# Apneas Detection through PDA

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*Abstract*— Patients those are suffering from sleep apnea and hypopnea syndrome (SAHS) have to suffer sleep apneas which are most expensive polysomnographies for diagnosis. Healthcare analysts are always looking for easy diagnosis with comfort for apneas patients and they are reducing the number of sleep apnea cases with alternative solutions. This paper describes implementation of an innovative technique of detection of Apnea diseases system based on interchanging of patient's information to and from an Android based mobile phone. Anywhere at any time, medical doctor's requirements for monitoring parameters of vital signs can be addressed by the system. Through this system, the patient information is collected by Remote Server and transferred to a mobile phone. The web application converses data on monitor to mobile phone. Here, this paper presents an alternative solution that entertain not only a transferring of physiological data but also actual analysis of these data located at a mobile device. Practically, web application on the server used to analyze data and mobile application to display that data on the phone which is analyzed in our system.

***Key words:*** Data Mining, Real-Time Monitoring, Sleep Apnea Detection

## I. INTRODUCTION

Healthcare is an important social aspect of day to day life due to increasing population; the advanced technologies have many inventions and digitization make huge scope of advancement in regular life. To improve health awareness, doctors must access actual and proper parameters of the patient's health, such type of parameter transporting is very important for both patients and doctors [1].

Now a day's Android operating system are most widely used in mobile for increasing performance and it provides custom application to users for development and deployment which is open source, so we bring these features of Android mobile to doctors for accessing medical parameters of patients anytime anywhere [2]. This system, Patient Data Viewer is an Android application which helps the doctor to view the up-to-date information of the patients' vital health parameters like blood pressure, heart rate, etc. The doctor can make notes regarding a patient and also view them. The doctor receives a notification whenever a patient is in danger, that is, whenever anyone one of the signal of the patient goes beyond a critical limit. All this information is collected and sent to the doctor's Android device from the hospital server[1].

## II. IMPLEMENTATION FRAMEWORK FOR THE SYSTEM

This implementation is based on a web based application using the j2ee platform that follows the three-tier architecture.

### A. Interfacing

The contents of the interfacing of devices are responsible for interacting with medical devices which records the physiological data. This data can be transferred to server through asynchronous transmission mode (i.e. data communication in both directions at same time). The selected device itself capable to provide facilities for development and testing.

### B. Data Analysis

Components that can store medical parameter in standard format of that application for easy exchange of data between different modules.

### C. Server

The server components are responsible for receiving medical parameters from device and storing it into database for further analysis of these parameters to determine status of patients (either their parameters indicates they are healthy or not) received data from the database when requested user which is accessed by using stored user accounts For deciding status of patients through sending email or message alerts to appropriate doctor when is in critical condition[1].

### D. User

This package contains following components: user accounts management i.e. creation and login/logout

Displaying patient's physiological data and signals with timestamp which triggers alert.

Displaying multiple patients profile associated with database. Manage patients associated with user.

### E. Database

A MySQL is used for storing medical parameters and analyzed data. The server will responsible for interacting and managing of all modules.

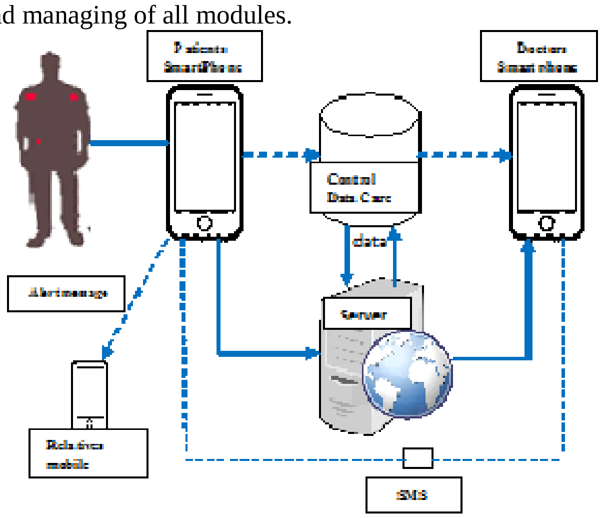



Fig. 1: System flow

## III. IMPLEMENTATION

The implementation is divided into three modules:
A) Module for getting and storing medical parameters into the database, B) Module for retrieving information from the database and displaying on the screen and C) Module for dealing with alerts.

