International Journal of Future Generation Communication and Networking
Vol. 13, No. 3, (2020), pp. 603 - 612

Smart Health & Fitness Monitoring System

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Abstract

Internet of things (IoT) is a 4th industrial revolutionary technology that is constantly growing and is making objects connected together. In the field of medical and health care, IoT is playing a significant role in making the medical equipment more efficient by allowing live monitoring of the patient's condition who is admitted to the hospital. This equipment takes inputs of patient's data precisely and accurately and also reduces human errors. The monitoring of patients from numerous places poses a significant challenge in the implementation of this technology for medical applications. Thus, the application of the Internet of Things in the medical field shows us the solutions for effective patient monitoring at reduced cost and it also helps in reducing the risk of spreading disease in the patient's body timely through continuous monitoring. In this research paper, we will talk about monitoring a patient's heartbeat and body temperature using IoT tools and also about the body's fitness level.

Keywords:*IoT, Android, Health, Fitness*

1. Introduction

In today's technological world the application of IoT in healthcare has been emerging as one of the most important applications. Due to a lack of proper medical care, people are getting suffered from various illnesses and are constantly under the shed of an unforeseen death [1].

Obtaining the highest level of health is a fundamental right of every person, which is also encouraged and protected by the World Health Organization (WHO) [2]. As a part of humanity, we also want to contribute ourselves for achieving this thought, so we are attempting to propose a networked system that uses IoT sensors to find out patient's health parameters which include his heartbeat and temperature and it uses a global network to ping the doctors so that they can take timely measures in case of any issues.

We decided to develop an IoT based integrated and dependable Health Monitoring System which will help the medical experts in monitoring their patients remotely, who are either admitted in hospitals or are confined within their homes.In addition to this, a person can himself monitor his fitness also and keep a check on his calorie status. For attaining thispurpose, we developed a healthcare monitoring system on an android platform with the combination of IoT which can administer real-time information about the physiological conditions of a patient.

The system mainly consists of a mobile device, dedicated sensors, and amicrocontroller (i.e., Arduino Uno) which is programmed with software (i.e., Arduino IDE). The patient's

ISSN: 2233-7857 IJFGCN

temperature and heartbeat rate are checked by the sensors and then are sent to the user's mobile device on which the application is installed and are displayed there. Thus, IoT and android based patient health monitoring system adequately monitor the subject's health status and sends an alert message in case of any abnormality.

