Development of a Real-Time Android Based Remote Monitoring Android App System for Multiple Patients

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ABSTRACT

Monitoring implies observing one form of disease or the other remotely , it involves monitoring ones medical condition over a certain period of time. With the present challenges in the health sector it has become necessary to adopt remote monitoring system in our health facilities . Remote monitoring systems are based on advanced wireless technology. In this paper, a real-time body temperature monitoring system was developed considering the cost effectiveness, ease of application, accuracy, and data security. The system provides a responsive interface between the doctor and the patient. This paper presents a monitoring system that has the capability to monitor physiological parameters for multiple patients. In this system, a wearable device was developed and attached on a patient body to collect all the required data and sends them to the database which can be accessed via the mobile phone.. The system App can detect the abnormal conditions and send the parameter wirelessly via a Wi-Fi device to the android based device. In evaluating the performance parameters like temperature obtained from four individuals were compared with existing result which shows a percentage error of 2.5% and accuracy of 97.4%. The second sample gives the percentage error of 5.1% and accuracy of 94.8%. The third sample gives the percentage error of 1.3% and accuracy of 98.6%. The fourth sample gives the percentage error of 2.9% and accuracy of 97.1%.

Keywords: Healthcare, Remote monitoring, Temperature, Sensors, and Wireless.

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1. INTRODUCTION

Some remote part Africa suffer from the challenges of inadequate medical expert, People in rural areas struggle to access timely and quality healthcare. Residents of these areas often have access to substandard medical healthcare, primarily because specialist healthcare providers are mostly based in areas of concentrated population. There is also the challenge of having very few experts especially in cases of chronic diseases even in urban areas. Effective management of chronic diseases can result in improved health outcomes and enhanced quality of life since more than 70% of primary care visits and two third of medical admissions into hospital emergency are related to chronic disease [5]. At present, wireless communication are devices used to understand the critical conditions of the human body. It is a small device which has a unique function.

The wireless sensor supports reliability, mobility. Modern healthcare provides effective medical information anywhere and anytime in the world, in an economic and patient-friendly manner [11]. Therefore, there is a need to improve in the monitoring of the patient and make them mobile. According to a report from the world health organization (WHO), the health condition of old people and pregnant women is becoming more serious and so there is a need for a regular checkup [4]. Wearable sensor devices can help people to provide healthcare information and this will go a long way to provide assistance. Secondly, the patient can comfortably be restricted to bed to be monitored by this devices". such as tracking of activities of the patient, monitoring health, all this information can be used to establish communication between the healthcare providers in case of an emergency [16].

According to [11]: "The medical world, today faces two basic problems in patient monitoring. Firstly, advancement in technology has made it possible to design and implement a more portable vital telemedicine monitoring system to acquire, display, record and to transmit the physiological signal from the patient body to the location. Telemedicine benefits the patient in term of the quick response of the healthcare providers and also benefit the healthcare providers who can streamline their effort to assist more patients.

1.1 Basic Healthcare Terminologies

Tele healthcare involve the use of technology to provide healthcare service at a distance. For instance, a doctor from one hospital performing surgery is supported by another doctor from somewhere. The major objective of this work is to make health care services available to patients in remote areas. It is also aimed at reducing the mortality rate in developing countries like Nigeria where the needed expertise is limited. The system should be able to significantly reduce the time interval in making health care accessible to rural areas.

1.3 Telemedicine

When electronic information and telecommunication technology are used to support distance healthcare it provides flexibity and efficient information dissemination. Telemedicine can be beneficial for those living in isolated areas. A patient who live in such communities can be seen by a physician to provide accurate examination. patient who live in such communities can be seen by a physician to provide accurate examination. A rapidly developing application of clinical medicine where medical data is transferred through an interactive mobile application or audio-visual media for the purpose of consulting, Telemedicine may be as simple as two health professionals' video conferencing equipment to conduct a real-time surgery, discussing a case over the telephone, or as complex as using satellite technology.

Interactive telemedicine services enable real-time interactions between patient and doctor, such as online communication, home visits, and phone conversations. History review activities such as ophthalmology assessments, psychiatric evaluations, and physical examination can be conducted comparable to those done in traditional face-to-face visits. Telemedicine services may be less costly compared to clinical visits. Telemedicine often used as a "tele" prefix, example telemedicine, as applied by radiologists, is called tele-radiology. Benefits of telemedicine is basically for people living in isolated and remote regions and is currently being applied in virtually all medical domains".

1.4 Tele-monitoring

Long distance monitoring has become necessary due to emerging challenges, Tele monitoring is one process that involves remote monitoring of patients not in the same location with the healthcare provider, the patient will have a monitoring device attached to their body, and the result will be transmitted via mobile phone to the healthcare provider. In this case, it prevents the patient from traveling and to obtain basic healthcare services.

Some common things that tele monitoring device keep track are blood pressure, weight, blood glucose, heart rate, and temperature. Monitoring parameters such as body temperature and pressure of the patient will be directly transferred to the doctor or healthcare provider remotely.

