temperature. Other values displayed are total step count, distance walked, and calorie burned. User can also set target steps to achieve per day and track the record. The application is the innovative method to digitalize the medical history and records. The medical history's screen primarily contains a list of names of the doctor with the date that was visited as subtitle. One can select any doctor's name to view the prescription and medication which was prescribed by that doctor. This screen contains symptoms, prescribed tests and medication. The medication block along with name of medicine it also contains dose, time of intake and before/after food.

9. Working of the Application

9.1. Communication with database (spreadsheet)

The app can establish connection with the database using Google app script. Google Apps Script is a very fast application development platform that makes it fast and easy to create business, professional or personal applications that easily integrate with Google Workspace, any social platform, various other Android applications, and other open platforms without additional plugins. can be integrated (Figure 10).

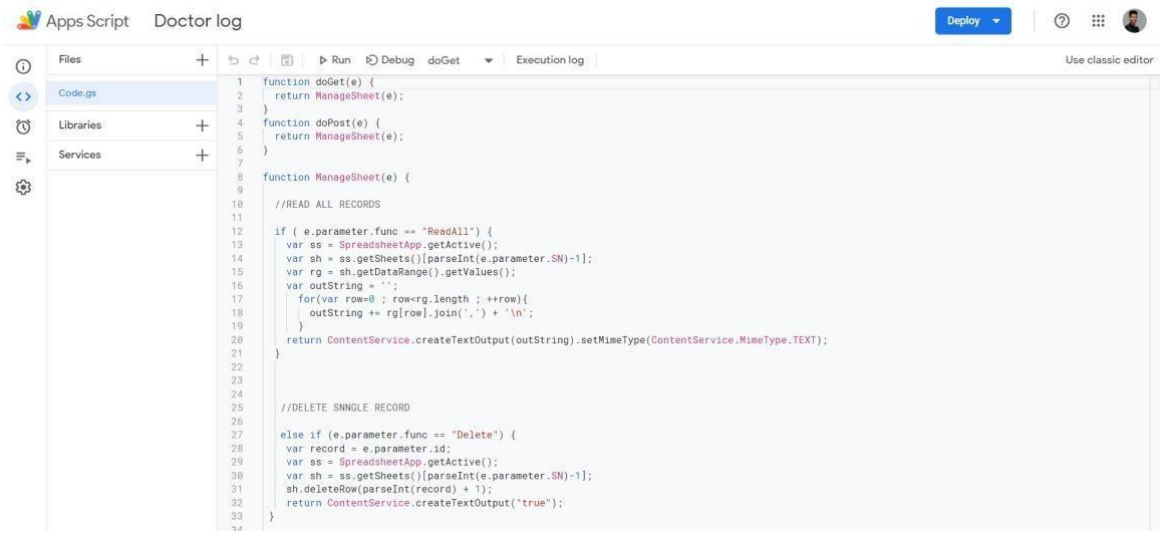


Figure 10. Google apps script

9.2. Communication with hardware

The communication is established using hive MQ server and extension in android application. We secure the connection using MQTT protocol and the broker connects the subscriber and publisher via port 1883. For the history of the band, we again depend on google apps script to fetch data stored in the database. This is done by the spreadsheet V3 in the android application which establishes a communication with the database and the application.

10. Desktop Software

The desktop version for the application Agami Arogya is a wider screen visual of patient details for the specific use of doctors. In this version doctors will be provided with a username and password through which a doctor could login into the application and after that can enter a patient's identification number to collect and display patient history and can also write new prescriptions for the patient.

10.1. Features Of Desktop Version (For Doctors)

The reason for creating a desktop version for the mobile application that provides facilities is mainly for a wider screen and so that doctors could use this application in their allotted rooms in hospitals. This application helps get rid of all the usage of papers while showing a doctor's previous medical history and while writing a prescription. Using this application, a patient doesn't have to carry a full file of medical history every time they have to visit a hospital by making it accessible to the doctor through the desktop, and a doctor doesn't have to write all the prescription details to the patient but can directly do the above through a desktop.

