Non Invasive GlucoPulse Watch 2.0

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Abstract - The non-invasive glucose measurement method is very important to decrease infection and physical injuries which are caused due to invasive glucose measurement. Bio-impedance measurement is gaining importance in the wide field of bio-research and biomedical systems due to its non-invasive nature. The basic principle of bio-impedance can be used for blood glucose analysis. The input from the bio-impedance sensor is given to the amplifier and signal conditioner AD5933. Pulse rate measurement is done with the help of the pulse sensor. AD5933 IC and pulse sensor are then interfaced with microcontroller Atmega 328p. We are using the I2C bus for displaying reading on the OLED screen. Results will also be stored in the database in the cloud using UART protocol in Atmega 328p.

***Key Words*:** Invasive, Non-Invasive, Atmega 328p, Bioimpedance, Bio-Impedance Measurement, Pulse Sensing, Internet Of Things.

1. INTRODUCTION

Health has always been the most important concern for humans. Nowadays, the changed lifestyle of the human being has led them to suffer many diseases like High BP, Low BP, Diabetes, etc. There is a significant rise in the no. of people suffering from Diabetes. The no. of victims suffering from Diabetes is about 62 million in India, which is more than 7.2% of the adult population.

Over 40 million people in India are using Invasive Glucose measurement devices. Invasive Glucose measurement devices are the devices that uses blood samples, pricked from the fingertip, for the measurement of the Glucose Level of an individual. Due to these invasive techniques, used for measuring the Glucose Level, many people are also suffering from infectious diseases. This is where our Non – Invasive GlucoPulse Watch2.0 comes into the picture. This watch can measure pulse rate along with the Glucose Level of a person wearing this watch.

The core technical innovation in this device is the combination of a pulse sensor and a bio-impedance sensor on a single PCB layout. The measured values by the device can also be monitored by the patient on the watch as well as by the doctors from anywhere with the help of the IoT feature.

A. Key Features

i. This approach of measuring has the potential to save a lot of time in patient-doctor interaction.

ii. This will help the patients to measure accurate glucose level using bio-impedance and pulse rate using a single module, hence reducing the trauma.

iii. Measurements can be monitored from anywhere irrespective of the physical location of the doctor and the patient.

B. Problems Faced Today by the People

i. No real-time and automatic technology is available for the common person.

ii. Embedding an IoT feature via which real-time monitoring would be provided.

iii. Portable non-invasive technique is not available to measure glucose level using bio-impedance.

iv. Such a prolific combination of pulse and glucose measurement and time on a single module is nowhere to be found.

v. Watch is accompanied by its own unique database in order to maintain 30 days past health record for future references.

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2. DESCRIPTION

The module is a multi-featured watch that has a lot of applications in the aspects of medical and electronics implications. The module consists of a controlling unit, sensing unit, and displaying unit. The controlling unit includes microcontroller Atmega328p which is used to process the input values from the sensors, the sensing unit consists of a pulse sensor and bioimpedance sensor which takes input directly from the body. The phenomena used by pulse sensor is sending the high-intensity light through our skin out of which some are absorbed by the capillary tissue while the remaining is reflected back to the photosensitive square which calculates the pulse rate giving corresponding analog values to the microcontroller unit. The bio-impedance sensor measures the bio-impedance of the covered area and sends the values to the microcontroller. The displaying unit consists of an OLED screen and any device like a smartphone, laptop for monitoring the measured values of glucose level and pulse rate. Monitoring of the measured values of blood glucose level and pulse rate can be so easily done that too anytime and from anywhere by the patient or by the doctor. The IoT feature in the module provides the liberty to check these measured values from any part of the world. There is also an additional feature of displaying the time and date of the region which gets updated by connecting with the internet. This feature will help in removing the need for wearing any additional watch for getting the time and date. Such a prolific combination of all the above-mentioned features has never been found.