2. Proposed Work Plan

2.1. Block Diagram of overall system

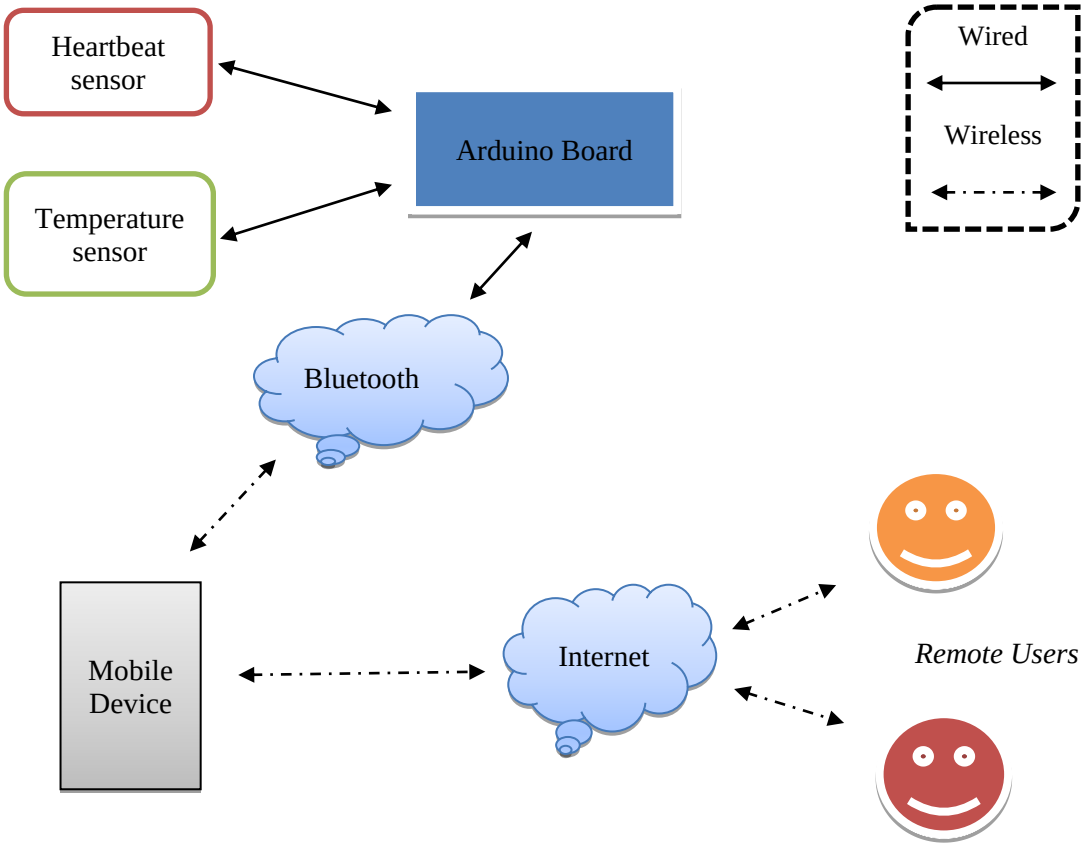

Figure 1. Block Diagram of Proposed System

2.2. Hardware Components

2.2.1. Power Supply: We can power our Arduino board using two ways, one by using a USB connection from a desktop or laptop and second by using an external 5V output power supply. We have used a USB connection in our project [3].

2.2.2. Arduino Uno: It is an ATmega328P based microcontroller board that is open for all i.e. can be used by anyone. The board has various input/output digital-analog pins that are used for the expansion and installation of various circuits. It has a total of 20 I/O pins out of which 14 are digital and 6 are analog. All the programming takes place using an Arduino IDE and the machine is connected with a USB type B Cable. We can use basic programming languages like C/C++ for the programming of Arduino

Programs [4].

2.2.3. Temperature Sensor (LM35): The LM35 is a sensor that can be integrated with an Arduino board to measure temperature. This sensor gave a digital output which is can be easily converted to degrees Celsius. It can be used for both body and room temperature with much precision. The sensor is properly sealed and is deoxidized. The scale factor is 0.1V/C [5].

2.2.4. Heartrate Sensor: It is also open for all Pulse Sensor which is a photoplethysmogram device used to measure the heart rate by not being introduced to the body. A simple touch to the sensor will calculate your heart rate (BPM) by the algorithms used by the Arduino board. The side which has a heart printed on it is being touched. It has a total of 3 pins. If the heart printed side is on the upper side than the leftmost pin is ground, on the other hand, the middle one is for the input +5V supply from the Arduino and the right one is the output of the sensor which is being plugged into the analog pins of Arduino board [5].

2.2.5. HC-05 Bluetooth-Module: It is a sensor that is used to connect the Arduino and the android application wirelessly, it is based on the SPP protocol. It sends the measured data precisely, and it can also be used as both master and slave modules which are the only slave in the case of HC-06, This makes the circuit less complex. It has 6 pins in total, in which 4 are programmable I/O pins & rest 2 are Vcc and ground [6].

2.3. Software Components

2.3.1. Android Studio: Android Studio is an IDE for developing android applications. It is developed by Google and JetBrains. It uses JAVA, Kotlin or C++ programming languages for developing applications and deploying them on the Google Playstore [7].

2.3.2. Arduino IDE: Arduino IDE is used to write programs for the Arduino board. It analyses using serial monitor and serial plotter to display the outputs of the Arduino board. By just adding some special rules for code structuring we can use basic programming languages like C/C++ for writing codes. The Arduino IDE converts the executable code into a hexadecimal encoded text file which is loaded into the Arduino board using the program called Loader which is installed in Board's Firmware [8].