## A. Module for Receiving and Storing Data

The hospital server contains all the patient data. When the application is being installed on the android operating system, the IP address of the server is supplied [4]. When the doctor supplies login information, the phone connects through the default HTTP client. Then a web connection is established with the server and login details are validated. Next, the server supplies the details of the patients under the doctor's supervision[2]. This is sent in the form of JSON objects. The app receives these JSON objects, decodes them and stores them in the phone. The advantage of this system is that the server coding can be done by the hospital management as per their needs. The only requirement is that the server must send data in the JSON object format. This can be exchanged with the existing applications on the server. The data thus received is stored in a SQLite database. The database contains a table with the names, current health parameters, diseases, reports, etc of the patient [8].

## B. Module for Displaying Data

The application displays the list of patients and details from the database through querying. Through various navigation options, the doctor can navigate to the patient's current heath parameter list, investigations, view heart rate, temperature etc. The doctor can also add notes for specific patient [8]. This will be saved into the patient's record in the database.

## C. Alerts Module

The hospital sever continuously evaluates the data of all patients to see if all of the patients' health parameters are within safe ranges. In case they cross the critical values (implies that the patient's condition is unstable), the hospital server sends a text message (including patient name, alarming health parameter and an identification word) to the concerned doctor's phone[3].

Doctor views the patient's data/history (heart beat, temperature) anytime, anywhere through the internet.

# IV. Results

Our implementation related to Apnea dieses which is real time social aspect so we seen the best performance has been measured through the sensitivity, specificity, accuracy and CPU time[2]in table 1 and comparative results of different methods shown in table 2.


Fig. 1: Patient's Data on Web Page

As per above assumptions real time result has shown below in the form of graph and table:

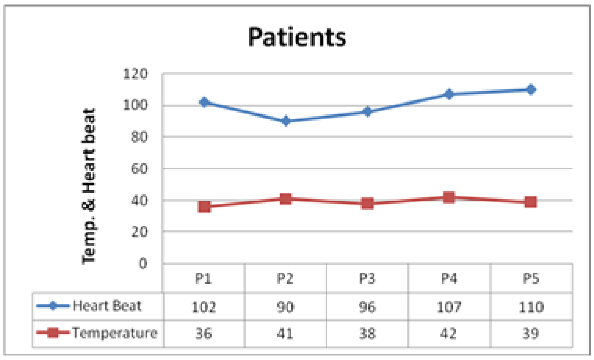



Fig. 2: Patients data with graph.

| Methods | SVM | SPO2 |
|---|---|---|
| ROC-AUC | 99.99% | 99.99% |
| ACCURACY | 86.00% | 90.00% |
| CPU-TIME | 0.039s | 0.033s |

Table 1: System Result

| Method | Ref. | Approach | Performance[%] | | |
|---|---|---|---|---|---|
| | | | Se | Sp | Acc. |
| QuicenoManrique et al. | [11] | ECG signal | | | 92.67 |
| Alvarez et al. | [12] | SaO2 and EEG signal | 91 | 83.3 | 88.5 |
| Xie et al. | [13] | Spo2 and ECG | 79.75 | 85.89 | 84.4 |
| Laiali Almazaydeh et al | [14] | Features extraction of Spo2 signal | 87.5 | 100 | 93.3 |

Table 2: Comparative Results

Se- sensitivity, Sp-specificity, Acc.-accuracy

## A. Unit Testing

Testing of individual software components or modules. Typically done by the programmer and not by testers, as it requires detailed knowledge of the internal program design and code it may require developing test driver modules or test harnesses.

Here, in the unit testing we are testing two modules i.e. receiving and storing data and displaying data, these modules contains the programs and coding for accepting input data and displaying on screen.

## B. System Testing

Entire system is tested as per the requirements. Black-box type testing that is based on overall requirements specifications, covers all combined parts of a system.

Through system testing we are testing required data has been catches by the sensor and send it to the server.

