

REMOTE PATIENT MONITORING BASED ON IOT

Submitted in partial fulfillment of the requirements for the award of Bachelor
of Technology degree in Biomedical Engineering

by

Chelsea Hannah A (39240012)



**DEPARTMENT OF BIOMEDICAL ENGINEERING SCHOOL OF BIO
AND CHEMICAL**

SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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This is to certify that this Interdisciplinary Project Report is the Bonafide work of Chelsea Hannah A (39240012) who has done the Interdisciplinary project work as an individual who carried out the Interdisciplinary project entitled "REMOTE PATIENT MONITORING BASED ON IOT " under my supervision from January 2022 to May 20

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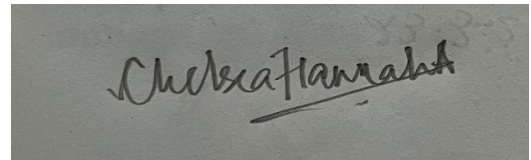
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DECLARATION

I, Chelsea Hannah A hereby declare that the Interdisciplinary Project Report entitled REMOTE PATIENT MONITORING BASED ON IOT done by me under the guidance of A. Sabarivani, at the department of biomedical engineering and is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biomedical Engineering.

DATE: 30/04/2022

PLACE: Chennai

A rectangular box containing a handwritten signature in black ink. The signature appears to read "Chelsea Hannah A" with a horizontal line drawn underneath the name.

SIGNATURE OF THE CANDIDATE

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ABSTRACT

The smart system for patient monitoring provides multiple options which change the path of diagnosis of disease. The system which we introduced reduces the cost of health care and helps the doctors to diagnose faster to take immediate treatment to patients. The modern medicine nowadays is hard and shows a data that there are many more patients than the doctors. The doctors cannot be able to attend the emergencies every time so the smart system for patient monitoring can helps the doctors to diagnose earlier and we can reduce the burden of the doctors. Real time patient monitoring system helps the doctors to prioritize and treat the patients in emergency conditions.

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6.1 Summary

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LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
CPU	Central processing unit
DC	Direct Current
EEPROM	Electrically Erasable Programmable Read-Only Memory
GSM	Global System for Mobile communication
IDE	Integrated Development Environment
IOT	Internet of Things
IR	Infrared Red
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
LED	Light emitting diode
MCU	Microcontroller
MQTT	Message Queuing Telemetry Transport
PIR	Passive Infrared
RAM	Random Access Memory
RFID	Radio Frequency Identification
RTC	Real Time Clock
SMS	Short Message Service

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The smart system for patient monitoring provides multiple options which change the path of diagnosis of disease. The system which we introduced reduces the cost of health care and helps the doctors to diagnose faster to take immediate treatment to patients. The modern medicine nowadays is hard and shows a data that there are many more patients than the doctors. The doctors cannot be able to attend the emergencies every time so the smart system for patient monitoring can help the doctors to diagnose earlier and we can reduce the burden of the doctors. Real time patient monitoring system helps the doctors to prioritize and treat the patients in emergency conditions. Proposed system consists of a microcontroller with built-in Wi-Fi and sensor. This sensor can measure Heart Rate, SpO2 level and Temperature of the patient. These values will send through Wi-Fi module which already built in Microcontroller to cloud database. The Cloud Database credentials are fed in microcontroller firmware. This Cloud database is integrated with Doctor/Care taker Android mobile application. When the vital parameter crosses its threshold, android application will push the notification.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE SURVEY

2.1.1 Literature survey 1

Lakshmi, G. Jaya and Ghonge, Mangesh and Obaid, Ahmed J. (2021) has designed Smart healthcare monitoring includes channels of communication, embedded internal and external sensors, IoT server, and cloud storage. The health parameters activities are done at various levels of refining named application layer, management layer, network layer and layer of device. Different data sensors have been collected by wireless media from nodes. It is saved as an unstructured dataset in the cloud. For security with username and password, a patient database is created. Authorized individuals have access to the cloud in order to monitor cloud sensor data in data log, analogue log, digital input and digital output.