2.4. Other Components

2.4.1. Jumper Wires: They are simple wires which are used to connect to two points with each other. They have pins on both ends. The benefit of using jumper wire is that you don't have to solder anything. They are generally used with breadboards and other tools to implement the circuit easily. We can use different colors of wires in order to maintain the connection readability.

2.4.2. Breadboard: A Breadboard is a device that is used to implement a temporary prototype circuit. This circuit consists of electronic devices, components that are connected with each other using jumper wires. It has

metal strip inside it and the holes are made up of plastic. There are three sections in the breadboard the upper and the lower ones has a vertical metal strip while the middle one has a horizontal one.

2.5. Algorithm of proposed system

This system's main objective is live monitoring of health status and condition of the patient and notifying relevant medical experts instantly in case of any abnormality. The second objective of the system is to show the fitness level and BMI level to the user. The project methodology is illustrated in the following steps:

Step 1: The dedicated sensors are connected to the Arduino board and the patient's body and the data is collected and transferred through the Bluetooth module to the android application wirelessly.

Step 2: When all the related parameters are received by the android device application, they are updated and uploaded into the database.

Step 3: The Android application obtains these parameters whenever variation occurs and displays them on the mobile screen and it also sends alert messages to remote users in case of emergency**.**

Step 4: The android application also acts as a pedometer and can be used to take care of calorie intake.

Step 5: The application shows the BMI level, sleep suggestion, and water intake suggestion as well.

3. Experimental Result Analysis

3.1. Circuit Configuration

Figure 1 illustrates the circuit implementation of the system in which the dedicated sensors are connected to the Arduino board using jumper wires which are then to be connected to the patient's body for gathering necessary data. The Arduino board is to be connected to a power source via USB cable to either a laptop or a 5V battery for powering up the system to work.