1.5 Remote Patient-tele monitoring

One major advantage of remote patient monitoring is that first It enables monitoring of patients at their location which will decrease healthcare delivery cost and increase quality of healthcare services, it minimizes cost and provides a quick response by a healthcare provider. Remote monitoring enables medical healthcare practitioners to monitor a patient remotely using various technological devices. The sensor node can sense, process and transmit the data to a mobile phone. Many a time, nodes are integrated with different sensor to perform various function; sensor used for monitoring heart activities called electrocardiogram sensor (ECG), sensor used for monitoring electrical activities is called electromyogram sensor, sensor used for monitoring of blood pressure is called pressure sensor, breathing sensor is for monitoring of respiration and temperature sensor for monitoring of body temperature. Remote patient monitoring is relatively a new area of interest which enables medical professionals to monitor a patient remotely using different technological devices. It is primarily used for monitoring patient health or specific diseases like heart diseases, diabetes, and hypertension

1.6 Motivation

Health services has always been tailored towards saving lives and improve efficiency in the health sector. However, rural-urban migration has led to a dearth in professional medical services available in rural or remote areas. Hence, the need for remote monitoring of patient's health which in turn enhance the quality of healthcare delivered and reduces mortality rate.

The work is aimed at developing a real time android based remote monitoring system for multiple patient. The objectives are as follow.

i. To develop an embedded wireless device for communication between patient and physician
ii. To develop an android application for monitoring multiple patients.
iii. To interface the embedded device and the android application.
iv. To carry out a performance evaluation of the developed system by benchmark and Compared the result from another system.

This system can only sense temperature parameter of multiple patient and transmit remotely to an android phone and it can be viewed by a doctor. Thermistor sensor for temperature reading can give more accurate readings. Also, the system would also include microcontrollers, Wi-Fi technology-based radio transceivers for remote monitoring to the receiver by the mobile application. patient monitoring system which incorporates the sensors used for the common masses who cannot afford the cost of services rendered by those complete systems as they can take their reading manually [2]. Wireless networks have been employed to reduce capturing biometric data is very high. This system makes remote monitoring accessible to the stress of healthcare and to increase efficiency.

Technology to provide healthcare service at a distance is an evaluation by appropriate medical specialists since the cost of a complete remote However, the accuracy of some of these monitoring systems poses a major challenge as they are based upon the principle of pulse oximetry, irregular heart rate, poor flow and low temperature of the body and many other factors [8], thus, producing false results. Also, the temperature monitoring system require high sensitivity to be able to detect the smallest change in readings.

Some of the existing systems have been known to make use of low sensitivity monitoring devices such as the LM35 which has an accuracy of 0.5°C guarantee able (at +25°C) and less accuracy at higher temperatures. To solve the problem of accuracy in low sensitivity temperature monitoring system, the work uses thermistor for temperature reading which can provide more accurate readings.

2.1 Applications

The most commonly used android application, data application on mobile phones is SMS text messaging, "with more than 60% of all mobile phone users as active users (over 2.4 billion out of 3.3 billion total subscribers at the end of 2007)" according to [3]. The rapid increase of the technologies extends the potential for exploitation of wireless medical application market. Nowadays, a large-scale wireless network and mobile computing solutions such. The presence of pervasive computing devices such as Bluetooth, Zig-bee, RFID and wireless sensor communication networking gives an innovative process for data transmission for medical applications. With advantages over wired alternatives such as ease of use, reduced risk of infection, reduced patient discomfort, enhance mobility and low cost of care delivery, reduced risk of failure. Wireless applications bring forth exciting possibilities for new applications in medical place.

2.2 Android Operating System

Android is a mobile operating system developed by Google, based on the Linux kernel and designed mainly for mobile devices. A typical instance is that of mobile devices like smartphones and tablets. Android is an open-source operating system. Android offers a unified approach to application development for mobile devices which means developers need to develop only for Android, and their applications should be able to run on different devices powered by Android.

Android application development can start on either of the following operating systems:

i. Microsoft Windows XP or later version.
ii. Mac OS X 10.5.8 or later version with Intel chip.
iii. Linux including GNU C Library 2.7 or later.

The following is the list of software for Android application programming.

i. Java JDK5 or JDK6
ii. Android SDK
iii. Eclipse IDE for Java Developers (optional)
iv. Android Development Tools (ADT) Eclipse Plugin (optional)

2.3 Wi-Fi module

The most popular standard device for automation and used in long-range wireless area network is Wi-Fi network module. The WIFI network module consists of three rules

2.3.1 Wireless client

Devices like "computers, tablets, and phones are common Clients on a network. When you are accessing a wireless hotspot or the router in your office or at your home, your device is the client. This can connect to more distance Apps or bridge two Ethernet networks.

2.3.2 Access point (master)

Devices that host and control the wireless connection for laptops computer, tablets, or smartphones are call access point. Wireless networks used in your home or office are generally a combination of a router and a wireless Access Point (AP).

2.3.3 Ad-hoc (mesh).

Devices such as (laptops, smartphones, or wireless routers) support a mode called ad-hoc. This allows those devices to connect together directly, in Ad-Hoc mode, all devices are capable of transmitting and receiving information to the other services without anything else in between. In Ad-Hoc network, every device must use the same configuration to participate.

2.4 Wireless body area network (WBAN)

Wireless Body Area Network (WBAN) as shown in Figure 1, [1] with sensors consuming very low power is used to monitor patients in any conditions within the hospital environment and outside the hospital, the network can transmit patient's vital information to the healthcare provider over the internet in real-time.