2.1.2 Literature survey 2

Mostafa Haghi Kashania Mona Madanipour Mohammad Nikravana Parvaneh Asgharic Ebrahim Mahdipourb had designed The IoT has a potential to decrease the strain on sanitary systems besides providing tailored health services to improve the quality of life. This study explains the lack of access to medical resources, growth of the elderly population with chronic diseases and their needs for remote monitoring, an increase in medical costs, and the desire for telemedicine in developing countries, make the IoT an interesting subject in healthcare systems

2.1.3 Literature survey 3

Lei Ru, Bin Zhang, Jing Duan, Guo Ru, Ashutosh Sharma, Gaurav Dhiman, Gurjot Singh Gaba, Emad Sami Jaha, Mehedi Masud, "A Detailed Research on Human Health Monitoring System Based on Internet of Things", The human health monitoring system based on the Internet of Things designed in this study has completed collecting the user's blood pressure, pulse, body temperature, heart rate, physiological information, and other vital sign data, which is suggested in practice. After long-term data collection, factors related to a potential risk prediction should be further explored in the future to expand the application of human health monitoring systems based on the Internet of Things. This will provide a scientific and effective basis for preventing and controlling chronic high-risk diseases in the near future.

2.1.4 Literature survey 4

IoT Based Handheld Smart Health Monitoring System for COVID-19 Bennet Praba, Anuj Kakar, Anushri Sharma, The main aim of the project is to provide a prototype which acts as a COVID-19 countermeasure by slowing down the spread. It is not only an informative project but also acts as a diagnostic tool that can be used to curb the virus. The project not only promises a certain degree of accuracy but does so at a fraction of its predecessors.

2.1.5 Literature survey 5

Wearables and mobile technologies in Autism Spectrum Disorder interventions: A systematic literature review Yiannis Koumpouros Theodoros Kafazis The current paper presents a thorough review of the literature on the use of wearables and mobile technologies for ASD-related interventions. It intends to give insights and

guidelines to researchers in order to develop more useful and closer to market products.

2.1.6 Literature survey 6

Diagnostic autism spectrum disorder approaches based on the Internet of Things and Machine Learning. Mehdi Hosseinzadeh, Jalil Koohpayehzadeh, Ahmed Omar Bali, Farnoosh Afshin Rad, Alireza Souri, Ali Mazaherinezhad, Aziz Rezapour & Mahdi Bohlouli The IoT-based systems help to diagnose and improve the patients' lives through applying Deep Learning (DL) and Machine Learning (ML) algorithms. This paper provides a systematic review of the ASD approaches in the context of IoT devices. The main goal of this review is to recognize significant research trends in the field of IoT-based healthcare. A statistical and functional analysis of reviewed ASD approaches is provided based on evaluation metrics such as accuracy and sensitivity.

2.2.7 Literature survey 7

Developing IoT Based Smart Health Monitoring Systems: A Review. Ashikur Rahaman, Md. Milon Islam*, Md. Rashedul Islam, Muhammad Sheikh Sadi, Sheikh Nooruddin had drawbacks . The future developed systems can employ Wi-Fi and IR sensors to overcome the range limitations of Bluetooth devices. Smartphones can be used as a health monitoring system as it makes the interaction between multiple sensors very easy. Various machine learning algorithms can be used to make the systems more accurate.

2.1.8 Literature survey 8

A review on diagnostic autism spectrum disorder approaches based on the Internet of Things and Machine Learning. Mehdi Hosseinzadeh, Jalil Koohpayehzadeh, Ahmed

Omar Bali, Farnoosh Afshin Rad, Alireza Souri, Ali Mazaherinezhad, Aziz Rezapour & Mahdi Bohlouli. This paper provides a systematic review of the ASD approaches in the context of IoT devices. The main goal of this review is to recognize significant research trends in the field of IoT-based healthcare. A statistical and functional analysis of reviewed ASD approaches is provided based on evaluation metrics such as accuracy and sensitivity.

2.1.9 Literature survey 9

A Review of Wearable Internet-of-Things Device for Healthcare Nico Suranthaa Prabadinata Atmajab Davidc Maulana Wicaksonod Procedia Computer Science. In this review, we discuss the utilization of wearable devices in handling the problem in the healthcare aspects, including disease detection, monitoring, and curing also explained how the architecture of wearable devices applied, another aspect of IoT research in healthcare after the sensor and algorithm is compact IoT devices. The device needs to be compact when it is used by the user not to disturb the user. Then so the room for improvements is always required for the future of IoT.