## C. End-to-End Testing

Similar to system testing, involves testing of a complete application environment in a situation that mimics real-world use, such as interacting with a database, using network communications, or interacting with other hardware, applications, or systems if appropriate.

With this testing we test complete operation of the system that start from sensors input received on computer system and compared with standard database then it produces final output.

### D. Acceptance Testing

Normally this type of testing is done to verify if system meets the customer specified requirements. User or customer does this testing to determine whether to accept application.

Our system meets specified requirement of user/patients due to the system observes 24 Hrs to patient and raise the alarm in critical condition.

### E. Software Quality/Performance Attributes

#### 1) Reliability:

The output depends on input data provided by sensor and compared with standard data so it will produces always accurate output even we are checking randomly.

#### 2) Availability:

The system developed by us will always available with patient. So, we will get better result.

#### 3) Portability:

This system is portable because it just requires computer and internet connection, we can check the output anywhere anytime through internet.

#### 4) Performance:

The performance of our implementation does not requires high configuration system, general computers will provides better performance.

#### 5) Features to be tested:-

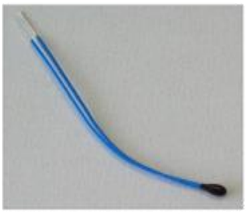
The testing is performed to check features like performance, validation, functionality and also the flow of modules. The test plan also includes testing using valid and invalid data.

### F. Hardware:

We are using thermistor as temperature sensor. All this sensors are connected via ADC (On PORTA on AVR Microcontroller).and Device(Buzzer) is connected via Device Driver IC ULN2803.

### G. Thermistor Documentary:

Thermistor



Negative temperature coefficient (NTC)

Fig. 3: NTC Thermistor

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements.

Thermistors differ from resistance temperature detectors (RTDs) in that the material used in a thermistor is generally a ceramic or polymer,while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range, typically −90 °C to 130 °C.

### H. Conduction Model

Many NTC thermistors are made from a pressed disc, rod, plate, and bead or cast chip of a semiconductor such as a sintered metal oxide. They work because raising the temperature of a semiconductor increases the number of active charge carriers - it promotes them into the conduction band. The more charge carriers that are available, the more current a material can conduct.

In certain materials like ferric oxide ($Fe_2O_3$) with titanium (Ti) doping a n-type semiconductor is formed and the charge carriers are electrons. In materials such as nickel oxide (NiO) with lithium (Li) doping a p-type semiconductor is created where holes are the charge carriers [9].

This is described in the formula:

$$I = n.A.v.e$$

I=Electric current (amperes)
n= Density of charge carries (count/$m^3$)
A=Cross-sectional area of material ($m^2$)
V=Velocity of charge carriers (m/s)
e= Charge of an electrons

Over large changes in temperature, calibration is necessary. Over small changes in temperature, if the right semiconductor is used, the resistance of the material is line early proportional to the temperature. There are many different semiconducting thermistors with a range from about 0.01 Kelvin to 2,000 Kelvin's (−273.14 °C to 1,700 °C)[citation needed].

### I. Pulse Sensor:

The Pulse Sensor is designed for hobby and educational applications to illustrate the principle of Photo Plethysmo Graphy (PPG) as a non-invasive optical technique for detecting cardio-vascular pulse wave from a fingertip. It uses an infrared light source to illuminate the finger on one side, and a photodetector placed on the other side measures the small variations in the transmitted light intensity.

The variations in the photodetector signal are related to changes in blood volume inside the tissue. The signal is filtered and amplified to obtain a nice and clean PPG waveform, which is synchronous with the heart beat. The original version of Pulse Sensor uses the TCRT1000 reflective optical sensor to sense the blood variation in the finger tissue and outputs a digital pulse which is synchronous with the heart beat.[5]

The Pulse sensor is based on the principle of photoplethysmography (PPG) which is a non-invasive method of measuring the variation in blood volume in tissues using a light source and a detector. Since the change in blood volume is synchronous to the heart beat, this technique can be used to calculate the heart rate. Transmittance and reflectance are two basic types of photoplethysmography.

