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Design & Development Embedded based Apnea Detection & Monitoring

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Abstract: Technological innovations in the field of medical science has played a vital role in disease prevention and diagnostic. This paper present ApneaBand, a real-time wearable system for monitoring, visualizing and analyzing physiological signals. ApneaBand consists of a set of non-invasive physiological sensors wirelessly connected via Bluetooth to a cell phone which stores, transmits and analyzes the physiological data, and presents it to the user in an intelligible way.In addition, this band provides motion state of users and environmental parameter like temperature.In this paper, we focus on an implementation of ApneaBandusing a heart sensor to monitor the user's pulse while sleeping. We also describe algorithms for automatically detecting sleep apneaevents. It avoids hospital's high cost and complicated procedures and expands the screening scope of sleep apnea syndrome.

I. INTRODUCTION

Due to the advancement in Technology in the field of Medical Science it has become much easier to determine different parameters of a patient through electronic machine-like Heart rate, temperature etc. In recent years there has been increasing interest in wearable health monitoring devices, both in research and industry. These devices are particularly important to the world'sincreasingly aging population, whose health has to be assessed regularly or monitored continuously. Theimplications and potential of these wearable health monitoring technologies are paramount. One such electronic device is ApneaBand. Sleep apnea is a sleep disorder, which is an under-diagnosed, but common condition that affect both children and adults. It is an involuntary action of breathing that occurs while the patient is asleep. It is characterized by periods of interrupted breathing and periods of reduced breathing. The U.S. Department of Health and Human Services defines Sleep Apnea is characterized by disruptions in breathing such as pauses orperiods of shallow breathing while sleeping. These disruptions may last for as long as a few minutes and can occur many times, typically after loud snoring. People with Sleep Apnea often feel sleepy or tired during the day. There are two types of sleep Apnea one is the most common type called asObstructive Sleep Apnea (OSA), it occurs when the muscles of the upper airway relax and the tongue falls back limiting the amount of air you caninhale. Second one is Central Sleep Apnea (CSP) may occur in old age, although themain cause of CSA are serious condition such as heart failure, stroke and some neurological diseases.

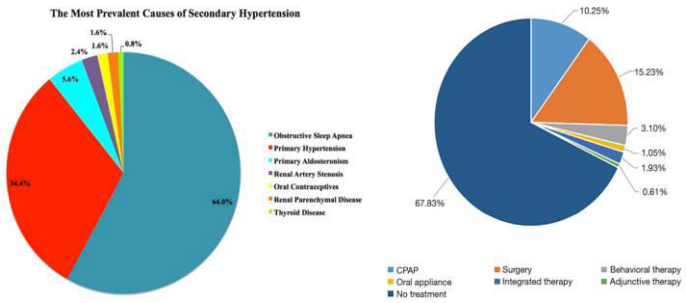


Fig (a) Fig (b)

The above figures shows occurrence & treatments of OSA

Figure (a) Contain 64.8% occurrence of OSA which is high in percent compared to other like primary Hypertension &Aldosteronism.

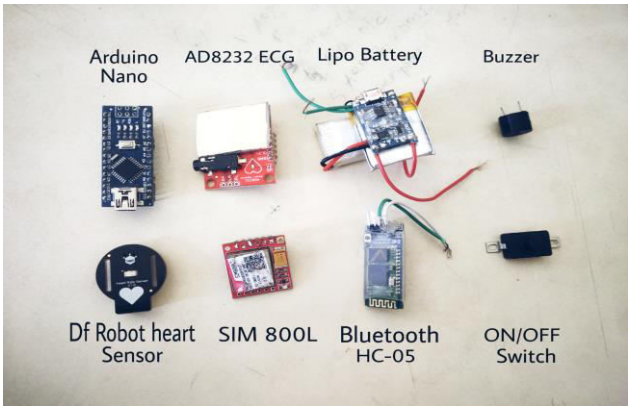
Figure (b) show treatment choice in OSA patients. Among the 67.83% patients choose the no treatment.

In this paper we describe ApneaBand, a wearable realtime health monitoring system. ApneaBand consists of a set of physiological sensors wirelessly connected via Bluetooth to a Bluetooth-enabled cell phone. These monitoring parameters can be shown on global as well as local server. Heart rate is simply measured by placing the thumb over pulse sensor for few seconds till the analog value is received by Arduino. Heart rate is then taken for 5 seconds to calculate heart rate per second. Then these values is multiplied by 60 to get heart rate in bpm (beats per minute). This method although simple, is not accurate and can give errors when the rate is high. Given all previous work, the main contributions of this paper are: (1)The implementation of a real-time, lightweight wearable health monitoring architecture, to wirelessly send physiological data to a cell phone; (2) The realtime storage, visualization and analysis of the physiological data on a cell phone.