2.1.10 Literature survey 10

A systematic review of IoT in healthcare: Applications, techniques, and trends Mostafa Haghi Kashania Mona Madanipour Mohammad Nikravana Parvaneh Asgharic Ebrahim Mahdipourb Journal of Network and Computer Applications. This study explains the lack of access to medical resources, growth of the elderly population with chronic diseases and their needs for remote monitoring, an increase in medical costs, and the desire for telemedicine in developing countries, make the IoT an interesting subject in healthcare systems. The IoT has a potential to decrease the strain on sanitary systems besides providing tailored health services to improve the quality of life.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

Aim of the project is to build an IOT based patient monitoring system that is able to send the Heart Rate, SpO2, and Temperature values to the cloud database using Arduino IDE.

3.2 SCOPE

Internet of Things (IoT) is the emerging technology, which contains huge amount of smart object and smart devices connected to the internet for communicating with each other. These smart devices are used to collect temperature, blood pressure, sugar level, heartbeat, lung and respiration information etc., which are used to evaluate the health condition of the patient.

The final results are displayed on the android device, on web server and also the results are sent to the user through SMS.

These data results can be stored in data base centre which can be invoked from remote location at any time in an emergency case of patient without delaying the time.

This project may play vital role in saving the patient life at emergency time since "Time is life"

CHAPTER 4

MATERIALS AND METHODS

4.1 BLOCK DIAGRAM

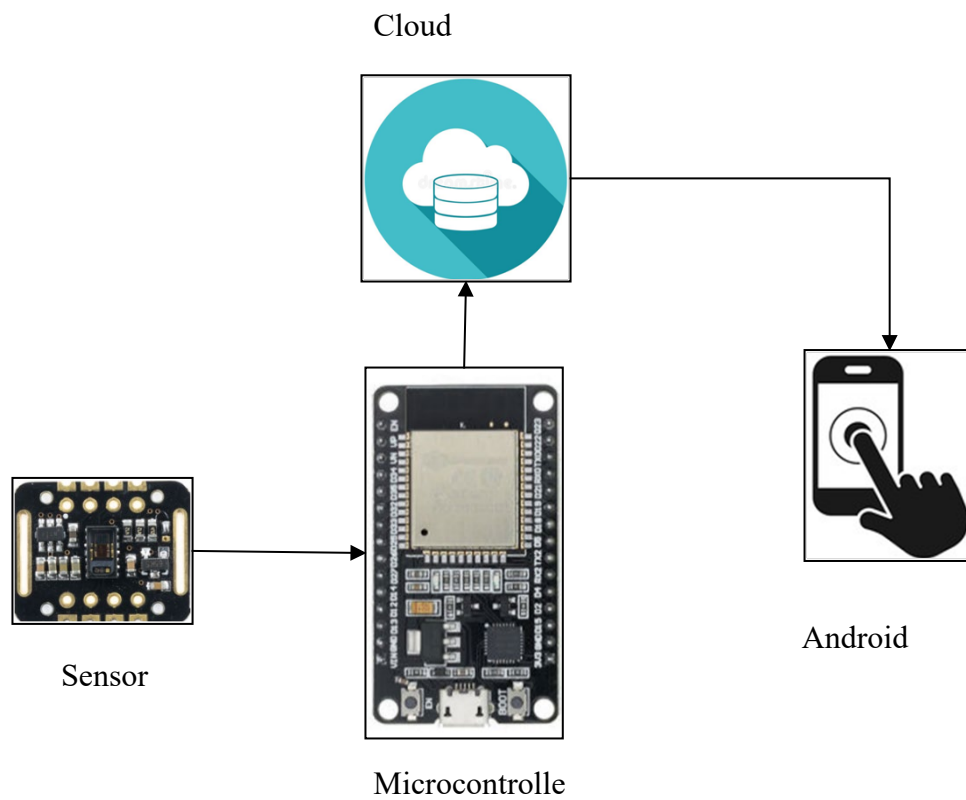


Fig 4.1 Block diagram

4.2 HARDWARE COMPONENTS

4.2.1 Power Supply:

5V DC power supply is used.