10.2. Compatibility With OS Software

The application provided can be used with any OS software and does not give any restrictions as to which software supports the application, a doctor could use this application if the system is containing a web browser.

10.3. Installation Of Application

This desktop version need not be downloaded or installed to be used; it uses links which provide access to the application. The desktop version was made in Apps Script-Web App application.

10.4. Web Application

Web apps are Android apps that a person can create using a website address (URL). When a user opens a web app on their device, the URL of the app opens in the Chrome browser. A web app is not required to be downloaded but can take the user to the browser using the link provided.

10.5. Web Application for Doctors

The web application is desktop version of the application for the doctors. All features in application are also possible in this desktop version. The web application starts with welcome page, where the doctor is taken to once the application is opened the page contains the logo of doctorate, the name of application and two buttons. When the user clicks this button, they are redirected to the page where the doctor can search for a patient's previous medical history by searching using the unique identification number provided to the patient in the mobile application of Agami Arogya. The doctor can also write a new prescription to the patient.

When the user clicks this button, they are redirected to the page where the doctor has to login with username provided to the doctor through the hospital for the desktop version and patient unique identification number as the password and can then write a new prescription for the patient in which it includes symptoms, medicines, doses, period of taking the medicine, etc. There is also an option for writing prescriptions in the history pages too. If the user clicks the patient history button in the welcome page, then they are redirected to this page where the user's username and password provided by hospital management is to be entered and can login to the application.

Once the user enters valid username and password and logins they are redirected to a page where the name of the user is displayed on top, below this a input area can be seen where the user can enter the unique identification number of a patient that the patient can share with the doctor to search and view their previous medical history like the previous doctors the patient has visited on which date, the symptoms shown by patient and medicines prescribed by them , the doses of medicine and period of medicine being taken etc. After the user enters the correct patient unique identification number they are redirected to a page where at top there is a button for the user to log out of the application and will take the user to the login page. Below the log out button there is a button Back which when clicked will take the user to the page for entering a patient unique identification number. Below this blue button details of the patient lies the patient unique identification number, name, age, gender, blood group, weight, phone number of the patient is displayed. When the user clicks the button- History they are redirected to a page where at the top there is a table displayed in which the patient's previously consulted doctors name and the date of consultation is displayed. Below the table there is an input area provided where the user must enter any number provided in the top row of the table shown above, if the user were to enter 1 then the prescription provided by the doctor below the number will be displayed (Figure 11).

Figure 11 Full history of selected doctor with date page

If the user wishes to add a new prescription for the patient, then they can click the New Prescription button provided which will navigate them to the prescription page, where the user (doctor) can write a prescription to the patient. When the user clicks the New Prescription button, they are redirected to a login page where the page contains two input boxes for the user to enter username used for logging into the application and the unique identification number of patient as the password to continue. When the user has successfully logged in using username and patient identification number, they are redirected to the prescription page where the user(doctor) can write a new prescription for the patient. At the top right corner, the present date is shown. Below this Symptoms shown and tests to be taken by the patient can be entered. A total of 5 symptoms and 5 tests can be

prescribed. Below medicines to be taken, the dosage of the medicine, period of the medicine to be taken and at what time the medicine should be taken, after or before food can be entered. A total of 5 medicines can be entered. At the bottom there is a Submit button that when clicked will save this prescription to the patient database.

10.6. Coding of the Web Application using Apps Script

The back end for the web application is done using App-Script which uses the JavaScript language. JavaScript is a very user-friendly language, and JS is the most used coding language when it comes to web application development alongside HTML, CSS and Node.js. JavaScript can be used to add more HTML pages to the application. HTML and CSS is used for creating and customizing the web application pages to be more appealing. Customizing the application is commonly done using CSS in which they provide a variety of products such as forms, styles for buttons, drop-down boxes and a lot more.

