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Design and implementation system for the monitored patient with heart disease

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Abstract

In recent decades, heart disease has become a major concern, and many people have died because of various health issues, heart disease is a critical issue in the health sector. We propose a monitoring system that include AD8232 ECG sensor based on the Arduino to monitoring the people that have heart disease. The AD8232 ECG sensor is a small chip that measures heart electrical activity, also can be recorded the signals and analyzed. In this paper, Electrocardiogram(ECG) with AD8232 ECG sensor are used to show ECG graph through the monitoring of the patients, it used to help diagnose various heart conditions.

The proposal scheme is simplified the process of connecting and show the signals on LCD screen. The results are shown the electrical activity, which used to diagnose the heart conditions for the different ages. The simulation of the proposal scheme by using proteus virtual system modeling; the results show the ECG graph. In addition, in the practice side, it is connected and applied on the human body to show the results for the monitoring that is represented the ECG signals.

Keywords: Electrocardiogram, Arduino, AD8232 Sensor, simulates electrodes.

I. Introduction

For many years, heart disease was one of the major killers of people's health. According to word health organization research, heart disease is the leading cause of death for the vast majority of people. As a result, this disease should not be taken lightly. As a result, the majority of health-care equipment and monitoring systems are designed to keep track of the disease**. [1]**

As a result, in this paper, you will learn how to monitor the heart and observation any changes in heart rate by using Arduino and ECG sensor. To detect every heartbeat, An ECG Sensor with disposable electrodes attaches directly to the patient's chest. The ECG sensor's electrodes sensor will convert the heartbeat to the electric signal. ECG electrodes are extremely light and thin, accurately measuring continuous heartbeat and providing heartbeat rate data. Only trained doctors and medical personnel are permitted to use this device. The ECG Sensor electrodes have three pins and are connected by a 30-inch cable. It has simplified the process of connecting the ECG sensor. patients, connects with Arduino on another side, and finally shows the signal on LCD screens **[2].** The paper is organized as follows . Section II deals with the heart. Section III presents Arduino. Also, section IV focuses on the simulation Section IV discusses The proposed scheme section V focuses on Performance analysis of scheme section VI discusses the Results and Discussions VII gives conclusions and hints for future work. We will learn about the heart, the Heart Valves, The coronary tree, Electrical model of heart. ECG, Definition and what is used for ,ECG leads and the location, of ECG electrodes,ECG wave ,component of ECG wave ,normal and abnormal ECG,in addition to Arduino and overview about it.

2. Heart

Heart is a cardiac muscle that contract to pump the blood through all parts of body by the circulatory system. Therefore, we can see in figure (1), the human heart is divided internally into 4 chambers, the 2 upper chambers, (the right and left atria); received blood as it returns to the

heart. These atria move the blood to the 2 lower chambers, (the right and left ventricles); which pump blood into major arteries of the circulatory system [**3,4].**

2.1The Heart Valves

The atrioventricular valves: During systole, the AV-valves (the tricuspid and the mitral valves), block the movement of blood from the ventricles to the atria. Stellular valves: During diastole, the aorta and pulmonary arteries are inserted into the ventricles. All of these valves close and open passively, meaning that they close when a backward pressure gradient pushes blood backward and open when a forward pressure gradient forces blood forward. The thin, filmy AV- valves require almost no backflow to close for obvious anatomical reasons, whereas the much heavier semilunar valves require relatively strong backflow for milliseconds **[5].**

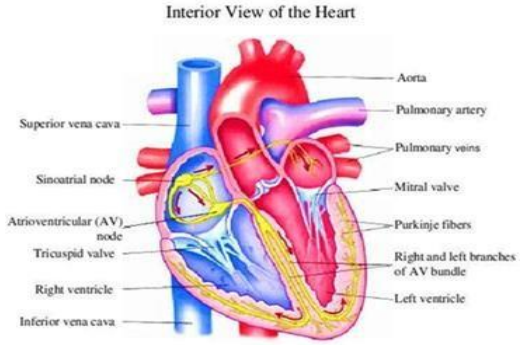

Fig.1 Shows the heart valve

2.2 The coronary tree

1- The Circulatory System:

Arteries are the blood channels responsible for transporting blood away from the heart. The heart receives approximately all of its nutritive blood supply from the aorta, from which the coronary arterial system branches into its first two major veins. The inner surface of the endocardium, measuring between 75 and 100 micrometers, can directly receive nutrients from the blood in the heart chambers. The left coronary artery, which divide near its origin into the left anterior descending artery (LAD), and the left circumflex artery (LCA), supply mainly the left ventricle's anterior and the lateral portions. Approximately 80% to 90% of the right ventricle and the posterior portion of the left ventricle are supplied by the right coronary artery **[6].**

2- The Vein System:

Veins: Are blood vessels that carry oxygenated blood to the heart. After blood has passed through capillary bed in the myocardium, it get in a series of cardiac veins, great cardiac vein, middle cardiac vein, and small cardiac vein. Before the blood is combined through, a common venous channel called coronary sinus, which is an inch long and opens in the cavity of the right atrium **[6].**

2.3 Electrical model of heart

Bioelectric sources spontaneously arose at the cellular level in the heart. To summarize, the heart cells are obscure in a fluid matrix that is separated from the interior of the cells by their membranes. These membranes regulate the transport of ions. In the resting situation, the interior of the cells has a negative potential when at rest. The cells are electrically polarized on the outside. However, in the senatorial (SA) and atrioventricular (AV) nodes, which are specific regions of the heart, muscle (myocardial) cells depolarize abruptly and then return to their resting value. This effect is caused by ions passing in either direction across the cell membrane. As a result, particularly SA and AV node cells generate an electrical [**4,6].**

3. ECG

3.1 Introduction to ECG

An ECG is a test that finds an electrical wave that controls how hard the heart muscle works. When a typical pacemaker is used, this electrical wave travels through the atria, causing them to constrict and aiding in the flow of blood from the atria to the ventricles. The electrical signal then passes through special conducting fibers to the heart chambers, forcing them to constrict. This causes blood to flow from the left ventricle to the bodily tissues via the aorta and from the right ventricle to the lungs.. An electrocardiogram (ECG) examination, can detect the presence of disturbances in the production and conduct of the electrical wave, which may be caused by a heart

conduction [7].

3.2 The purpose of the ECG?

- Screening tests for cardiomyopathies, coronary artery disease, and left ventricular hypertrophy.
- Before surgery, to eliminate the possibility of coronary artery disease.
- Can provide data in the presence of metabolic changes such as hyperactivity, hypocalcemia, and kalmia, among others.
- Monitor the progression of any cardiac disease you may have.
- The identification of heart diseases, such as myocardial, aortic, and cognitive heart diseases, as well as infarction and coronal insufficiency.
- It is the most common cardiologic test that assesses rhythm problems in patients with known or suspected cardiac disease**[7,9].**

3.3 ECG LEADS

For recording electrocardiograms from standard bipolar limb leads, the electrical connections between the limbs and the electrocardiographic. The term bipolar refers to The electrocardiogram is recorded from two separate electrodes on the body, in this example the limbs. A lead is a combination of two wires and their electrodes that make a complete circuit with the electrocardiograph rather than a single wire connection from the body. Despite the fact that the electrocardiograph is a high-speed recording device, mechanical meters are utilized in each case to represent it. A moving paper meter includes twelve leads: six limb leads (I, II, III, aVR, aVL, and VFvf) and six chest leads (v1-v6). The limb leads are made up of standard bipolar I ii, and iii" leads as well as augmented "aVR, aVL, and aVF" leads. The Bipolar leads got their name from the fact that they measure the difference in electrical voltage between two extremities **[6,8].**