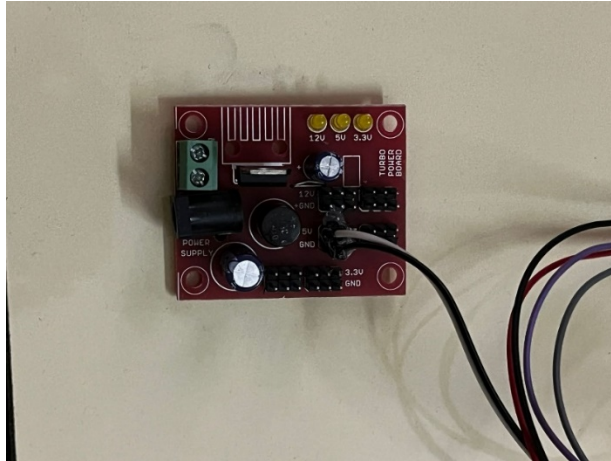


Fig 4.2 power supply

4.2.2 ESP32 Dev board:

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios.

The ESP32 series of chips includes ESP32-D0WDQ6, ESP32-D0WD, ESP32-D2WD, and ESP32-S0WD.

Featured Solutions

4.2.2.1 Ultra-Low-Power Solution:

ESP32 is designed for mobile, wearable electronics, and Internet-of-Things (IoT) applications. It features all the state-of-the-art characteristics of low-power chips, including fine-grained clock gating, multiple power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario, ESP32 is woken up periodically and only when a specified condition is detected.

ESP32 is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP32 integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters, and power management

modules. As such, the entire solution occupies minimal Printed Circuit Board (PCB) area.

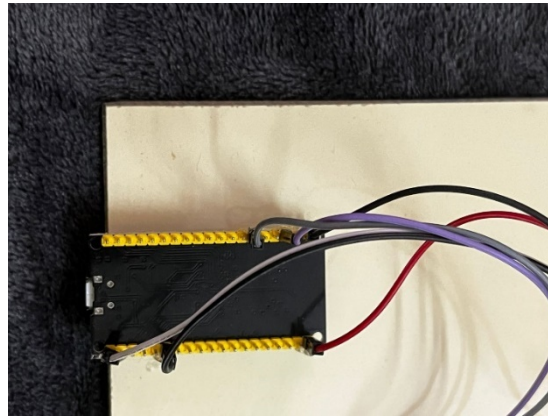


Fig 4.3 ESP32 Dev board

4.2.2.2 Block Diagram:

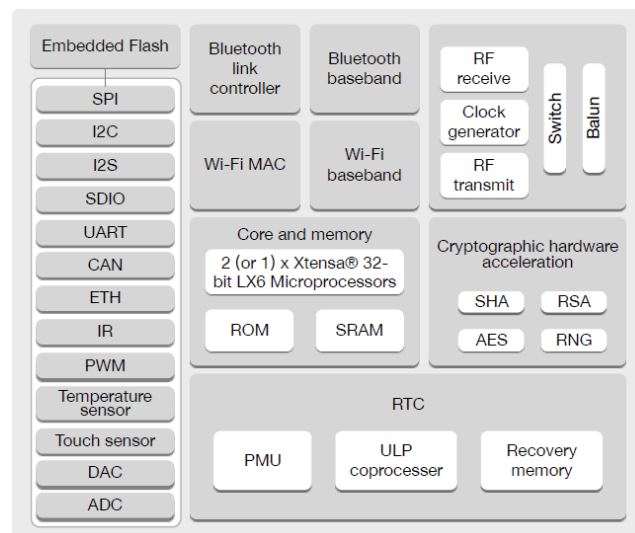


Fig 4.4 Functional Block Diagram

4.2.2.3 Pin Layout

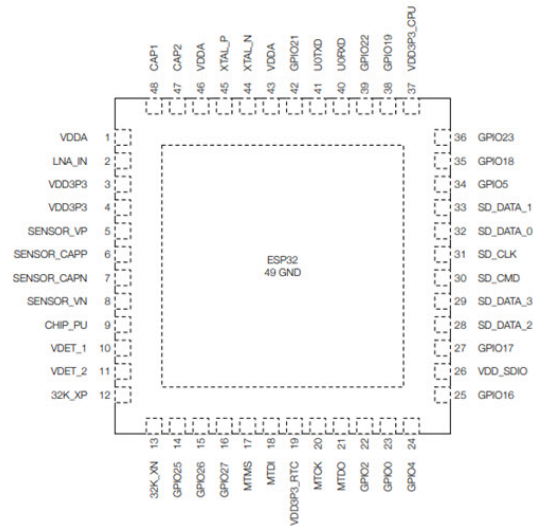


Fig 4.5 pin layout

4.2.3 Heart Rate and Pulse Oximeter (Max30102):

The MAX30102 is an integrated pulse oximeter and heart-rate monitor module. It includes internal LEDs, photo detectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on a single 1.8V power supply and a separate 3.3V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. The module can be shut down through software with zero standby current, allowing the power rails to remain powered at all times.