II. SYSTEM OVERVIEW

We shall describe in this Section the three main hardware components of ApneaBand's current implementation.

A. Physical Components



Microcontroller:

We are using Arduino Nano as microcontroller. Which comes with an operating voltage of 5V, however, the input voltage can vary from 7 to 12V which has the low power consumption. Arduino Nano Pinout contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins. Each of these Digital & Analog Pins are assigned with multiple functions but their main function is to be configured as input or output.

Pulse Sensor:

Pulse sensor has three pin and connection of it with Arduino is very easy.The heartbeat sensor consists of light emitting diode and a detector like a light detecting resistor or photodiode. The heart beat pulses cause the variation of blood to different region of the body.Where tissue illuminated with the light source, that is light emitted by LED, it either reflect or transmit the light. Some of the light absorbed by the blood & the transmitted or the reflected light is received by the light detector. The amount of light absorb depends on the blood volume in that tissue. The detector output in the form of electrical signal & it is proportional to the heart bit rate.

We choose the DfRobot Heart sensor Because it has some special function like it has two kinds of signal output mode: analog pulse mode and digital square wave mode. You can change its output mode using the dial switch. Connection is made through 5V supply provided by Arduino, the ground pin of the pulse sensor is connected to the ground of the Arduino and the signal pin to the A0 of Arduino.

ECG Module&Temperature sensor :

It has some relative features like ECG Calculation & temperature measurement. We are using AD8232 ECG moduleis a cost-effective board use to measure the electrical activity of the heart. This electrical activity can be chart as an ECG or Electrocardiogram and output as an analog reading.

To measure the temperature & humidity we are usingDHT11 sensor. The sensor can measure the temperature from 0 to 50 Degree Celsius & humidity form 20% to 90% with accuracy. The sensor comes with dedicated NTC to measure temperature & an 8 bit microcontroller to output the value of temperature & humidity as serial data.

B. Wireless Data Transmission

Once a serial data stream is produced by the sensor, a wireless transmitter is required to send the data to the cell phone. We chose Bluetooth because of its pervasiveness, availability on today's cell phones and other mobile devices, and relatively low power consumption. After evaluating several Bluetooth transmission modules, we chose the HC-05 module. It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic and urban conditions. It is IEEE 802.15.1 standardized protocol, through which one can build wireless

personal area network. It uses frequency hopping spread spectrum radio technology to send data over air. It contains serial communication to communicate with devices. ApneaBand can run continuously for about 12 hourswith two AAA rechargable batteries which provide power to the sensor and the Bluetooth transmitter.

C. *Mobile Phone Application*

We create Mobile application using MIT App Inventor. MIT App Inventor for android is visual programing environment for creating applications for android based smartphones & tablets. It constitutes an alternative, quite easy but also powerful programing platform as it allows the development of app using data base, interactive maps & other advanced concept & most importantly you do not have to write code.

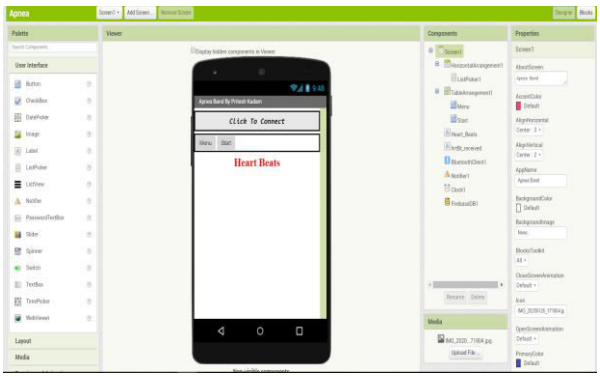


Figure 1 App Inventor Designer windowwhere you select the components for your apps.