The light is emitted into the tissue and the reflected light is measured by the detector. As the light doesn't have to penetrate the body, the reflectance PPG can be applied to any parts of human body. In either case, the detected light reflected from or transmitted through the body part will fluctuate according to the pulsatile blood flow caused by the beating of the heart.

IR LED and a photodetector are placed on two opposite sides and are facing each other. When a fingertip is plugged into the sensor, it is illuminated by the IR light coming from the LED. The photodetector diode receives the transmitted light through the tissue on other side. More or less light is transmitted depending on the tissue blood volume. Consequently, the transmitted light intensity varies with the pulsing of the blood with heart beat.

A plot for this variation against time is referred to be a photoplethysmographic or PPG signal. The following picture shows a basic transmittance PPG probe setup to extract the pulse signal from the fingertip.[1]

The PPG signal consists of a large DC component, which is attributed to the total blood volume of the examined tissue, and a pulsatile (AC) component, which is synchronous to the pumping action of the heart. The AC component, which carries vital information including the heart rate, is much smaller in magnitude than the DC component. A typical PPG waveform is shown in the figure below (not to scale).

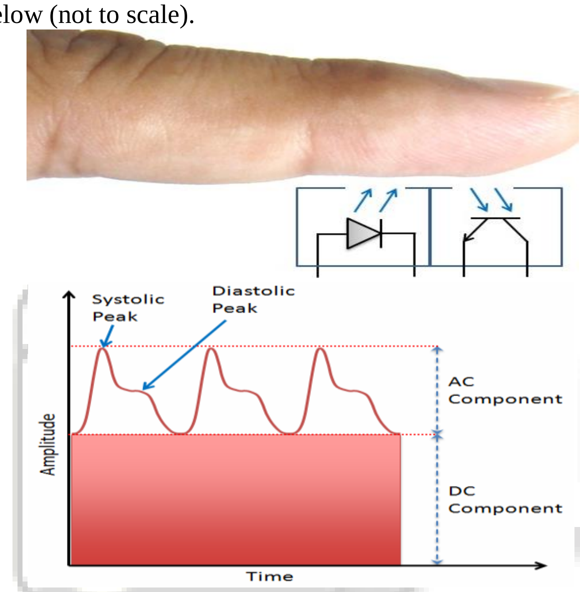



Fig. 4: PPG signal

The two maxima observed in the PPG are called Sytolic and Diastolic peaks, and they can provide valuable information about the cardiovascular system (this topic is outside the scope of this article). The time duration between two consecutive Systolic peaks gives the instantaneous heart rate.

### J. *Implemented System:*

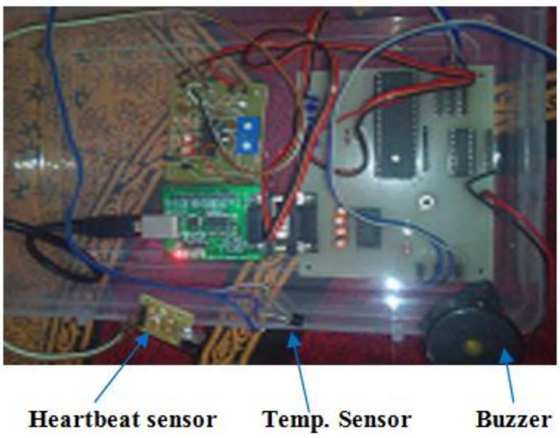



Fig. 5: Implemented System

### K. *Sensor Deployment*

Although the sensor fits on almost any of the five finger tips, we have found that the sensor performance is better if used on the middle or index finger. The flexible elastic Silicone rubber case helps to attach the sensor to the finger. The infrared LED illuminates the finger from the top.

## V. CONCLUSION

In this work we are using the Android Open Source Platform. The system helps the doctor to view the patient data and monitor his health condition through the doctor's mobile device. The system will be very useful for medical practitioners who are on the move and still want to be in touch with the patient's condition. We are developing a prototype of this application using random generated data to verify the patient's data and generate alerts. Because of the absence of server push support for Android, we have adopted the method of using SMS to activate the app to alert the doctor. The Android Cloud to Device communication mechanism presently being developed by Google may provide server push for Android. Due to availability of wearable monitoring devices this application can also be extended to include data from patients not staying in hospitals.

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