11. Web Application (For Administrative Office)

The web application shown here is to be used by a hospital management to store a doctor's personal information like name, date of birth, phone number, email id, educational qualification, specialization, department, username and password to be used by doctor to login into desktop application for Agami Arogya, modify this information when needed and to add daily patient visiting records by searching whether a patient has visited the hospital before or is a new patient to the hospital with the help of the unique patient identification number provided to patient in Agami Arogya mobile-application. It also fulfils the need of the hospital management to keep track of details of patients that visit the hospital per day and store their data in the database. If a patient has previous visiting history to the hospital, then the date at which he/she visited, and the respective department consulted will be shown and can enter a new entry. If not, then the patient is registered newly with the unique identification number. It is used by hospital management to store a doctor's personal information.

The welcome page contains the logo of Agami Arogya and three buttons. The function of these three buttons is explained below in detail. By clicking on each button, the button instructs the page to roll over to the next set of pages as coded in background using JavaScript. Hence each button is a portal to the next set of pages which performs the specific task assigned by the user. Here the user being the office staff of the medical field/hospital. Only these verified officers will have the authority and access to this webapp that allows them to create doctor accounts, edit details of medical staff and/or enrol patients to the hospital to keep their entry record safe. When this button is clicked, in the code a command is passed through JavaScript and the user is taken to a page where new doctor information can be entered. The information that would be asked are doctor name, date of birth, phone number, email id, educational qualification (drop-down menu), specialization (drop-down menu) and department. When the user clicks this button, the same as the previous button a command is passed, and they are directed to a page where they can get doctor information by entering doctor personnel phone number. Here the information can be altered as well although some important details that are not to be changed and should be kept the same as doctor name, age, educational qualification and specialization can't be changed. Any other information (like phone number, email id etc.) can be changed. When this button is clicked, the user is redirected to a page where the user can check whether a patient has visited the hospital before with the use of Patient Unique Identification Number, if they have the user can view patient previous visit details like the dates and respective departments visited. If the patient is new, then the user can create a new record of the user with the unique identification number. When the user clicks the New Doctor button, they are redirected to a page where the user must enter doctor personal information like doctor name, date of birth, phone number, email id, educational qualification, specialization, department. After this a username and password for doctor login must be entered, password must be re-entered for checking. If details are not entered, then the below popup is shown. When the user clicks the Doctor information button, they are redirected to a page where they must enter the doctor personal phone number. If the phone number is valid the personal information of the doctor like name, date of birth, phone number, email id, educational qualification, specialization, department, username and password used for logging into the desktop application is displayed. Below this the user can make changes to the information of the doctor but not to name, date of birth or educational qualification and specialization. After entering the changes when the user clicks the button Save Changes at the bottom of the page the changes will be saved to the database. When the user clicks

the New Patient button on the welcome page they are redirected to this page where the user must enter the patient's unique identification number. If the patient has visited the hospital before then their previous visit details such as the date of visit and the respective department visited will be displayed and below there will be input boxes for entering date and department. If this is the first time the patient is visiting the user can click the New button. When the user clicks the New button information is asked to enter about the new patient like patient unique identification number then the date and department for visiting can be entered. In the new patient registration page when the user clicks the New button information is asked to enter about the new patient like patient unique identification number then the date and department for visiting can be entered.

12. Hardware Implementation

The main objective of the project is to establish a paperless and complete digital transmission of data between medical staff and patient, hence also supporting remote access of medical data of patients to medical staff. This wireless and paperless technology will be soon implemented soon, thus Agami Arogya (Future of Health) is a prototype to achieve the same. This is due to the difficulty in achieving the operational compatibility and compatibility among telecommunications, IoT (Internet of Things) services and sensor data accumulating technique used, device standards and communicating protocols. Agami Arogya has two components to its architecture. Hardware for collecting patient vitals which then will be sent to the database for further uses. This patient data that is recorded using band can be further used for analysing patient activity and to understand active health. The software side of the project is a combination of Mobile and Desktop application through which doctor and patient get access to the digital world. The doctor can add his diagnosis information to the database through a mobile or desktop application which then can be used by the patient to view his health track record and medicines. This combination of hardware and software completes the need of the future medical system thus Agami Arogya (future health).