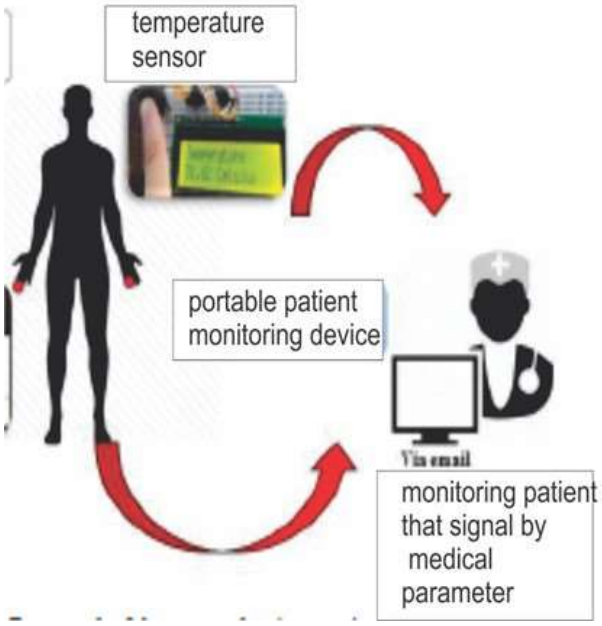

Figure 1: Wireless Body Area Network

2.5 SIM card

In addition, the use of GSM mobile phones The sensor attached to the patient's body will sense the blood pressure and temperature. When it detects the abnormality, it issues an alarm to the patient and sends email/ SMS to the physician. The advantage of the system is that it consists of several relays that reduce system power consumption increase lifetime and speed up the system and transfer for long distance. The disadvantage is when there is over reliance on network which of course, causes delay in transmission. The paper in [13] proposed a system to monitor the physiological parameters like body temperature, pressure and Respiration and so on, the coordinator node has attached on the patient for collecting the signal from the wireless sensor. The sensor sends a signal to the base station or control room of a healthcare provider. Each node composed of healthcare sensor and RF receiver which send information back to the server, sending of data of every patient is stored in the server which each having its own ID. Data inquiry, analysis, and system management are processed on the web page of the server.

When the system detects an abnormal condition in a patient, it will send the condition through email/SIM. The advantage to the patient and associate relative of patient and people that may use continuous remote health monitoring. The disadvantage is that the base station needs to be constantly monitored. [10] designed and implemented IOT system in healthcare application using wireless body sensor networks that can monitor disabled person and patient. The sensing system is efficient in solving the problems of both patients and healthcare providers by monitoring human activities and interacting with the environment. Their system can sense three parameters namely, heart rate, stress level, and temperature which are monitored and transmitted to M2M patient monitoring screen and also viewed by a remote health app. The limitation is poor network [5] designed and implemented a human pulse rate and temperature monitoring system based on ZigBee technology. The device uses high sensitivity and accuracy components such as the use of disposable ECG electrodes for pulse rate monitoring and a thermistor for temperature require a small microchip, called a "Subscriber Identity Module (SIM) Card, to function. SIM is usually inserted inside the phone, and (when properly activated) stores the phone's configuration data, and detailed information about the phone itself, such as which calling plan the subscriber is using. When the subscriber removes the SIM Card, it can be reinserted into a different mobile phone that is configured to accept the SIM card and used as normal.

2.6 Wireless sensor network

The wireless sensor network is a collection of devices that can communicate wirelessly with each other and can be used to sense, process signals by other devices. Typically, a WSN consists of various target sensor nodes and also centralized collection point exists in the network to collect all the processed signals.

2.7 Related Work

This section deals with various method and approaches adopted by various researchers for monitoring of patient health parameters. The reviews of other related works are discussed below: The reference in [4] proposed a smart mobile internet of things healthcare system for monitoring patient risk using a smartphone. They designed web and mobile application to cater for the doctor, patient, hospital service needs and also laboratories analysis. The system alerts the physician in real time about the change of a parameter of the patient. The challenge in this internet of the things healthcare system is security, exchange of data and authentication.

While [9] presented a monitoring device that has the capability to monitor patient's physiological parameter such as temperature from the patient body. The coordinator node will have been attached to the patient body to collect all signal from the patient body using the sensor and transmit them to the base station monitoring. The system consists of the transmitting and the receiving units. ZigBee technology is used for wireless transmission and results are displayed through a Liquid CrystalDisplay (LCD). The limitation is that detailed information about the patient cannot be viewed, it can only display the result and can only be used over a short distance due to the transmitting medium. A wearable device was proposed by [1] to measure temperature and pulse rate only by using a fingertip. The system consists of a pulse rate monitoring software and a wearable device that can measure the temperature and pulse rate by using a fingertip. The device is able to record the data parameter and display the result on LCD. The recorded data can be viewed as a historical file on LCD. The limitation is that result can only be viewed when there is power.

The work in [7] proposed system based on advance wearable and wireless sensor technologies for real-time heart monitoring device is developed. They also considered the ease of application, low power consumption, low cost, and accuracy. The system provides an interface between the patient and the doctor for communication, and give warning messages to the doctor and patient under critical circumstances.

The system can monitor patient heartbeat remotely and get the latest healthcare service while the android device is held under the supervision of the expert. The limitation is that the system needs expert supervision.