A. Block Diagram

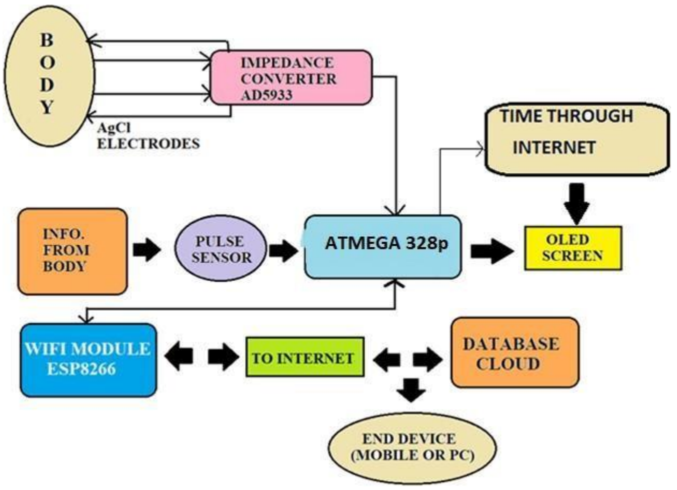

Fig -1: Working Block Diagram

B. Resources Used

i. **Microcontroller Atmega328p:** It is an Atmel 8-bit AVR RISC-based microcontroller with following features:

1. 32 KB ISP flash memory with read-while-write capabilities.

2. 1 KB EEPROM, 2KB SRAM

3. 23 general-purpose input/output lines

4. 32 general-purpose working registers.

5. Three flexible timers/counters with compare modes

6. Internal and external interrupts

7. Serial programmable USART a byte-oriented 2-wire serial interface

8. 6-channel 10-bit Analog to Digital converter.

ii. **Pulse Sensor:** It consists of three wires where red represents 5V, black represents ground and purple represents an analog output of pulse sensor. The analog output of the pulse sensor is connected to an analog input pin of Atmega328p.

iii. **Wi-Fi Module ESP8266:** This Wi-Fi module is a self-contained SoC and has integrated TCP/IP protocol stack which can give any microcontroller access to your Wi-Fi network.

iv. **Bio-impedance Sensor:** It is highly precised impedance converter system that includes an on-board frequency generator with a 12-bit, 1 million samples per second analog-to-digital converter. The frequency generator allows the external impedance ,in complex form, to be excited by a known frequency. The response signal from the bio-impedance sensor is sampled by the on- board Analog-to-Digital Converter (ADC) and a Discrete Fourier Transform (DFT) and then is processed by an on-board DSP engine. The DFT algorithm results a real (R) and imaginary (I) data-word at every output frequency. It requires 4 electrodes to get the measurement of bioimpedance.

v. **OLED Screen:** It is a 0.96 inch blue OLED display module with a resolution of 128x64 and can be interfaced with any microcontroller using I2C protocols. The package includes display board, 7 pin male header pre-soldered to board. It consists of 4 pins: VCC, Ground, SCL, SDA.

3. WORKING

The input is given to the bioimpedance sensor from the body. In the case of raised glucose levels, the bio-impedance level also decreases. Bioimpedance sensor measures the bioimpedance level of the covered region and sends the corresponding analog values of bioimpedance to the microcontroller via I2C protocol. The pulse sensor works on the principle of photoplethysmography. It is used to measure the change in volume of blood in the finger which leads to change in the light intensity through the finger.

There is a flow of blood that is decided by the heart pulses. As the light emitted by the pulse sensor is absorbed by the blood, the signal pulses are recorded which are equal to the number of heartbeat pulses. The basic pulse sensor consists of an LED and a photodiode. The variation in the flow of blood is caused by heartbeat pulses.

The Wi-Fi module is serially connected to the microcontroller via the UART protocol. The Wi-Fi module is used for setting the IoT feature through which the output of measured values of pulse rate and glucose level can be accessed from any part of the world using some Unique IDs by the patient or the doctor. The measured output values of pulse rate and glucose level can be seen on the OLED screen connected to the microcontroller. This module is also used to get the present time and date with the help of the internet which will be displayed on the watch (OLED screen) worn by the patient.