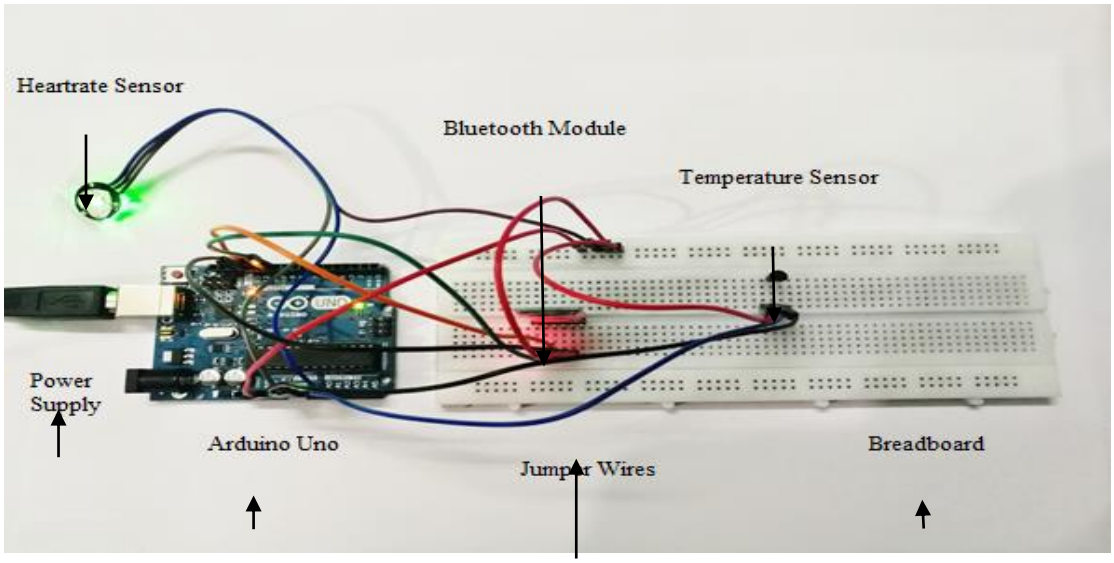

Figure 1. Circuit Configuration

3.2. User interface

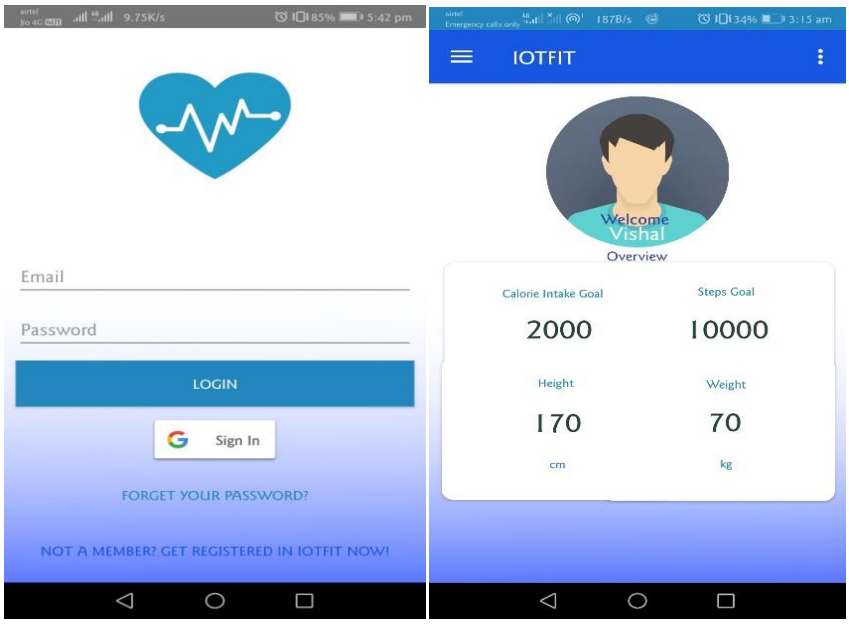

Figure 2. Login ScreenFigure 3. Main Screen

Figure 2shows the login screen of the application which has the option to log in the app by entering the user's e-mail id and password or by Google sign-in method and if they are new users, then they can register themselves first and then login.

Figure 3 shows the interface of the main screen of the application where the information like name, calorie intake goal, step goal, height, and weight provided by the user is displayed.

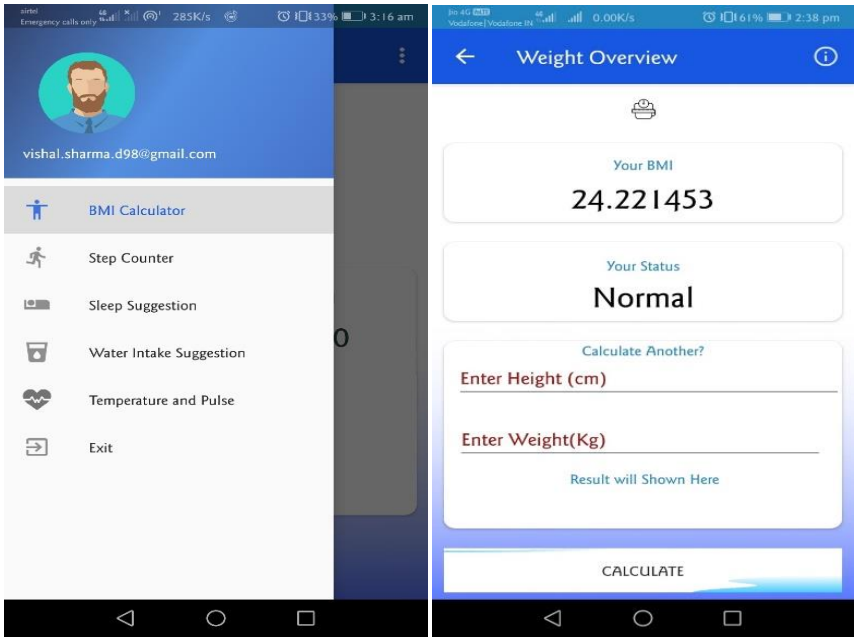

Figure4. Navigation MenuFigure5. BMI Layout

Figure 4shows the interface of the navigation menu from where we can choose from the list of activities which activity we would like to do. The list includes BMI calculator, step counter, sleep suggestion, water intake suggestion, temperature and pulse, and exit option.