3. DESCRIPTION OF COMPONENT

3.1 Method Adopted

In this section, steps and components used in achieving the stated objectives are presented. The system consists of transmitting and receiving the device.

3.1.1 System Block Diagram

The flowchart diagram as shown in figure 2 shows the integration of different subunits of the system, integrated to function as desired.

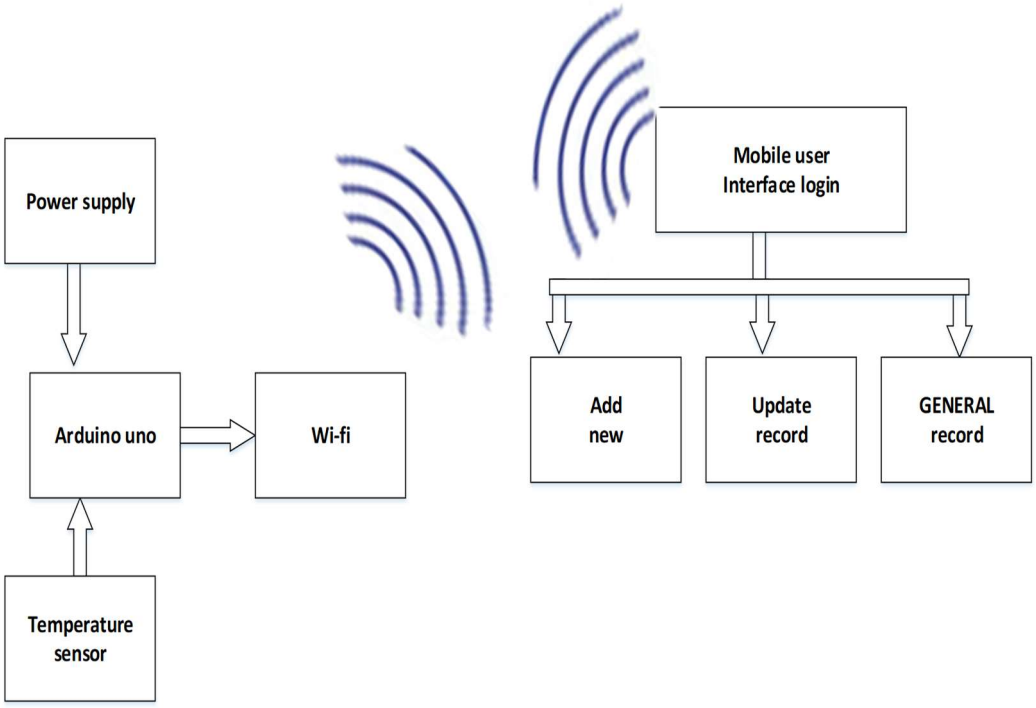

Figure 2: Transmitting subunit Receiving subunit

The system was powered with 5V- 12V. The thermistor sensors are used to measure the body temperature of the patient and the microcontroller collects the parameter, processes the signals and sends it via a wireless transmission medium. The temperature output is collected by the microcontroller of the Arduino board. The Arduino board is interfaced with the Wi-Fi module and the Parameter view using an android phone. Data is transmitted through the (TX) antenna and receiver received through (RX) antenna. This signal is given as input to Wi-Fi and output values are displayed on a mobile phone using android application.

3.2 System Design

The pictorial representation of the developed system is presented in Figure 3. DC voltage of 5V-12V was used to power the system. The sensor detects the temperature. Microcontroller collects the reading and processes it before passing it to WI-FI module. The WI-FI module transfers the reading to android phone.

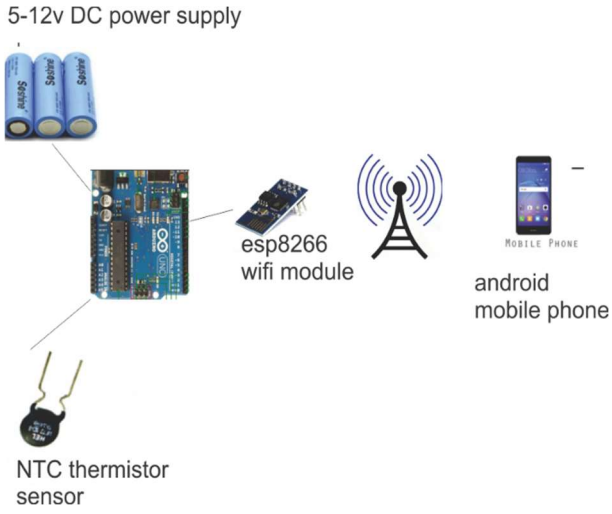

Figure 3: Pictorial representation of the system

3.3 Alarming Mechanism

The steps for the alarming mechanism are explained below:

i. Acquire temperature from device to the mobile phone.
ii. Mobile phone stores the temperature parameter in database.
iii. Analyze the temperature record.
iv. Alarm the doctor if necessary

3.4 Acquisition and management of Data

3.4.1 Acquisition of Data

The flowchart shown in figure 4 is the process taken by the system to get the required data needed for computation and analysis. The following are the element the system used for data acquisition:

Transducer: this a device that converts variations in a physical quantity, such as temperature or pressure, into an electrical signal, or vice-versa.

Signal condition: enables quality measurement on the transducer. It is often needed between transducer and analog to digital converter (ADC).

ADC: is a chip that takes data from the environment and converts it to a discrete level that can be interpreted by the processor.