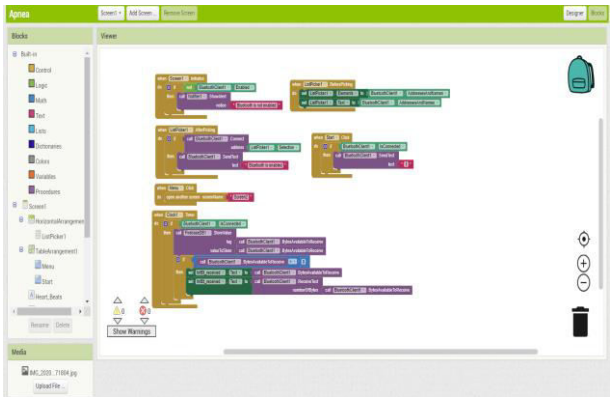
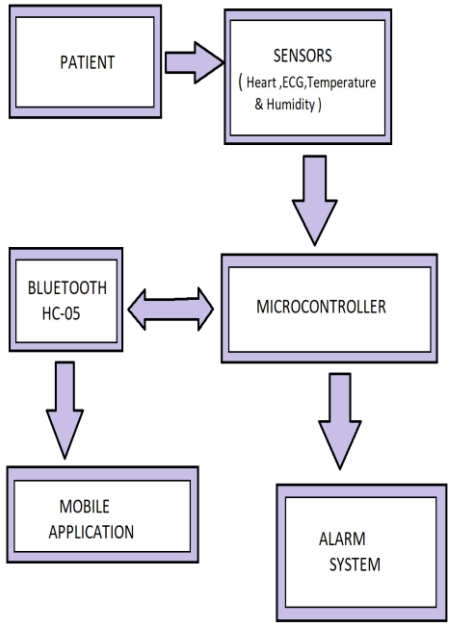
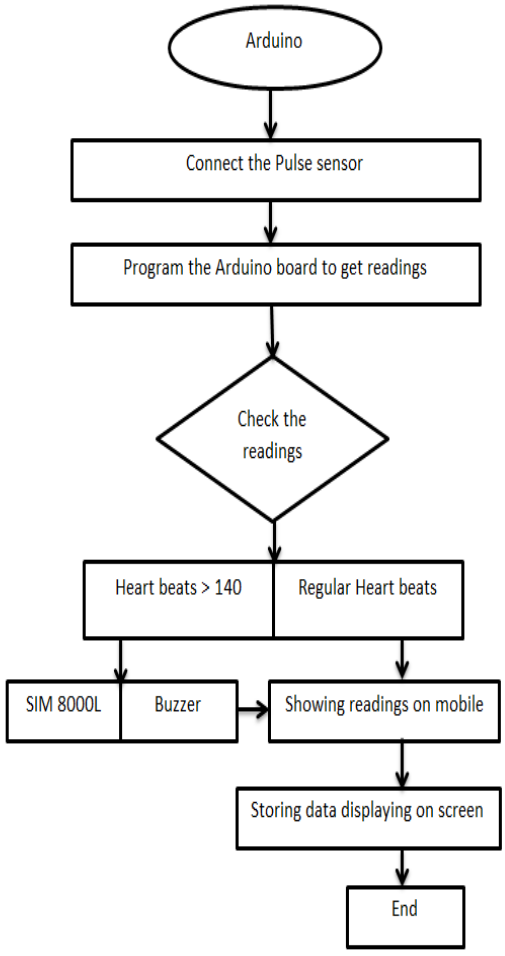


Figure 2App Inventor Blocks editor,where you assemble program blocks .

D. *Architecture*





III. AUTOMATIC DETECTION OF SLEEP APNEA

Sleep apnea is an under-diagnosed, but common sleep condition that affects both children and adults. It is characterized by periods of interrupted breathing (apnea) and periods of reduced breathing (hypopnea). The most common form of sleep apnea, called *obstructive sleep apnea* (OSA), is caused by the partial or complete constriction of the patient's upper airway. Regular sleep apnea leads to repeated hypoxemia4, asphyxia5 and awakenings, and produces immediate symptoms such as increased heart rate and high blood pressure and long term symptoms such as extreme fatigue, poor concentration, a compromised immune system, slower reaction times and cardio/cerebrovascular problems.

In ApneaBand we have implemented a methods for theautomatic detection of sleep apnea events.

We calculating the apnea using the heart rate when it is above the 140 bit it will alert the band user & also it will alert the person by the calling the neighbor.

IV. FUTUREWORK

Some areas that we would like to explore in future research include:

(1) Incorporating other sensors inApnea band, such as galvanic skin response (GSR).

(2) Finding correlations betweenlifestyle variables such as current activity, diet, exercise,stress levels, etc. and changes in physiological signals;

(3) Developing algorithms for extracting respiration rateand blood pressure from the plethysmography signal;

(4) Carrying out a study on blood oximetry at high altitudes(pilots);

(5) ComparingApneaBand performance withpolysomnography in a sleep clinic;

(6) collaborating withmedical doctors in further user studies;

(7) addressing theso important issues of privacy, liability and security.

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