Figure 5 shows the layout of the BMI calculator activity which calculates the BMI status of the users and displays their result whether they are underweight, normal, or overweight. There is also an option to calculate another person's BMI status too.

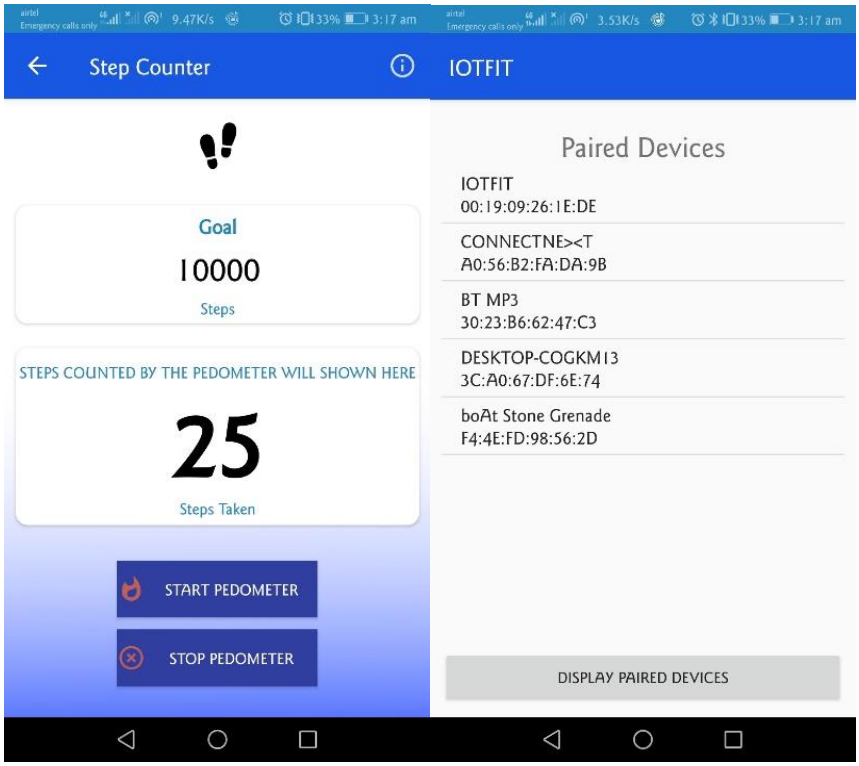

Figure 6. Step Counter Layout Figure 7. Bluetooth Devices

Figure 6shows the layout of step counter activity which displays the goal of steps decided by the user. This activity has two options: - start pedometer and stop pedometer.

Pressing the start pedometer button will start the pedometer which will count the number of steps the user has walked and pressing the stop pedometer button will stop the pedometer.

Figure 7 shows the list of paired Bluetooth devices from where we can pair with our IoTFit system.