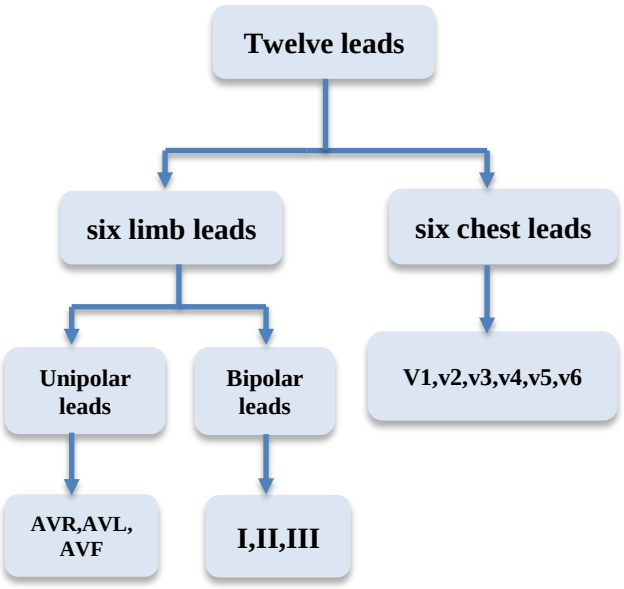

Fig.3 shows ECG leads

3.4 ECG electrodes

An interface between the body and the electronic measuring apparatus is required to measure and record potentials and, consequently, currents in the body. Biopotential electrodes serve as the interface. In any practical measurement of potentials, current flows in the measuring circuit for at least a fraction of the measurement time. This current should be extremely minor. In practice, 14 is almost never zero. As a result, Biopotential electrodes must be capable of conducting a current between the body and the electronic measuring circuit. Because current is carried by ions in the body but not in the electrode and its surroundings, the electrode served as a transducer **[9].**

3.5 ECG wave

A record of this current can be obtained by attaching electrodes to various parts of the body. This is known as an electrocardiogram, or ECG or EKG. The p wave, a deflection induced by atrial current; the QRS complex figure, which depicts the transmission of electrical activity into the ventricles; and the T wave, which occurs as the ventricles reset themselves, are all major elements of the ECG. The ECG is frequently used to diagnose an abnormal heart rhythm or a developing heart attack. An example of an ECG heartbeat is shown below **[6].**

Components of ECG wave

The EKG is a real-time recording of the electrical

activity of the heart caused by cell depolarization and repolarization.

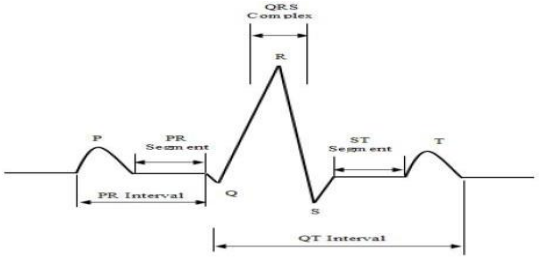

Fig.4 shows ECG wave

The EKG waveform consists of

P Wave: Atrial depolarization is represented by this waveform.

QRS: Denotes depolarization of the ventricles

T Wave: Denotes ventricular repolarization Intervals are defining as the amount of time that elapses between one waveform and the next.

Baseline (Isoelectric Line): The baseline is the Flat line of the EKG tracing represents no electrical activity. Positive deflections occur above the isoelectric line, while negative deflections occur below the isoelectric line.

P-Wave: The SA node generates an electrical stimulus known as the P wave, which is normally upright and no more than 3mm in height.

The PRI (PR Interval): represents the spread of the atrial depolarization wave as well as the time it takes for the impulse to travel through the AV node and to the ventricles. The PRI is defined as the time between the start of the P-Wave and the start of the QRS. Normally, the PRI is no longer than 0.20 seconds long.

QRS Complex: The QRS represents the electrical impulse's depolarization of the ventricles and ventricular conduction time. The QRS is typically narrow, with a conduction time of less than "0.12" seconds. beginning to its return to the isoelectric line [6].