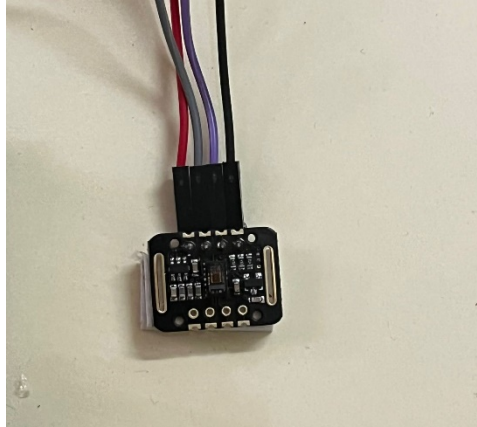


Fig 4.6 Max30102

4.2.3.1 Pin description:

This sensor has 8 pins. 4 pins are more useful:

VCC: Module power supply – 3 to 5 V

GND: Ground

SCL: I2C clock bus

4.2.3.2 System diagram:

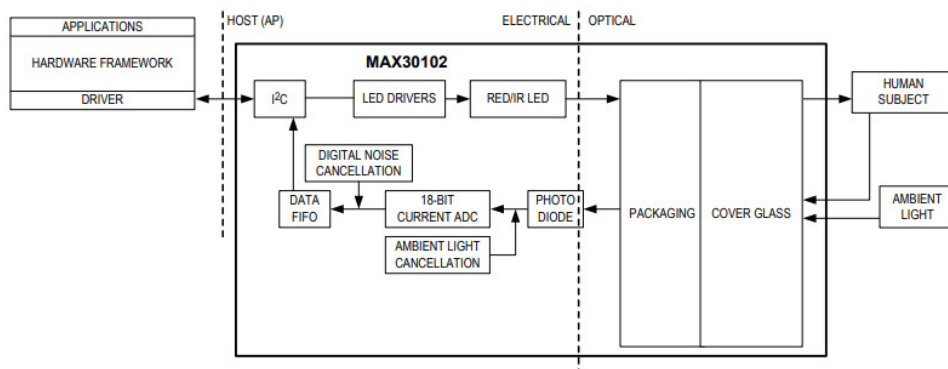


Fig 4.7 System diagram

4.2.3.3 Functional Block Diagram:

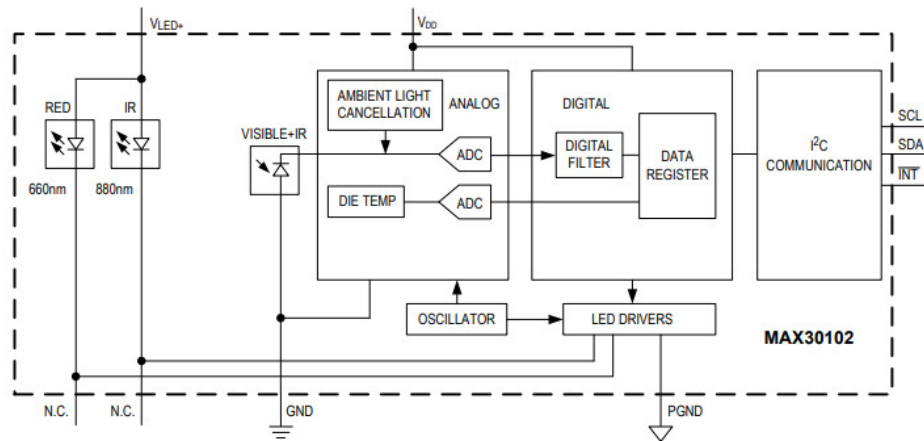


Fig 4.8 Functional block diagram

4.2.3.4 SpO₂ Subsystem:

The SpO₂ subsystem of the MAX30102 contains ambient light cancellation (ALC), a continuous-time sigma-delta ADC, and a proprietary discrete time filter. The ALC has an internal Track/Hold circuit to cancel ambient light and increase the effective dynamic range. The SpO₂ ADC has programmable full-scale ranges from 2 μ A to 16 μ A. The ALC can cancel up to 200 μ A of ambient current.

