International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-05, Issue-03, June 2019

Health monitoring device for visually impaired people based on Virtual Instrumentation

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Abstract Heart rate monitoring using Photoplethysmography (PPG). Photoplethysmography (PPG) signal has often used to estimate the heart rate, respiratory rate, blood pressure. Accurate heart rate (HR) estimation using photoplethysmogram is a challenging task due to motion artefacts. This paper also introduces the text to speech conversion for visually impaired individuals. • Method: This article provides a heart rate estimation from the PPG signals which is interfaced with Arduino and LabVIEW. Software development is done using LabVIEW i.e., VIs are developed to calculate the peaks of PPG signals, the time at which peaks are occurred and hence the heart rate. Arduino microcontroller is used to collect PPG sensor data. • Results: Experimentation is done using 25 PPG datasets. Results obtained are compared with true values. The average absolute estimation error is 1.1 beats/min. It is observed that proposed system has provided precise performance. Text to speech conversion also executed successfully and it gives us softer and clearer voice output. These results show that the system is competent to be used for PPG-based heart rate monitoring.

Keywords:- Arduino UNO, Data reading and writing, Heart rate, LabVIEW, LM35, Physiological data monitoring, PPG sensor, Text To Speech technique.

I. INTRODUCTION

Continuous measurement of patient parameters such as heart rate and rhythm, respiratory rate, blood pressure, blood oxygen saturation, and many other parameters have become a common feature of the care of critically ill patients. When accurate and immediate decision-making is crucial for effective patient care, electronic monitors frequently are used to collecting and display physiological data. Increasingly, such data are collected using non-invasive sensors from less seriously ill patients in a hospital’s medical-surgical units, labor and delivery suites, nursing homes, or patients’ own homes to detect unexpected life-threatening conditions or to record routine but required data efficiently[12].

Speech synthesis has long been a vital assistive technology tool and its application in this area is significant and widespread[15].

Visually impaired people face some problems in the medical field, that are –

- Unable to read the information displayed on the screen
- To access instruments or devices with complex user interfaces
- Unable to access written information[7]

The term written information includes paper, handwritten notes, prescriptions, and display of electronic component. When the written information is language based then the speech is the best solution to convey the information to blind people. In this paper, we developed the system which overcomes the above-mentioned problems[7].

II. HARDWARE

In this experiment, Arduino UNO, pulse sensor (Photo-plethysmographic sensor) and temperature sensor (LM35) are used to estimate heart rate and body temperature of the subject.

i. Arduino UNO :

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc[14]. Arduino UNO microcontroller

 DOI : 10.35291/2454-9150.2019.0238

ISSN : 2454-9150 Vol-05, Issue-03, June 2019

board is used to acquire data from photo-pletysmographic sensor and temperature sensor(LM35).

ii. Pulse Sensor :

Pulse sensor (Photo-pletysmographic sensor) is used to detect heart rate. It is an integrated optical amplifying circuit and noise eliminating circuit sensor. Clip the Pulse sensor to fingertip and connect it to Arduino. Arduino is interfaced with LabVIEW software and heart rate is calculated.

iii. LM35 (Temperature Sensor) :

Temperature sensor (LM35) is used to measure the body temperature of the subject.

III. SOFTWARE

The Selection of Virtual Instrumentation is due to its more extensive graphical capabilities along with its availability. VI Package Manager can be used to interface Arduino with LabVIEW for ADC. LabVIEW program will be built for audio output. National Instrument's LabVIEW is a platform and development environment for visual programming. The purpose of such programming is automating the usage of processing and measuring equipment in any laboratory setup. Controls and indicators on the front panel allow an operator to input data into or extract data from a running virtual instrument.

Tools used:

- LabVIEW
- Arduino IDE

IV. METHODOLOGY

Fig. 1 shows the schematic diagram of the developed system :

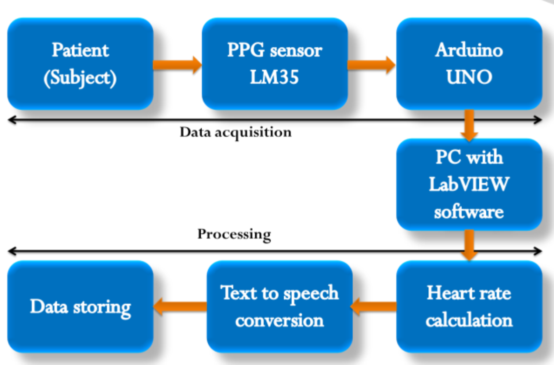

Fig.1 : Schematic Diagram of Patient monitoring system using Virtual Instrumentation

- Data acquisition
- Processing
  - BPM calculation
  - Text to speech conversion
  - Data storing

A. Data acquisition

PPG makes use of low-intensity infrared (IR) light. When light travels through biological tissues it is absorbed by bones, skin pigments and both venous and arterial blood. Since light is more strongly absorbed by blood than the surrounding tissues, the changes in blood flow can be detected by PPG sensors as changes in the intensity of light. The voltage signal from PPG is proportional to the quantity of blood flowing through the blood vessels. Even small changes in blood volume can be detected using this method, though it cannot be used to quantify the amount of blood.