4. RESULTS

The pulse sensor has been implemented and shows accurate measured values for an adult to validate the results. The app has been created and display same values to the user of the app using the predefined login credentials.
Even the performance is better than conventional method.

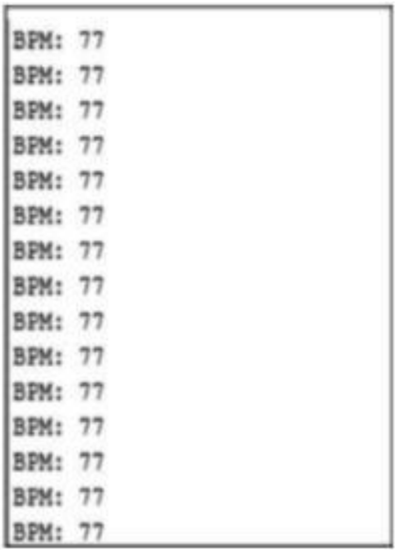

Fig -2: Measurement of Pulse Rate using Pulse Sensor

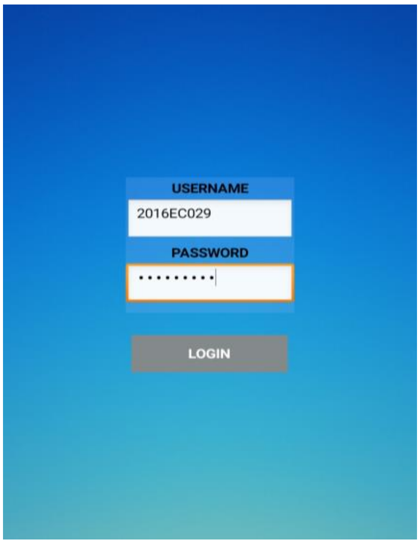

Fig -3: Login Page of the developed app

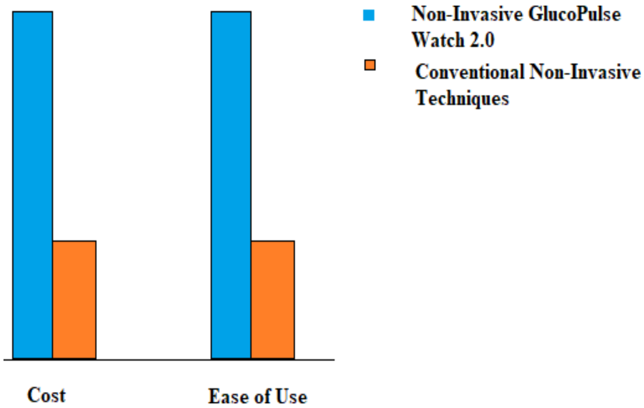

Fig -4: Comparison of Conventional and Non Invasive GlucoPulse Watch 2.0

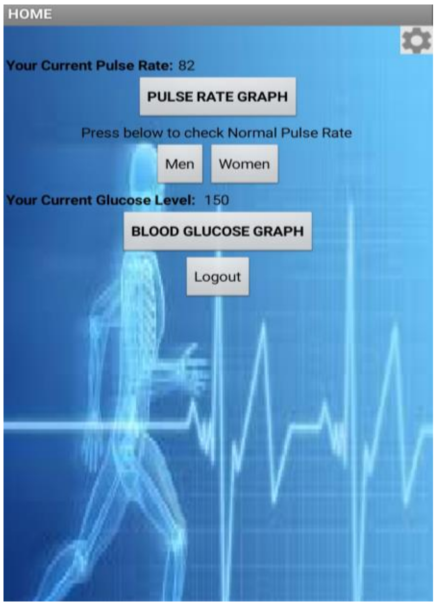

Fig -5: Homepage of the developed app

5. CONCLUSIONS AND FUTURE SCOPE

1. Output is taken within few seconds.

2. Reduced cost as compared to the conventional methods of measuring glucose level non-invasively.

In the future, an additional feature of measuring the body composition, the skin water content in the body, ECG and other features which can be determined using bioimpedance.

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