The internal ADC is a continuous time oversampling sigma-delta converter with 18-bit resolution. The ADC sampling rate is 10.24MHz. The ADC output data rate can be programmed from 50sps (samples per second) to 3200sps.

Temperature Sensor

The MAX30102 has an on-chip temperature sensor for calibrating the temperature dependence of the SpO₂ sub-system. The temperature sensor has an inherent resolution of 0.0625°C. The device output data is relatively insensitive to the wavelength of the IR LED, where the Red LED's wavelength is critical to correct interpretation of the data. A SpO₂ algorithm used with the MAX30102

output signal can compensate for the associated SpO₂ error with ambient temperature changes.

LED Driver

The MAX30102 integrates Red and IR LED drivers to modulate LED pulses for SpO₂ and HR measurements. The LED current can be programmed from 0 to 50mA with proper supply voltage. The LED pulse width can be programmed from 69µs to 411µs to allow the algorithm to optimize SpO₂ and HR accuracy and power consumption based on use cases

4.3 SOFTWARE COMPONENTS

4.3.1 *Arduino Software (IDE)*

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

4.3.2 *Writing Sketches*

Programs written using Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and are saved with the file extension. `.ion`. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

You can return the software to its default setting of selecting its language based on your operating system by selecting **System Default** from the **Editor Language** drop-down. This setting will take effect when you restart the Arduino Software (IDE). Similarly, after changing your operating system's settings, you must restart the Arduino Software (IDE) to update it to the new default language.

4.3.3 Introduction to Firebase:

With a variety of server-side technologies that are on the market today, developers have a tough job of deciding what kind of backend is most suitable for their app.

4.3.3.1 Firebase

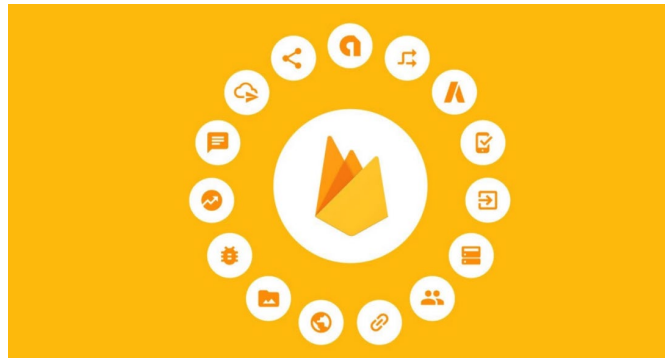


Fig 4.9 Firebase

Firebase is a mobile and web app development platform that provides developers with a plethora of tools and services to help them develop high-quality apps, grow their user base, and earn more profit.

Develop & test your app

- Realtime Database
- Auth

- Test Lab
- Crashlytics
- Cloud Functions
- Firestore
- Cloud Storage
- Performance Monitoring
- Crash Reporting
- Hosting

Grow & Engage your audience

- Firebase Analytics
- Invites
- Cloud Messaging
- Predictions
- AdMob
- Dynamic Links
- Adwords
- Remote Config
- App Indexing

4.3.3.2 Realtime Database

The Firebase Realtime Database is a cloud-hosted NoSQL database that lets you store and sync between your users in realtime.

The Realtime Database is really just one big JSON object that the developers can manage in real-time.

Realtime Database => A Tree of Values

With just a single API, the Firebase database provides your app with both the current value of the data and any updates to that data.



Fig 4.10 Realtime Database

Realtime syncing makes it easy for your users to access their data from any device, be it web or mobile. Realtime Database also helps your users collaborate with one another.

Another amazing benefit of Realtime Database is that it ships with mobile and web SDKs, allowing you to build your apps without the need for servers.

When your users go offline, the Realtime Database SDKs use local cache on the device to serve and store changes. When the device comes online, the local data is automatically synchronized.

The Realtime Database can also integrate with Firebase Authentication to provide a simple and intuitive authentication process.

4.3.3.3 Authentication



Fig 4.11 Authentication

Firebase Authentication provides backend services, easy-to-use SDKs, and ready-made UI libraries to authenticate users to your app.

Normally, it would take you months to set up your own authentication system. And even after that, you would need to keep a dedicated team to maintain that system. But if you use Firebase, you can set up the entire system in under 10 lines of code that will handle everything for you, including complex operations like account merging.

You can authenticate your app's users through the following methods:

- Email & Password
- Phone numbers
- Google
- Facebook

- Twitter
- & More!