The acquired signal has two components: AC and DC. AC component indicates the variations in blood volume synchronization with heartbeats. DC component indicates the reflected or transmitted optical signal by tissues. These components are then connected to Arduino UNO board through analog pin A1.

To determine body temperature, the temperature sensor (LM35) IC is used. The output signal from temperature sensor (LM35) is also connected to Arduino UNO board through analog pin A0.

B. Processing

First of all, we have to interface Arduino UNO board with LabVIEW software. We have to install LIFA(LabVIEW Interface For Arduino) and LINX package for this interfacing. The LabVIEW Interface for Arduino (LIFA) Toolkit allows developers to acquire data from the Arduino microcontroller and process it in the LabVIEW Graphical Programming environment. LINX is an open source project by Digilent and is designed to make it easy to develop embedded applications using LabVIEW. After interfacing Arduino UNO board with LabVIEW, further processing is done in LabVIEW software.

i. BPM calculation

To calculate the heart rate from the acquired signal, we have to determine the number of peaks in the signal. After that, we have to calculate the duration between the first and last peak from a group of ten successive peaks. Using these two parameters, we can easily calculate heart rate using the following formula:

$$\mathrm{H.R.} = \frac{600}{\text{Time duration between ten successive peaks (sec)}}$$

beats/minute

Detection of peaks and the calculation of time duration and heart rate is by designing of VI in LabVIEW. VI is the

 DOI : 10.35291/2454-9150.2019.0238

ISSN : 2454-9150 Vol-05, Issue-03, June 2019

graphical programming which is designed in LabVIEW. Detection of peaks is done by using a sub VI block named as "Peak detector".

ii. Text to speech conversion

A text to speech system converts normal language text into speech. Synthesized speech can be created by concatenating pieces of recorded speech that are stored in a database. A text to speech system is composed of two parts: a front end and a back end. The front end has two major tasks. First, it converts raw text containing symbols like numbers and abbreviations into the equivalent of written out words. This process is called text normalization, pre-processing, or tokenization. The front end then assigns phonetic transcriptions to each word and divides and marks the text into prosodic units, like phrases, clauses, and sentences. The process of assigning phonetic transcriptions to words is called text to phoneme conversion. The back end often referred to as the synthesizer then converts the symbolic linguistic representation into sound[14]. The text to speech system has been designed in the LabVIEW software. Text to speech conversion is carried out by using the constructor node and invoke node blocks.

iii. Data storing

In the developed system, the data storing process is carried out by designing a VI in LabVIEW using some File I/O functions. Data file can be stored in the form of .txt, .csv, or .lvm file(LabVIEW Measurement file). "Write Delimited Spreadsheet file.vi" and "Write Measurement file.vi" are the sub VI blocks which are used to store physiological data. For further analysis or study purpose, we have to read this stored data. Hence to read stored data two more sub VI blocks are used which are: "Read Delimited Spreadsheet file.vi" and "Read Measurement file.vi".

V. GUI

Fig. 2 & Fig. 3 shows the GUI designed for the system.

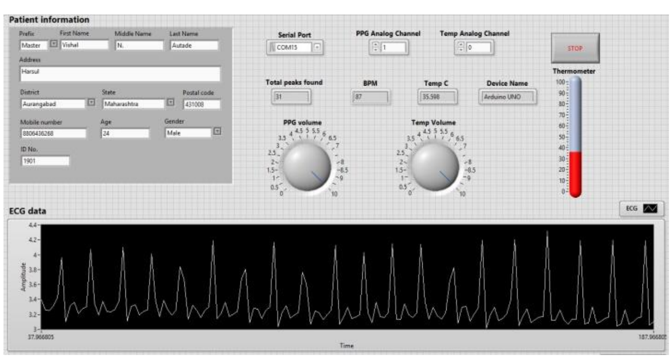

Fig. 2 : Front panel (Monitoring physiological data and data storing)

Fig. 3 : Front panel (Reading stored data)

Using these GUIs, we can enter and save the patient information. Also we can see pulse waveform, body temperature and heart rate of the patient.

VI. RESULTS

Experimental results on 25 PPG datasets are recorded and compared with true values. The average absolute estimation error is 1.1 beats/min. It is observed that the system has provided precise performance. Text to speech conversion is also executed successfully and it gives softer and clearer voice output.

VII. CONCLUSION

Heart rate and the temperature of the body of a subject has been calculated accurately and validated. TTS technique has been designed and developed in LabVIEW for proposed system. These results show that the system is competent to be used for PPG-based heart rate monitoring. LabVIEW platform is used for software development – GUI(Graphical User Interface) and monitoring.

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