The sensor collects the data in form of signal, these signals are converted into digital form.

3.4.2 Data Management

Database Memory
This is where these acquired data are stored so that it can be accessed offline, that is, without WIFI network so that the content can be accessed while you are not connected to the device.

The database memory can store all the report received by the transmitter. The database memory is developed using SQLite which is an aspect of SQL which stand for the structured query language.

Data Analysis
The data taken is analyzed to know whether the temperature is normal or abnormal so that the doctor will be alarmed to take action concerning the patient

3.5 Transmitting Device
Transmitting device was integrated with the different component as follow:

3.5.1 Power Supply
The system is powered using a direct current source with minimum and a maximum output voltage of 5v-12v.

3.5.2 Temperature Sensor:
Measure the amount of heat energy or coldness
that is generated by an object which enables us to sense any physical change to that temperature producing either analog or digital output. We have a different type of temperature sensor, based on contact with a physical object such as a thermostat, thermistor, resistive temperature detective and thermocouple. In the case of this project, we used thermistor because of is sensitivity, size flexibility and range of measurement for this project. When the sensor come in contact with the body, it senses the temperature and the microcontroller processes the signal.

3.5.2.1 Thermistor Sensor
Thermal resistors are temperature dependent variable resistors. Thermistors are classified as: "Positive Temperature Coefficient (PTC) and Negative Temperature Coefficient (NTC)". When temperature increases, the NTC thermistor resistance will decrease and, PTC thermistor resistance will increase. They exhibit the opposite response with temperature (Philip Kane 2016). Figure 5 shows the diagram of the thermistor sensor and Figure 4 shows the Voltage divider circuit and ADC with a common reference.

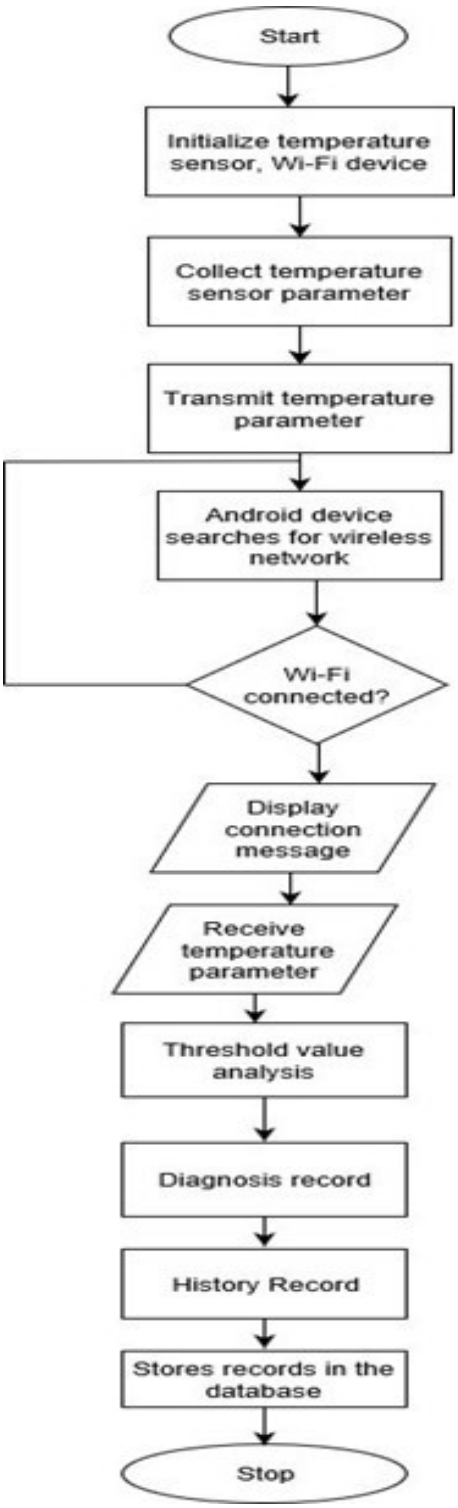

Figure 4: Voltage divider circuit and ADC with a common reference.

The temperature sensitivity coefficient is about ten times greater than those of resistance temperature detectors (RTDs) and about five times greater than that of silicon temperature sensors (silistors). NTC sensors are typically used in temperature measurement, range from −55°C to 200°C while (PTC) used in an electrical current control application.

3.5.2.2 Computing the Temperature of a Thermistor Sensor:Steinhart-Hart equation

It provides a much accurate result approximation of the thermistor's response curve

$$\frac{1}{T} = \frac{I}{To} + \frac{1}{B} * In\left(Ro * \frac{\left(\frac{ADCMAX}{ADCVAL}\right)-1}{Ro}\right) \quad 3.5$$

Ro cancels out, which leaves:

$$\frac{1}{T} = \frac{1}{To} + \frac{1}{B} * In\left(\left(\frac{ADCMAX}{ADCVAL}\right) - 1\right) \quad 3.6$$

Take the reciprocal of the result to get the temperature in Kelvin. And add 273.15k to convert to degree Celsius.