4. Arduino

Arduino is an open-source programmable circuit board that can be integrated into a wide range of simple and complex makerspace projects. This board contains a microcontroller that can be programmed to sense and control physical objects by responding to sensors and inputs **[10].**

4.1 Overview of Arduino

Arduino is a single-board microcontroller that makes it easier to use electronics in multidisciplinary projects. The hardware is a simple open source hardware board built around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. A standard programming language compiler and a boot loader that runs on the microcontroller comprise the software **[11,12].**

4.2 Hardware Specifications of Arduino

- ATmega328 Microcontroller
- 5V is the operating voltage.
- Recommended Input Voltage: 7 to 12 volts
- The input voltage ranges from 6 to 20 volts.
- 14 I/O Digital Pins (of which 6 provide PWM output).
- Six analog input pins
- 40 mA DC current per I/O pin
- 50 mA is the DC Current for the 3.3V Pin.
- Flash Memory Size: 32 KB (ATmega328).
- Two KB of SRAM (ATmega328).
- One KB EEPROM (ATmega328)
- 16 MHz is the clock speed.

4.3 Arduino software

The Arduino Software (IDE), which is open source, makes it simple to create code and upload it to the board. It is compatible with Windows, Mac OS X, and Linux. The environment was written in Java and built on top of Processing and other open-source technologies. This program is compatible with all Arduino boards**. [8].**

5. The proposed scheme

We propose a monitoring system that include AD8232 ECG sensor based on the Arduino Tmega2560 to monitoring the people that have heart disease as shown in Figure 6. The AD8232 ECG sensor is a small chip that measures heart electrical activity, also can be recorded the signals and analyzed. In this scheme, it contains LCD 20x40 (Alphanumeric LCD), heart beat sensor 2, Arduino Uno

(ATMEGA328P V3.0 Blue) ,rheostat 10k, connective wires, ground, Dc power and switch. We simulated the proposal scheme by using proteus simulation. In addition, we explained more details as the following.

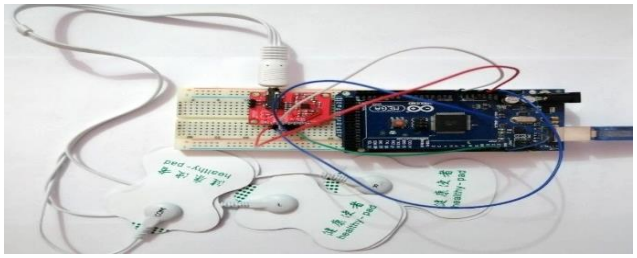

Fig.6 shows Circuits components

1.The Arduino Tmega2560 is a microcontroller-based board. It contains 54 digital I/O pins (with 15 of them being PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It includes everything you need to get started with the microcontroller; simply plug it into a computer via USB or power it using an AC-to-DC adapter to get started. [2,3,12].

Fig.7 shows the Arduino Mega2560

2.AD8232 ECG sensor as shown in figure 8, it measures the electrical activity of the heart. An ECG or electrocardiogram is used to record. The AD8232 Single Lead Heart Rate Monitor functions as an op-amp to help in acquiring a clean signal from the PR and QT Intervals easily. The AD8232 is a signal-conditioning integrated circuit that is intended for use in ECG and other bio potential measurement applications. Its goal is to collect, enhance, and filter tiny Bio potential signals in the presence of noisy situations like motion or remote electrode placement. The AD8232 module detaches nine connections from the IC, onto which pins, wires, or other connectors can be soldered. To use this monitor with an Arduino or other development board, the pins SDN, LO+, LO-, OUTPUT, 3.3V, and GND must be connected. This board also has RA "Right Arm," LA "Left Arm," and RL "Right Leg" connectors for connecting and utilising custom sensors. Furthermore, an LED indication light will pulsate in sync with the heartbeat**. [2,3].**

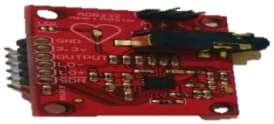

Fig.8 shows AD8AD8232

Table.1 table of material

S.N	Components name	Description	Quantity
1	ArduinoBoard	ArduinoMega2560 Development Board	1
2	sensor for the electrocardiogram	ECG Sensor AD8232 Kit	1
3	ECG electrodes	_	3
4	Connecting Wires	Jumper Wires	5
5	Breadboard	-	1
6	Data cable	-	1