Using Firebase Authentication makes building secure authentication systems easier, while also improving the sign-in and onboarding experience for end users.

Firebase Authentication is built by the same people who created Google Sign-in, Smart Lock, and Chrome Password Manager.

4.3.3.4 *Firebase Cloud Messaging (FCM)*

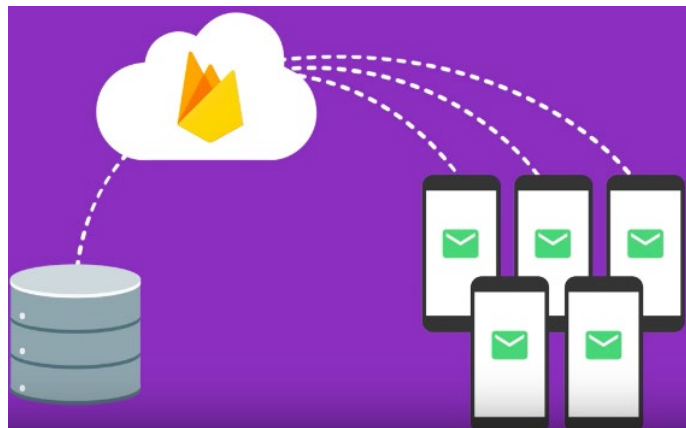


Fig 4.12 Firebase Cloud Messaging

Firebase Cloud Messaging (FCM) provides a reliable and battery-efficient connection between your server and devices that allows you to deliver and receive messages and notifications on iOS, Android, and the web at no cost.

You can send notification messages (2KB limit) and data messages (4KB limit).

Using FCM, you can easily target messages using predefined segments or create your own, using demographics and behavior. You can send messages to a group

of devices that are subscribed to specific topics, or you can get as granular as a single device.

FCM can deliver messages instantly, or at a future time in the user's local time zone. You can send custom app data like setting priorities, sounds, and expiration dates, and also track custom conversion events.

The best thing about FCM is that there is hardly any coding involved! FCM is completely integrated with Firebase Analytics, giving you detailed engagement and conversion tracking.

You can also use A/B testing to try out different versions of your notification messages, and then select the one which performs best against your goals.

4.3.3.5 Remote Config

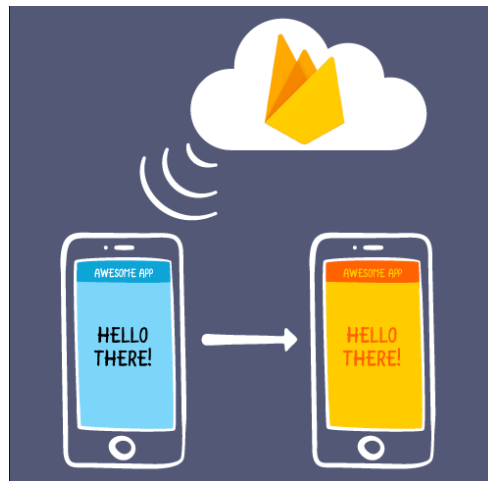


Fig 4.13 Remote Config

Remote config essentially allows us to publish updates to our users immediately. Whether we wish to change the color scheme for a screen, the layout for a particular section in our app or show promotional/seasonal options—this is

completely doable using the server-side parameters without the need to publish a new version.

Remote Config gives us the power to:

- Quickly and easily update our applications without the need to publish a new build to the app/play store.
- Effortlessly set how a segment behaves or looks in our application based on the user/device that is using it.

4.3.4 Android

The android is a powerful operating system and it supports large number of applications in Smartphones. These applications are more comfortable and advanced for the users. The hardware that supports android software is based on ARM architecture platform. The android is an open-source operating system means that it's free and any one can use it. The android has got millions of apps available that can help you managing your life one or other way and it is available low cost in market at that reasons android is very popular.

The android development supports with the full java programming language. The android is an operating system and is a stack of software components which is divided into five sections and four main layers that is given in fig 4.14.