13. Innovation in Agami Arogya

i. Digitalization of the healthcare system.

ii. Patient vital monitoring.

iii. Storage facility for patient lifetime health track record.

iv. Easy patient data navigation for doctors.

v. Live patient data monitoring for patients and doctors.

vi. Health alerts for patients.

13.1. Technical Specifications of Agami Band

Table 1 Electrical specification of Agami band

HARDWARE	INPUT VOLTAGE	WORKING CURRENT	COMMUNICATI ON PROTOCOL
MPU6050	2.37 - 3.46 v	3.36 mA	I2C
MAX30100	1.5 - 2.2 v	20mA	12C
OLED 128*64	3.3 - 5 v	490uA - 37mA	I2C
BUZZER	3.3 - 5v	10 - 20mA	NA
NODEMCU ESP8266	4.5 - 10V	200 - 500 mA	NA

13.2. Specifications of Agami Mobile Application

1. Mobile application supports 18278 doctors per patient.
2. Mobile application supports 18278 patients per doctor.

3. QR code support for patient data acquisition and sharing.
4. Easy patient vital monitoring and complete health track record of patient from birth.

13.3. Specifications of Agami Desktop Web Application

1. Simple user interface.
2. Minimum memory footprint as no installation is required.
3. Supports all OS operating systems and any browser.
4. No requirement for a third-party plugin.

14. Test Results

The main objective behind the project was to bring digitization of the healthcare industry, so it becomes easy for patients and doctors to communicate and to maintain patient track record from birth. This project also enhanced the possibility of remote and paperless consultation of doctors via implementation of IOT networking, android application, standalone embedded system and app script in backend. The smartband has served many main purposes like tracking eligibility or a few notification alerts. Hardware integrity was tested in different conditions and had an excellent track record of accuracy. Hardware was able to detect various patient activities such as standing, idle, walking and hand waves; different health alerts such as idle and medicine alert systems were tested. Application part of the project was tested and worked flawlessly, the application was able to store patient data, live patient vital monitor, and health goals for individuals was tested successfully. Desktop version of agami arogya was also able to record and maintain patient data. The user friendliness and the reliability of hardware, application and the cost effectiveness of the project was constantly evaluated based on the facts of adaptation of the digital ecosystem.

15. Conclusion

This project demonstrates the implementation of IEEE standard 802.11 (using either frequency hopping spread spectrum or direct sequence spread spectrum) to implement wireless transmission in the IEEE standard 2.4 GHz band for local area networks. This standard enabled us to make the band more reliable with respect to communication with the database and data transfer. The results from hardware were precise and accurate which were displayed in the android application of the patient. The patient application was also able to share the same to any doctor selected by the user, including the stored medical history from the database. The application of medical staff has a facility to scan the QR code of patient ID and gain access to the entire medical history of the patient. The same application also allows the doctor to control the electrical gadgets in his office premises. The application can also sort the data according to date and displays convenience of the medical staff. On the other hand, we provide an alternative digital solution via desktop web application that supports all browser and operating systems and does not require external plugins or installation. The database supports the hardware, android application and desktop webapp all at once and provides two-way communication with all devices and users. It made all the devices operational for all users with help of google apps script and spreadsheet V3 extension in both smartphones and desktop PC/laptops. This is a true means to digitalize the entire procedure replacing all conventional pen paper methods with modern technology of data sharing, display and storage.

References

[1] Islam SR, Kwak D, Kabir MH, Hossain M, Kwak KS. The internet of things for health care: a comprehensive survey. IEEE access. 2015 Jun 1;3:678-708.
[2] Blake JW, Giuliano KK. Flow accuracy of IV smart pumps outside of patient rooms during COVID-19. AACN Advanced Critical Care. 2020 Dec 15;31(4):357-63.
[3] Krishnan DS, Gupta SC, Choudhury T. An IoT based patient health monitoring system. In2018 international conference on advances in computing and communication engineering (ICACCE) 2018 Jun 22 (pp. 01-07). IEEE.

