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REGULAR ARTICLE

Analysis of Vital Signs through a Smart Heart Beat Technique Based on Arduino

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The work reports an analysis of vital signs of human beings through a smart heart beat and pulse monitoring system based on Arduino device. Vital signs include heart rate, pulse monitoring and oxygen level of a human being. The system contribute improvements in individual's healthcare out-comes. AD8232 ECG sensor is used through Arduino Mega which amplify and filters the ECG signals obtained from the electrodes. Arduino Mega is powered by 5 V supply voltage. ECG sensor uses 3 cables which has disposable patches and connected to the chest of human being to capture bioelectric signals. Hence, heart rate and pulse of a human being has been monitored. An additional capacitive filter circuit is used Furthermore, MAX30102 sensor have been used to determine the oxygen level of a person. The results obtained from the study provides a good accuracy. The heart rate varies as per the age of human being. The oxygen accuracy level falls in the range of 95% to 100%.

Keywords: Heart rate, Pulse, ECG, Arduino, Oxygen level.

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1. INTRODUCTION

A vital monitoring system for human healthcare is a medical technology particularly intended to endlessly supervisor and record the essential physiological parameters of a patient. These parameters include vital signs such as heart rate, blood pressure, respiratory rate, body temperature, and oxygen saturation levels. The systems are crucial in various healthcare settings consisting of medical centers, intense care units, emergency divisions and even home healthcare.

The heart rate is measured in terms of bits per minute. The heart is an organ in human being which circulates oxygenated blood throughout the body. Figure 1 indicates PQRST waveform [1-3] of ECG waveform of electric impulses created due to single heartbeat. ECG is mainly used to study the electrical activity of heart, so that we can know any heart abnormality or heart disease. Human heart has four chamber i.e. right auricle, left auricle, right ventricle and left ventricle. In Fig. 1. P wave indicates excitation state of right and left auricle together. This is also called as depolarization of both atrium. QRS interval indicates excitation state of both the ventricular together. For the forceful contraction QRS shows a high peak. T wave indicates return of the ventricle from excited state to the normal state.

Arulnath T.S. et al. [4] in 2017 developed a heart-beat monitoring system using embedded system based on photo phelthysmo graph. P. Bansal et al. [5] in 2018 developed a smart heart rate monitoring system using infrared transmitter and receiver section. The obtained heart rate is given to Raspberry pi and used through Internet of things. A.R. Barai et al. [6] in 2017 developed a noninvasive heart rate monitoring system. In this system instead of monitoring the heart rate message is sent to doctor through Global System for Mobile (GSM) and radio frequency module. F. Jibril et al. [7] in 2019 developed a heart rate monitoring and detection system based on microcontroller. Here the system uses pulse sensor to magnitude heart rate and GSM module transmit the message. I. Ishaq et al. [8] in 2020 developed online monitoring health system using Arduino. Heart rate and temperature is recorded to the cloud service which can be access in real time by the medical staff. A. H. Kioumars et al. [9] in 2011 developed a wireless network for heart rate and temperature sensing. In 2015 A. Rini et al. [10] developed a movable heart rate computation set-up for isolated health monitoring arrangement.

In the present work a heart rate and pulse monitoring system has been reported based on Arduino device. Electric impulse from heart beat are collected through ECG sensor cables and given to Arduino mega through AD8232 ECG sensor and displayed it on Arduino IDE. Furthermore, MAX30102 sensor is used and connected

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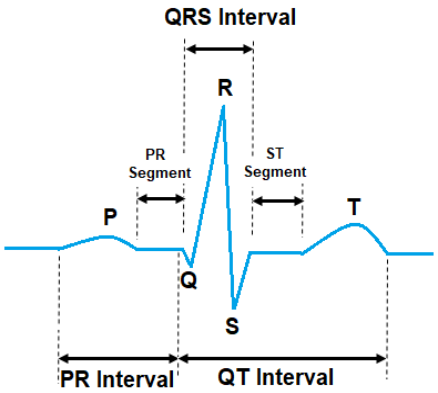

Fig. 1 – PQRST waveform of ECG

2. IMPLEMENTATION

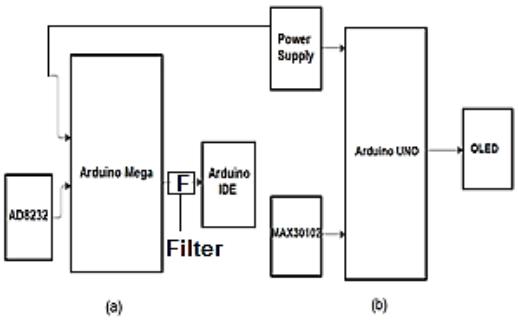

Fig. 2 – Block diagram of the scheme

Fig. 2(a) indicates block diagram of heart beat sensing device. Here Arduino Mega is powered by 5 V power supply. Electrical activity of heart is given as input to the AD8232 sensor. The output of the sensor is connected to the Arduino Mega. Arduino IDE reads the electrical activity of heart received from Arduino Mega through a capacitive filter circuit and heart rate is dis-played in the computer.