Figure 5 chip thermistor

3.5.3 Arduino System

Arduino is an open source hardware and software for building digital devices and interactive objects. Arduino can sense and control objects in the physical and digital world. There are different types of Arduino such as Arduino Uno, red board, Arduino Mega, Arduino Leonardo and lilypad Arduino. In this research, Arduino Uno is used because it is compatible with other component used in this work and efficient in programming. While it was not actually the first microcontroller to be released but is the most actively used and most widely documented in the market. Because of its extreme popularity. Figure 6 shows the diagram of Arduino uno and Figure 7 show Arduino programming environment. After the Arduino was powered, it collects, processes the temperature and sends to the WiFi module for transmission

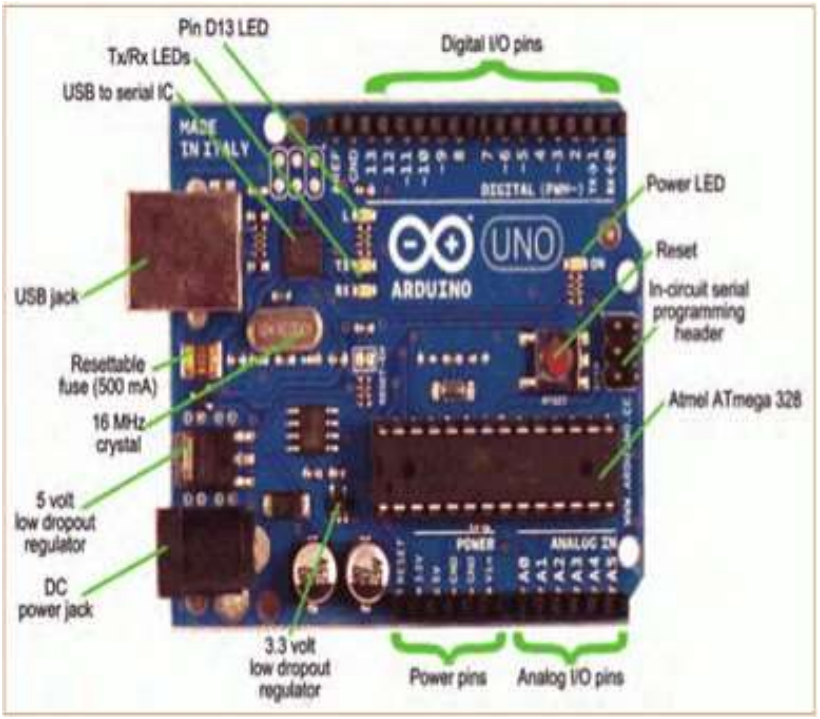

Figure 6: Arduino Uno board

Figure 7: Arduino Programming Environment

3.5.4 Wi-Fi Module

They are a different type of wireless module for wireless transmissions such as Bluetooth, NRF, ESP8266, Arduino shield, ZigBee and electric Imp . In this research work, we use ESP8266 because of the consideration of cost, size, range and easier to program. ESP8266 has the capability of either hosting an application or offloading all WIFI networking function from another application processor. Figure 8 is the Wi-Fi module ESP8266. WIFI module enables data to transmit to the receiver and it can also save as receiver.

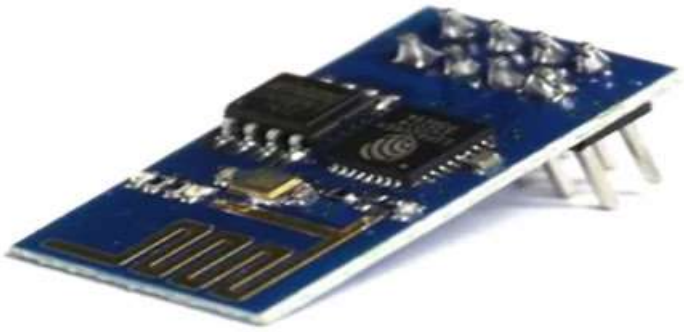

Figure 8: Wi-Fi module ESP8266

3.6 Receiver device

The receiver device is a device used to receive signals of different kinds, depending on the context of the application. It can be an analog signal, wave or digital signals through wired media. The receiver is mostly used in communication, in network communication it is the device that receives and decodes the signal and transform them into another computer device understanding. In this case, the android phone is used as a receiver. The android application was programmed and installed inside the mobile phone in other to receive the data sent by the transmitter. The android app can able to perform the following function:

Store data: the data is stored privately on the app and guest cannot access them unless the security key is known. Which make internal storage a good place for data that the user can directly access them.
Threshold value analysis: the application can enable the user to view the diagnosis record and history of the patient that is stored in the database

3.7 Health App

The app was developed using android programming language with visual studio IDE. The pseudo code for the android application is shown as follows: Case add patients

If add new
Submit
Add patient to a database
If capture temperature
Save temperature
Else don't save temperature
View data by code/name
Then display for selection code/name
Else go back to user the interface

- Case patient record

Patient in database
Patient history
Exit
Go back to user interface

- Case user interface

Data requesting
Save data
If view data history
Exit
Else recapture data
Save data
Exit
Go back to the user interface

4. RESULTS AND DISCUSSION

This section discussed the result obtained from the system construction and development. This includes assembly of hardware, software application development, and evaluating system performance.

4.2 Hardware development

This system was developed on the breadboard to check the performance before implementing it on the Vero board. During the hardware implementation and testing, some of the components got damaged and needed to replace. After replacement and troubleshooting, it worked perfectly.