ISSN: 2233-7857 IJFGCN

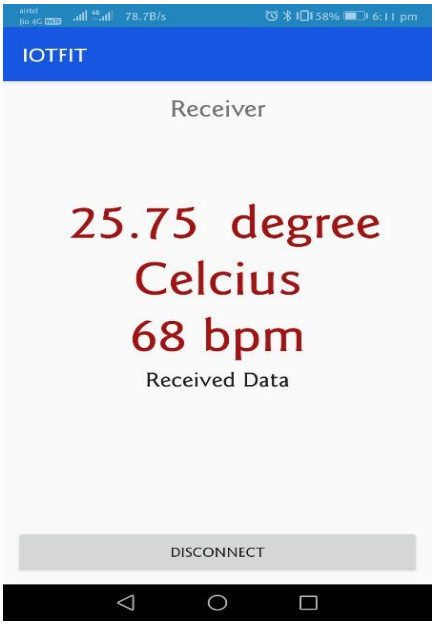

Figure 8. Room Temperature and Heartbeat Rate

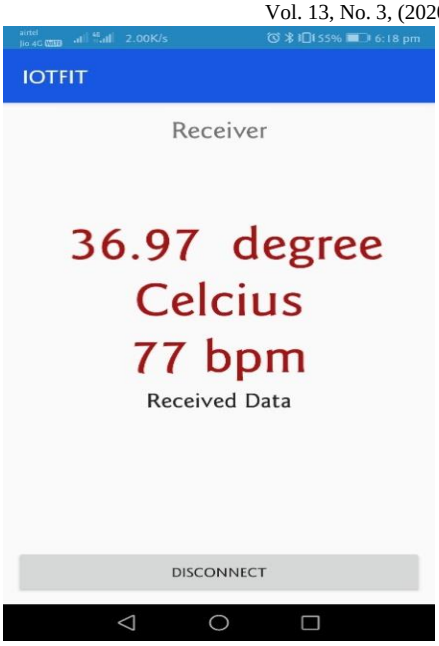

Figure 9. Body Temperature and Heartbeat Rate

Figure8 shows the screenshot of temperature and pulse activity which shows the data of temperature (room) and heartbeat rate received after connecting the device to the application through the Bluetooth module.

Figure 9shows the screenshot of temperature and pulse activity which shows the data of temperature (body) and heartbeat rate received after connecting the device to the application through the Bluetooth module and sensors to the user's body.

The data provided by the user and system is updated in the firebase database and the output provided by the sensors via Bluetooth is displayed on the screen of the application in the form of string which gets updated continuously after a particular interval of time. Any variation in the output will be directly showed on the application.