Fig. 2(b) indicates block diagram sensing oxygenated saturation in blood. A power supply is added to the Arduino UNO. MAX30102 sensor is also associated to the Arduino UNO though which Arduino can read humans oxygen level. Finally, oxygen level is displayed in OLED display.

Fig. 3 shows circuit diagram of heart rate sensing. The circuit consists of Arduino Mega with AD8232 sensor. AD8232 comprises of 6 pins such as GND, 3.3V, OUTPUT, LO-, LO+, SDN. These 6 pins are associated to analog pins of Arduino mega from A1 to A6. The data from AD8232 is taken by Arduino mega and then it can be displayed in the serial plotter and serial monitor of the Arduino IDE. The serial plotter displays the signals coming from the analog pin A3 and it calculates the heart beat and display it in the serial monitor. If the input electrode is removed from the chest than it will display the Lead OFF message in the serial monitor.

Fig. 4 shows circuit diagram of oxygen level sensing. It consists of Arduino UNO with MAX30102 sensor. A 5 V DC power supply is given as input to the Arduino UNO. For oximeter the module used is MAX30102 and output is displayed on SSD1306 which is an OLED display. MAX30102 is combined to the input of the Arduino UNO and OLED display is connected at the output of Arduino UNO. Oxygen saturation level percentage in the blood can be seen on the OLED display. When the finger of a person is gently placed over the top of IR LED of MAX30102 the result of oxygen saturation level is displayed on OLED display. When the finger is removed from then sensor the screen start displaying "PLEASE PUT FINGER".

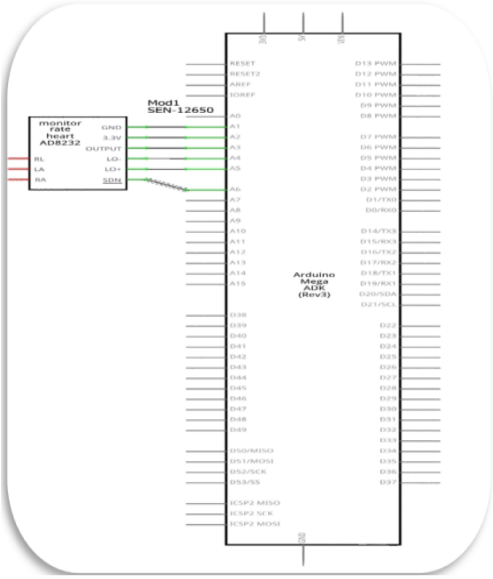

Fig. 3 – Circuit diagram of heart rate sensing

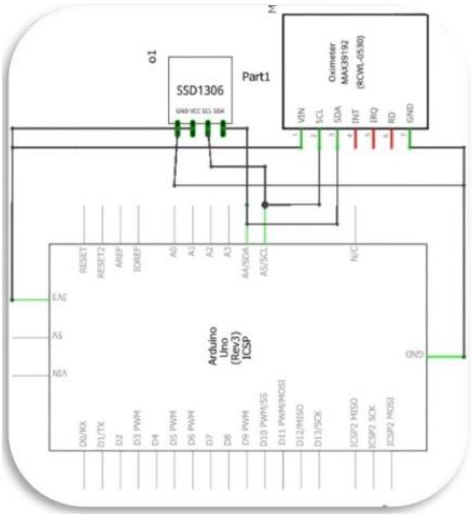

Fig. 4 – Circuit diagram of oxygen level sensing

3. RESULT AND DISCUSSION

Fig. 5 indicates the prototype of the system. It consists of a power supply, laptop, Arduino Uno, step-down transformer, ECG electrodes, AD8232 sensor, Arduino mega, MAX30102 and OLED display. A 5 V dc power supply is used to power up the Arduino Uno