4.3 Android application

The health app was developed to remotely monitor the patient temperature parameter, store patient record and add new patient into the database. The application comprised of six modules: Login module, user interface, add patient, patient record, system database, remote monitoring (requesting). The application was designed in such a way that there is an administrator login applet to input data and enable access to various accounts in the database, this can be seen in figures 10, 11, and 12.

4.4 Database Specifications

Database design is the process of developing database structures to enter user data requirements for a system or software. It starts with requirement analysis, which identifies each user. The patient detailed was recorded and any inconsistencies were resolved by the users of the Android application. Figure 12, 13,14,15 and Figure 16 shows fields for data to be collected when adding a new patient to the database such as the patient name, patient address, patient code, patient age and gender and displays respectfully.

Figure 9: Login interface design

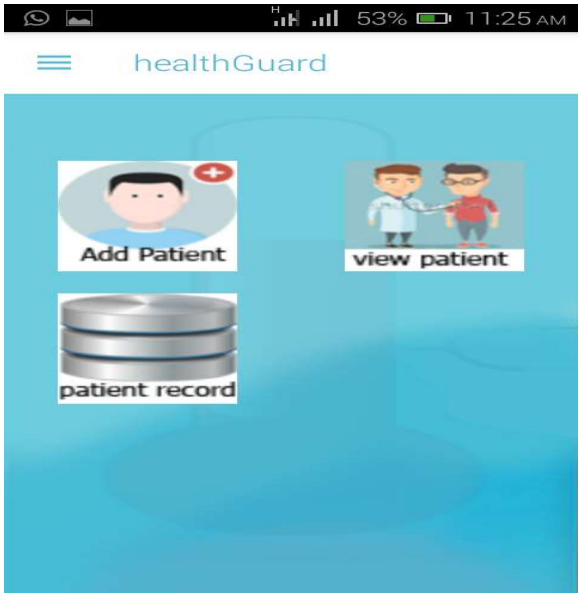

Figure 10: user interface design

Figure 11: add new patient applet

Figure 12: shows user data successfully captured

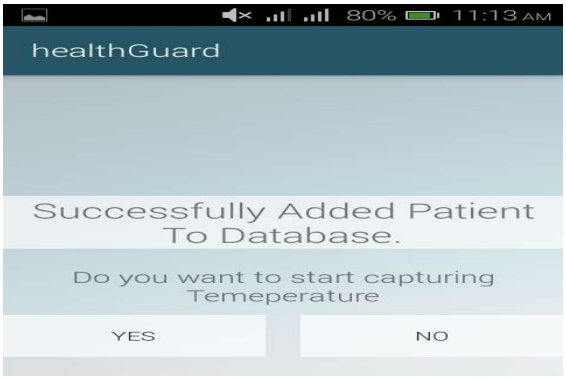

Figure 13: shows app requesting to read user's temperature

Figure14: Displays patient's details after reading temperature

Figure 15: Overall patients' record

Figure 16: shows temperature captured for a patient with date and time

Figure 17: shows multiple temperature reading of a Patient taken at different times.

4.5 Android Application Testing

Sub- android application Testing

The Sub- android application testing is divided into four modules:
The Login module, Remote Patient Monitoring System menu module, General Patient Record module, Patient record module

Prescription module

The Log- In module was first designed and tested to ensure that only authorized users have access to the application. This tested ok

Remote Patient Monitoring System menu module was developed and tested to ensure that the data is captured from the sensor and displaying the appropriate access addressed. General Patient Record module was also developed and tested to ensure that the patients' records taken are stored in the database and the record of any patient whose code or name is searched is displayed.
Patient History module was also developed and tested to ensure that the records of the parameters being measured at different time intervals are stored in the database and displayed on the interface

4.6 Hardware component result

Ihe prototype implementation of the circuit is shown in Figure 19.