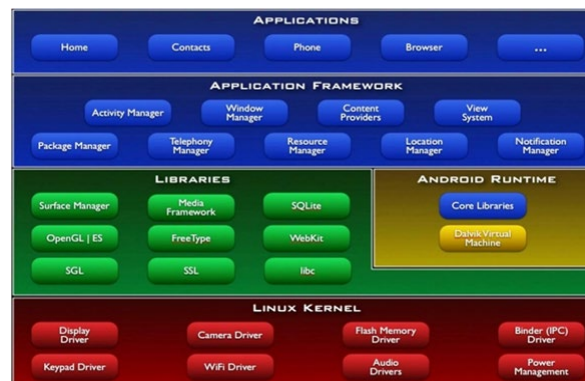


Fig 4.14 Android

4.3.5 Linux kernel:

The android uses the powerful Linux kernel and it supports wide range of hardware drivers. The kernel is the heart of the operating system that manages input and output requests from software. This provides basic system functionalities like process management, memory management, device management like camera, keypad, display etc. the kernel handles all the things. The Linux is really good at networking and it is not necessary to interface it to the peripheral hardware. The kernel itself does not interact directly with the user but rather interacts with the shell and other programs as well as with the hardware devices on the system.

4.3.5.1 Libraries:

The on top of a Linux kernel there is a set of libraries including open-source web browser such as web kit, library lab. These libraries are used to play and record audio and video. The SQLite is a data base which is useful for storage and sharing of application data. The SSL libraries are responsible for internet security etc.

4.3.5.2 Android Runtime:

The android runtime provides a key component called Dalvik Virtual Machine which is a kind of java virtual machine. It is specially designed and optimized for android. The Dalvik VM is the process virtual machine in the android operating system. It is software that runs apps on android devices.

The Dalvik VM makes use of Linux core features like memory management and multithreading which is in a java language. The Dalvik VM enables every android application to run its own process. The Dalvik VM executes the files in the .dex format.

4.3.5.3 Application frame work:

The application frame work layer provides many higher-level services to applications such as windows manager, view system, package manager, resource manager etc. The application developers are allowed to make use of these services in their application.

CHAPTER 5

RESULT AND DISCUSSION

5.1 RESULTS

The experimentation outcomes are analyzed in this section discussing various compliances and assessing outcomes obtained from their implementation. Various modules like pulse acquisition, body temperature monitoring, heart rate, and physiological information acquisition are observed in the upcoming subsections.

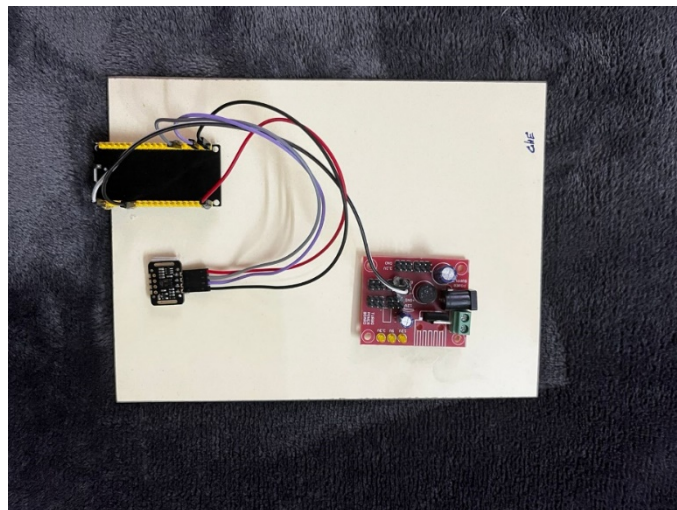


Fig 5.1 Patient monitoring device

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

In the study, the wireless sensor technology is combined with the human health monitoring terminal based on the Internet of Things to test the health-related indexes. The test results are analyzed. It is observed that the human health monitoring system of the Internet of Things is relatively stable and has functions such as an accurate collection of human health data, real-time monitoring and alarming, and evaluation of subjects. The subjects were assessed for temperature using the thermometer, which provides the temperature values of 36.4, 36.7, and 36.5 (°C), respectively, demonstrating relatively accurate and stable testability. Similarly, the pulse rate monitoring module employing the ECG observes the test outcomes of 78, 78, and 79 (times/min), respectively, similar to the medical pulse meter results.

6.2 CONCLUSION

Monitoring can reduce hospitalization in the short term and prevent or delay complications from diseases, such as microvascular stroke or heart attack, in the long term. This enables patients to become more educated and be in charge of their health. Many good clinical outcomes are the result of education. The system developed for patient monitoring based on the Internet of things is an alternative that can be used to help patients with chronic diseases. Therefore, in this paper, a combination of cloud computing systems and IoT is used. At the core of IoT, the prioritization framework is used to prioritize sensitive requests, and in cloud computing.

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