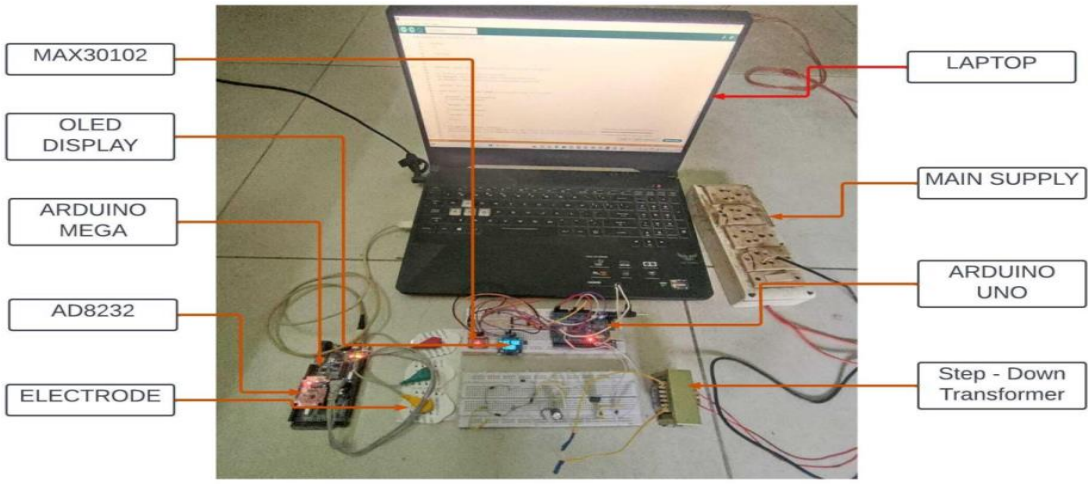

Fig. 5 – Prototype of the system

where MAX 30102 sensor and OLED display are connected. AD8232 sensor is associated to Arduino mega. Arduino mega is combined with the laptop through a micro USB cable. Arduino mega is also powered by 5 V supply through the USB cable. AD8232 sensor has three cables namely red, yellow, and green as shown in Fig. 6. These cables are wired into a 3.5 mm jack. The 3.5 mm jack of the three cables is connected to 3.5 mm slot of AD8232 module. The three cables are connected to the dis-posable patches which is paste to the chest and it will capture the bioelectric signal and display it on Arduino ide.

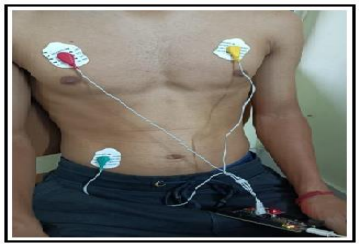

Fig. 6 – Single Lead connected to the human

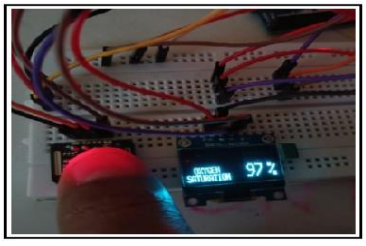

Fig. 7 – Oxygen Saturation level.

Fig. 7 shows oxygen saturation level showing on OLED display by using MAX30102 sensor module.