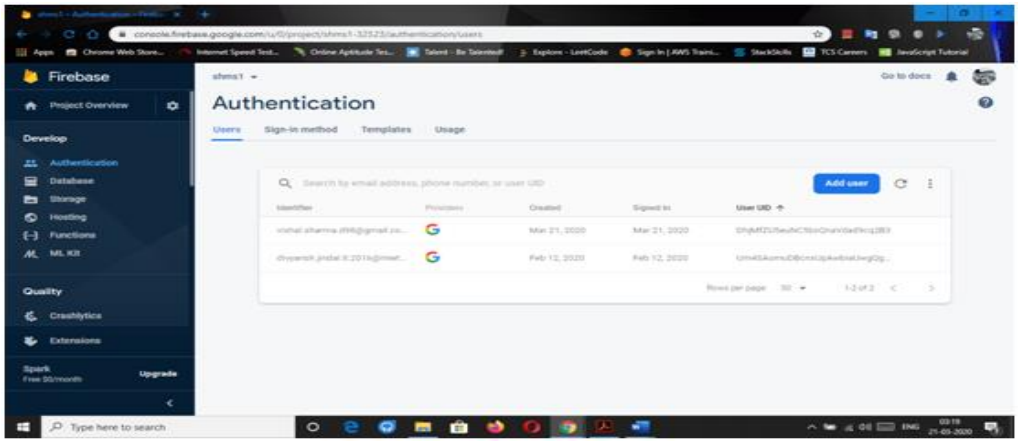

Figure 10. Authenticated User Database

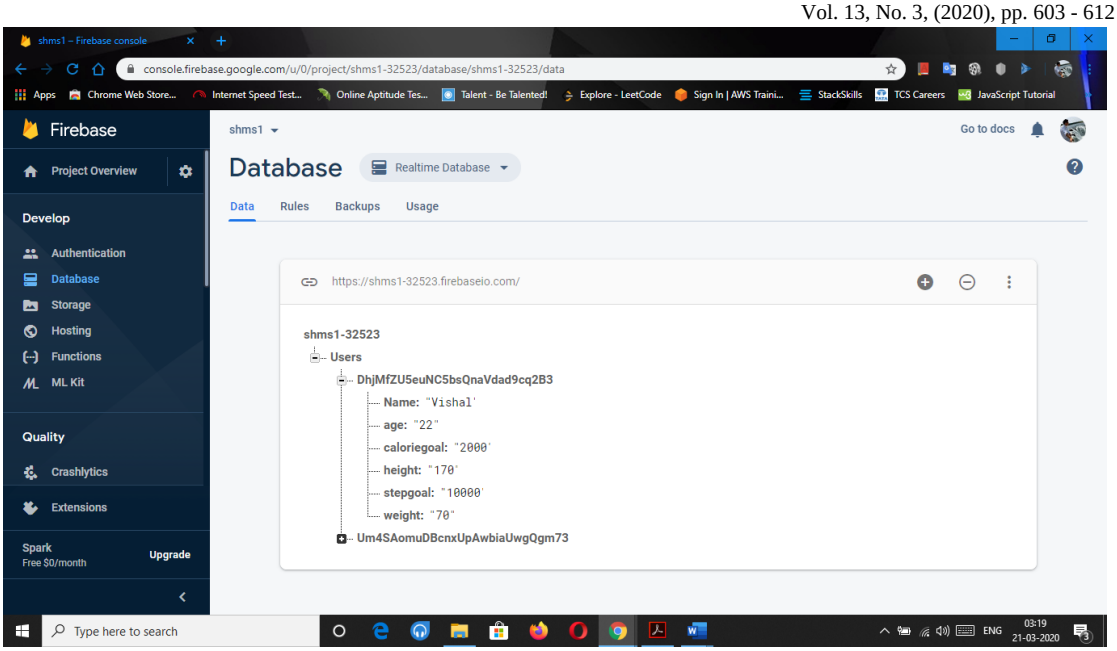

Figure 11. User's Data

Figure 10 shows the screenshot of google firebase database in which all the authentic registered user's e-mail ids and login information are stored and listed.

Figure 11 shows the screenshot of the user database. In this, all the information provided by the user during the registration process is stored and is sent back to the application after a successful login.

4. Comparison Table

Table. 1. Comparison between proposed and previous work

S.no	Features	Proposed Work	Previous Work
1.	Application Area	Health care & Fitness Monitoring	Health care
3.	Sensor Used	Heart rate Sensor, Temperature Sensor, Bluetooth Sensor	Heart rate Sensor, Temperature Sensor, Wi-Fi Sensor
4.	Technology Used	Mobile based algorithm deployment, Bluetooth Sensor device	Mobile based algorithm deployment, Wi-Fi Sensor device
5.	Implementation of Algorithm	Less Complex	Complex
5.	Result Output	36℃ to 38℃ (Normal Body Temperature) & 66 bpm to 98 bpm (Normal Heart rate)	35.8℃ to 38.1℃ (Normal Body Temperature) & 67 bpm to 97 bpm (Normal Heart rate)

6.	**Cost Feasibility**	Low	Moderate
7.	**Reliability**	Good	Good
8.	**Additional Features**	Available (BMI Calculator, Step Counter, Water In-take & Sleep Suggestions)	Not Available
9.	**Android Compatibility**	4.0 & Above	4.0 & Above

5. Conclusion

The proposed system of IoT based health monitoring can be immensely used in case of emergencies as it can be monitored live and daily and the data stored in the database can also be used for future references. This research paper accentuates on patient health monitoring system based on the Internet of Things for constant and live monitoring of the health condition of a person and for the timely detection of the diseases at initial stages.

We have come up with a system and application that allows all the health-related parametric information of a person to be transmitted safely to the doctor. This system's motive is to automatically collect a person's health-related data through sensors, and immediately inform the doctor if any major changes take place in his body, by sending an alert message directly to him. The system will make sure the patient's data is available to the doctor and it will also help in avoiding the necessity of visiting a doctor whenever for a routine check-up.

The problems related to health care delivery cost, information sharing, and lack of healthcare professionals can be dealt with by this IoT based health monitoring system, and also it enhances the services for the patients and users by telling them about their fitness level too.

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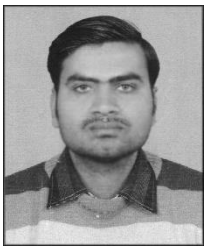

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ISSN: 2233-7857 IJFGCN