[4] Hasan MK, Shahjalal M, Chowdhury MZ, Jang YM. Access point selection in hybrid OCC/RF E-health architecture for real-time remote patient monitoring. In2018 International Conference on Information and Communication Technology Convergence (ICTC) 2018 Oct 17 (pp. 716-719). IEEE.

[5] Laxminarayan S, Istepanian RS. UNWIRED E-MED: the next generation of wireless and internet telemedicine systems. IEEE Transactions on Information Technology in Biomedicine. 2000 Sep;4(3):189-93.

[6] Jian Z, Zhanli W, Zhuang M. Temperature measurement system and method based on home gateway. Chinese Patent. 2012 Dec 5;102811185.

[7] Puustjärvi J, Puustjärvi L. Automating remote monitoring and information therapy: An opportunity to practice telemedicine in developing countries. In2011 IST-Africa Conference Proceedings 2011 May 11 (pp. 1-9). IEEE.

[8] Khattak HA, Ruta M, Di Sciascio EE. CoAP-based healthcare sensor networks: A survey. In Proceedings of 2014 11th International Bhurban Conference on Applied Sciences & Technology (IBCAST) Islamabad, Pakistan, 14th-18th January, 2014 2014 Jan 14 (pp. 499-503). IEEE.

[9] Larson EC, Goel M, Boriello G, Heltshe S, Rosenfeld M, Patel SN. SpiroSmart: using a microphone to measure lung function on a mobile phone. In Proceedings of the 2012 ACM Conference on ubiquitous computing 2012 Sep 5 (pp. 280-289).

[10] Jara AJ, Zamora-Izquierdo MA, Skarmeta AF. Interconnection framework for mHealth and remote monitoring based on the internet of things. IEEE Journal on Selected Areas in Communications. 2013 Aug 23;31(9):47-65.

[11] Zhiao Z, Nakdahira Z. Healthcare application based on Internet of Things. In Proc. IEET Int. Confe. on Technology. Application 2013 Nov (pp. 661-662).

[12] Kortoom YK, Fittop N, Ramamoorthy D. Canny matters as construction bricks for application of Internet of Things. IEE-E Interne Networks and Comput.;17.

[13] Achmed Z, Miguel G. Assimilating Wireless Sensing Nets with Cloud& Computing. In 2010 Sixth Int. Confe. Mobi. Ad-hoc Sense. Netks 2010 Oct (pp. 263-266).

[14] Chhabra AS, Choudhury T, Srivastava AV, Aggarwal A. Prediction for big data and IoT in 2017. In2017 International Conference on Infocom Technologies and Unmanned Systems (Trends and Future Directions) (ICTUS) 2017 Dec 18 (pp. 181-187). IEEE.

[15] Maia P, Batista T, Cavalcante E, Baffa A, Delicato FC, Pires PF, Zomaya A. A web platform for interconnecting body sensors and improving health care. Procedia Computer Science. 2014 Jan 1;40:135-42.

[16] Duquennoy S, Grimaud G, Vandewalle JJ. The web of things: interconnecting devices with high usability and performance. In2009 International Conference on Embedded Software and Systems 2009 May 25 (pp. 323-330). IEEE.

[17] de Morais Barroca Filho I, de Aquino Junior GS. IoT-based healthcare applications: a review. In Computational Science and Its Applications–ICCSA 2017: 17th International Conference, Trieste, Italy, July 3-6, 2017, Proceedings, Part VI 17 2017 (pp. 47-62). Springer International Publishing.

[18] Islam SR, Kwak D, Kabir MH, Hossain M, Kwak KS. The internet of things for health care: a comprehensive survey. IEEE access. 2015 Jun 1;3:678-708.

[19] Kulkarni A, Sathe S. Healthcare applications of the Internet of Things: A Review. International Journal of Computer Science and Information Technologies. 2014 May;5(5):6229-32.