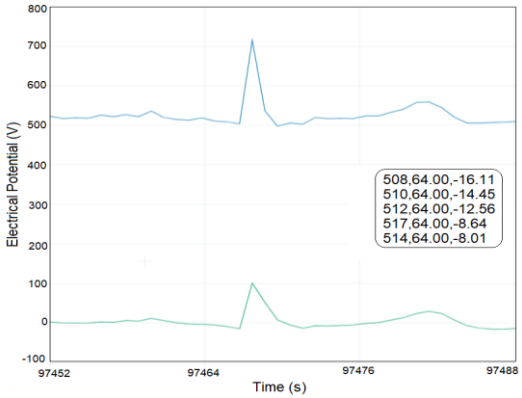

Fig. 8 – Reported ECG waveform for a 21 year aged human

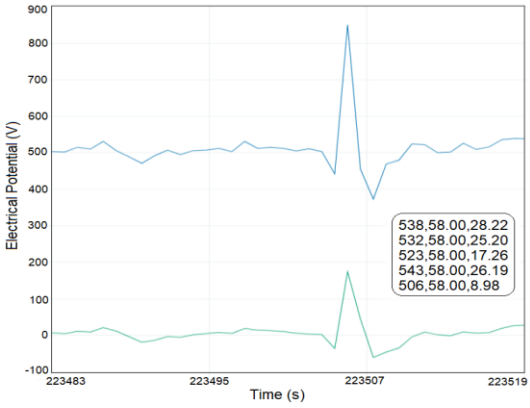

Fig. 9 – Reported ECG waveform for a 24 year aged human

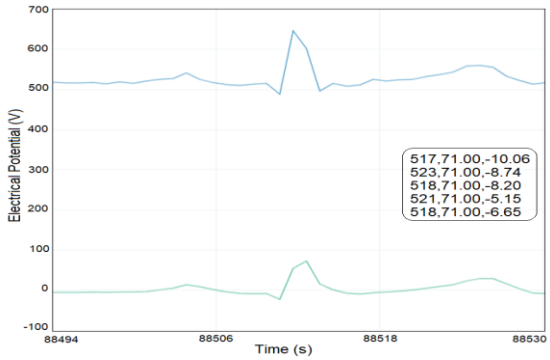

Fig. 10 – Reported ECG waveform for a 37 year aged human

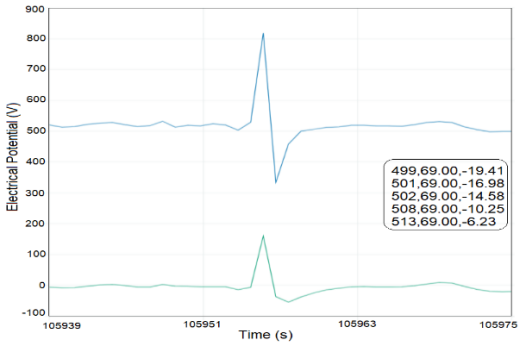

Fig. 11 – Reported ECG waveform for a 43 year aged human

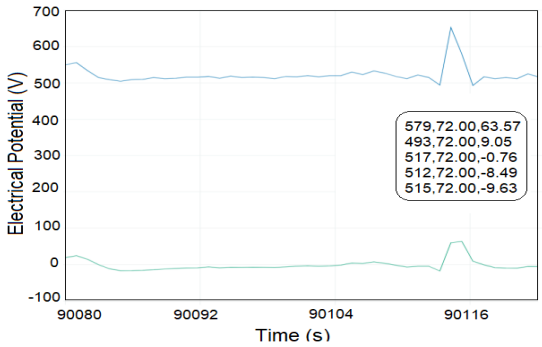

Fig. 12 – Reported ECG waveform for a 49 year aged human

Fig. 8 indicates a recorded waveform for 21 years aged human. 508 is the R peak and 64 is the heart rate. Fig. 9 shows a recorded waveform for 24-year-old person. It shows that R peak has reached to 538 and 28.22 shows peak of the filtered graph and 58 is the heart rate. Fig. 10 shows a recorded waveform for 37-year-old person. It shows that R peak has reached to 517 and – 10.06 shows peak of the filtered graph and 71 is the heart rate. Figure 11 shows a recorded waveform for 43-year-old person. It shows that R peak has reached to 499 and – 19.41 shows peak of the filtered graph and 69 is the heart rate. Figure 12 shows a recorded wave-form for 49-year-old person. It shows that R peak has reached to 579 and 63.57 shows peak of the filtered graph and 72 is the heart rate.

4. CONCLUSION

The work reported here is mainly focus on study of heart beat and oxygen saturation level detection with the help of Arduino device. For the study of heart beat detection AD8232 ECG sensor is used through Arduino Mega. 3 cables for ECG sensor are connected to human body and different aged person's ECG waveform have been recorded throughout the investigation. MAX30102 sensor module is used for the detection of oxygen level saturation in human being. Oxygen level accuracy level found in between 95% to 100%. IOT based health monitoring system including features like blood pressure and temperature using mobile application is the future scope of the project work.

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Аналіз життєво важливих ознак за допомогою техніки розумного серцебиття на основі Arduino

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У роботі представлено нові розробки щодо проведення аналізу життєво важливих ознак людини за допомогою розумної системи моніторингу серцебиття та пульсу на основі пристрою Arduino. Життєві ознаки включають частоту серцевих скорочень, моніторинг пульсу та рівня кисню в організмі людини. Система сприяє покращенню результатів лікування людини. Датчик ЕКГ AD8232 використовується через Arduino Mega, який посилює та фільтрує сигнали ЕКГ, отримані від електродів. Arduino Mega живиться від напруги живлення 5 В. Датчик ЕКГ використовує 3 кабелі, які мають одноразові накладки та з'єднані з грудною кліткою людини для захоплення біоелектричних сигналів. Таким чином, відстежується частота серцевих скорочень і пульс людини. Використовується додаткова схема емнісного фільтра. Крім того, датчик MAX30102 використовувався для визначення рівня кисню в організмі людини. Результати, отримані в результаті дослідження, забезпечують хорошу точність. Частота серцевих скорочень змінюється в залежності від віку людини. Рівень точності кисню знаходиться в діапазоні від 95% до 100%.

Ключові слова: Частота серцевих скорочень, Пульс, ЕКГ, Arduino, Рівень кисню.