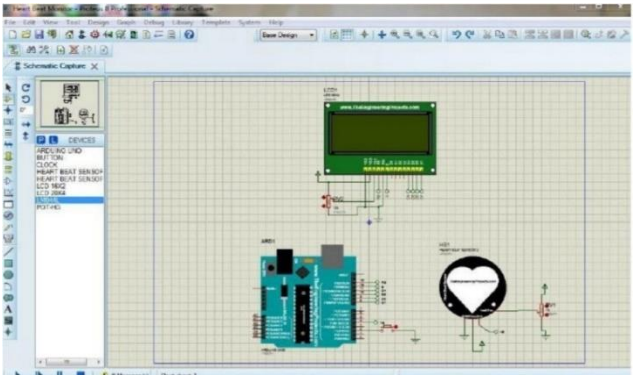

Fig 9. The proposal scheme in Proteus

Proteus virtual system modeling used to implement the proposal scheme as shown in the figure 9. In Fig (9) represent the Architecture of the system which use to measure and monitor the heart.

6. Performance analysis of scheme

The proposal scheme applied on the body based on configuration in table 1, the sensor pads should snapped onto the leads. When the pads placed closer to the heart, the measurement becomes more accurate. As a result, the reference electrode placed on the body's right kidney, while the two electrodes placed on the right and left chest. The nine connections on the IC had separated for the AD8232 heart rate monitor. As they originate from the IC's pins, we commonly refer to these connections as "pins," but they are actually holes to which you can solder wires or header pins. Five of the board's nine pins will be connected to an Arduino (Uno or Mega); for this project, we will be using an Arduino Mega 2560. You require five pins, identified as GND, 3.3v, OUTPUT, LO-, and LO+. The data from the sensor is read by Arduino and sent to the serial port. This data is read from the serial port and then draws it out by processing. Optimal placement. Furthermore, the reference electrode placed on the torso's right femur, and the two On the right and left, electrodes are positioned. arms.

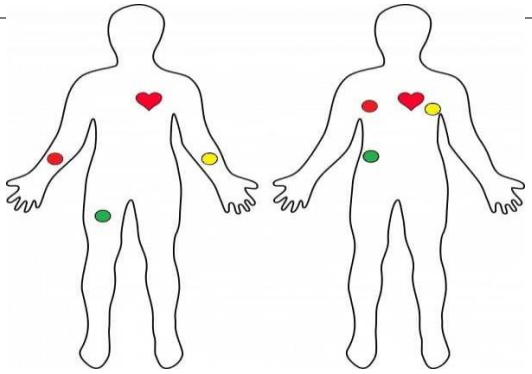

Fig.10.Scenario shows the case Gender: male, Age: 14 years' old, Agreement: from his father ,Case: not have any heart disease

7. Results and Discussions

In order to monitor the electrocardiogram of patient Scenario, who is 14 years old and does not suffer from any heart diseases. Where we made sure that the three electrodes were placed on the chest and the right kidney or the right and left arm and the right femur and connected them correctly as shown in the figure(10).The resulting signals will be displayed in the chart as the values are noted in the screen as shown in the figure(11). As the ECG signal values appear in the form of a graph and the signal value appears in the form of a scale for better visualization. The sign appears to us in a normal situation, since the patient does not suffer from any disease.

Fig .10 the graph result of diagnose case A

8. Future Developments and Applications

Applications:

1) Acquisition of Biopotential signals such as temperature and oxygen ration.
2) Remote ECG portable health monitors.
3) Gaming accessories.
4) Heart rate monitors for fitness and activity.

Advancements:

1) Using internet of things (IOT) technology, Data can be uploaded or delivered directly to doctors.
2) Using more electrodes allows for more measurement that is accurate.

Conclusion

The proposal monitoring system was present based on Arduino and AD8232 ECG sensor. In this study, the proposed scheme is effectively applied to monitoring the people that have heart disease under critical condition. The obtained results show the track the electrical activity of the heart. It has also been shown that the proposed technique by using Arduino and AD8232 ECG sensor are more effective compared with another system about the cost and available materials. In the future, we intend to track and monitor patients outdoor about Oxygen saturation (SpO2) and blood pressure.

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