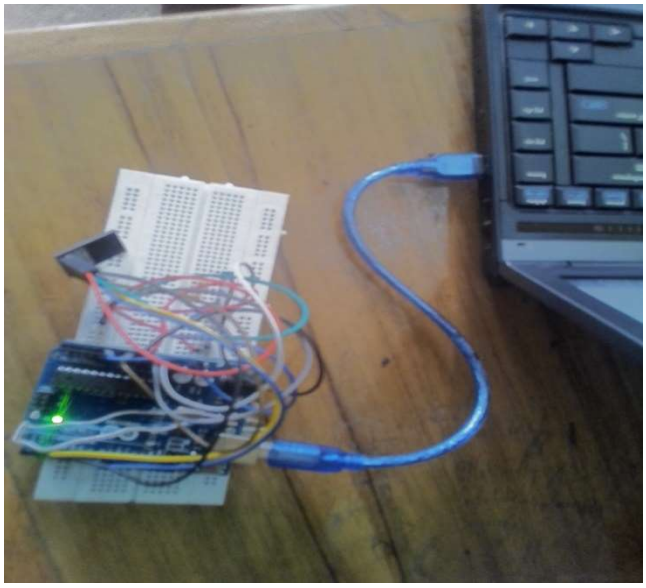

Figure 18: System prototype

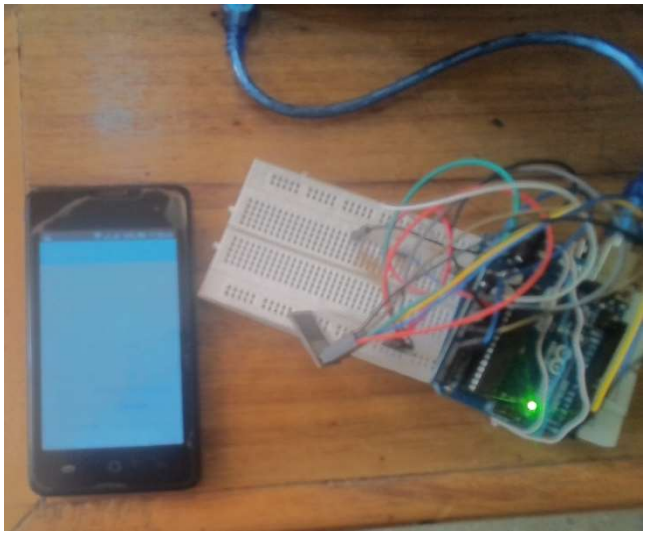

Figure 19: Full system prototype with mobile phone

4.8 Testing and Result

The following steps were taken in order to check the accuracy of the project

i. Actual values were obtained from four (4) adults using a real-time android base remote monitoring system.
ii. The device was used to check for the values of the temperature
iii. The accuracy of the measured parameters was compared against the existing values obtained from another device. The temperature values from the project is compared with existing project (James et al. 2016) as shown in table 1.

$$\text{Percentage Error} = \frac{(\text{Actual Value} - \text{measured value}) \times 100}{(\text{Actual value})}$$

$$\% \text{ Accuracy} = 100 - \% \text{ error}$$

Table 1 shows the result of temperature obtained from four individuals compared with existence result. The first sample gives the percentage error 2.5% and accuracy of 97.4%. The second sample gives the percentage error of 5.1% and accuracy of 94.8%. The third sample gives the percentage error of 1.3% and accuracy of 98.6%. The fourth sample gives the percentage error of 2.9% and accuracy of 97.1%.

Table 1: Comparison of research values and existing values from a different device (ZigBee based wireless patient temperature and pulse monitoring system, James et al. 2016).

Test	Project (ºC)	Existence (ºC)	% error	%Accuracy
Sample 1	38.5	39.5	2.5	97.4
Sample 2	35.1	37.0	5.14	94.8
Sample 3	37.0	36.5	1.3	98.6
Sample 4	36.1	37.2	2.9	97.1

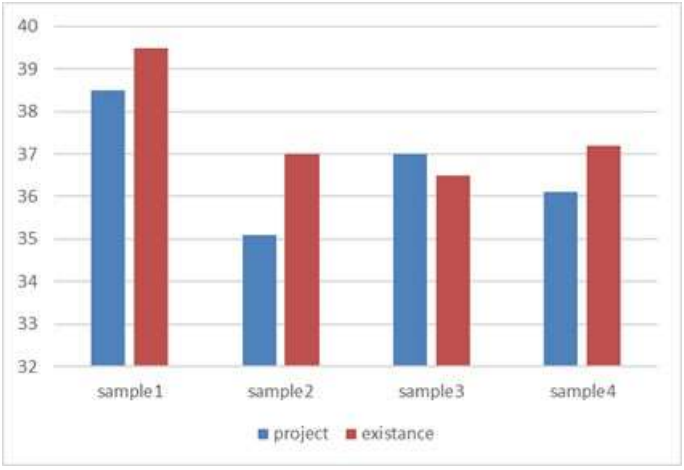

Figure 20: Comparison of research values and existing values from a different device

4.9 Performance Evaluation

The traditional method of monitoring patient's health cannot be compared with this system which is automated, saves time and the limited resources available. Currently, several different types of an integrated remote monitoring system for multiple patient devices exist. These devices act as one that can monitor multiple patients using an android phone. The integrated devices are activated daily by the patient. Data are collected from the patient, provide educational information, and visual monitoring with a physician for real-time assistance. Some instruments can also self-activate and alert patient's medication must be taken. Data are subsequently transferred to health care physician through patient-specific algorithms to classify the risk and alert the physician whether data exceed predetermined values. These application store previous test results through a specific device program. Table 2 shows the performance evaluation of various applets of the developed android software

Table 2: Performance evaluation table for the developed android program

User Interface	Expected Result	Actual Result
General patient record	The android application should be able to store, upload and view the previews record	The result received by the android phone was store and view.
Patient history	The android application should be able to store, view the patient history and can recapture temperature	The temperature was capture when the device made a request and store.
Physician diagnosis	The android application should be able to store and display the result on the android phone for doctor to view	When tested was ok.

5. CONCLUSION

A Real-Time Android Based Remote Monitoring Android App System For Multiple Patients is a system that will effectively contain the present gap suffered by those living in rural environment who cannot access medical facility. The flexibility and robust nature of the system developed will help narrow the gap between those leaving in urban centres and rural communities This real-time android base remote monitoring system has been tested and found to have the potential of capturing vital health data like temperature which is stored in the database which can also be transmitted to a doctor when a set of threshold is exceeded and too high for local health personnel to handle .

5.1 Recommendations

The recommendations for the developed system are listed below

i. The system can be upgraded by adding other sensors to measure other health parameters of patients for a robust health monitoring system.
ii. The software should be developed to work with Java, iOS devices, so that it will be accessible to everyone irrespective of the software platforms they use.

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