IMPLEMENTATION OF AN AUTOMATIC DEFRIBILLATOR FOR CARDIAC PATIENTS

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Abstract— **The telemedicine system is an emerging area in the world. The major concepts of the telemedicine systems are providing the diagnosis system for all patients without moving them from their place to clinical areas. This paper presents an automatic defibrillator system specialized for cardiac patients and monitoring their heart beat in an android device by the help of Bluetooth technology. This paper is most suitable for the cardiac patients who are in the remote areas. The proposed system consists of five subsystems namely, (i) Electrocardiogram (ECG) acquisition system, (ii) Heart Rate (HR) acquisition system, (iii) Processing of ECG and HR signals, (iv) Defibrillator control unit, (v) Monitoring unit. It emphasizes the hardware realization of embedded diagnostic system, analyses the collection process of ECG and HR, comparison of ECG and HR, controlling of defibrillator under the co-ordination of Peripheral Interface Controller (PIC) microcontroller. The defibrillator will be controlled directly by the PIC microcontroller. Here a Bluetooth module is added with the hardware which can be connected with Android devices for monitoring the process continuously even by the patients too.**

Index Terms— **Electrocardiogram, Heart Rate, Peripheral Interface Controller, Bluetooth, Android Device.**

I. INTRODUCTION

Telemedicine is a subset of telehealth, which includes both remote clinical service delivery and non-clinical elements of the healthcare system. Telemedicine is the use of telecommunication and information technologies in order to provide clinical health care at a distance. It helps eliminate distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations.

Although there were distant precursors to telemedicine, it is essentially a product of 20th century telecommunication and information technologies. These technologies permit communications between patient and medical staff with both convenience and fidelity, as well as the transmission of medical, imaging and health informatics data from one site to another.

Early forms of telemedicine achieved with telephone and radio have been supplemented with video telephony, advanced diagnostic methods supported by distributed client/server applications, and additionally with telemedical devices to support in-home care.

II. OBJECTIVE

The main objective of this paper is,

- To implement an automatic defibrillator for cardiac patients who are all in remote areas.
- To monitor the Electrocardiogram (ECG) signal and heart rate (HR) of the patients through an android device.

This objective can be implementing by designing the special type of defibrillator and by using the bluetooth data transmission technology of an android device.

III. FEATURES

A. PIC

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

1. CORE FEATURES

- High-performance RISC CPU
- Only 35 single word instructions to learn

- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input, DC - 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory,
- Up to 368 x 8 bytes of Data Memory (RAM)
- Up to 256 x 8 bytes of EEPROM data memory
- Pin out compatible to the PIC16C73/74/76/77
- Interrupt capability (up to 14 internal/external
- Eight level deep hardware stack
- Direct, indirect, and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC Oscillator for reliable operation
- Programmable code-protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low-power, high-speed CMOS EPROM/EEPROM technology
- Fully static design
- In-Circuit Serial Programming (ICSP) via two pins
- Only single 5V source needed for programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.5V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial and Industrial temperature ranges
- Low-power consumption:
  - < 2mA typical @ 5V, 4 MHz
  - 20mA typical @ 3V, 32 kHz
  - < 1mA typical standby current

2. PERIPHERAL FEATURES

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and post scaler
- Synchronous Serial Port (SSP) with SPI. (Master Mode) and I2C. (Master/Slave)
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max resolution is 12.5 ns,
  - Compare is 16-bit, max resolution is 200 ns,
  - PWM max. Resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9- Bit addresses detection

IV. METHODOLOGY

Heartbeat monitoring is used to measure the heart beat of a human. Usually heart beat is measured in terms of number of beats per minute. But in the real world, no one needs to wait for a minute. Actually in this paper we are going to measure the heart rate for some few seconds, and we have to convert this for a minute. If the heart beat getting lower from the set level the defibrillator will activates the shock wave to activate the heart again. All the data's will be transferred to the mobile phone with the help of the Bluetooth.

A. BLOCK DIAGRAM

The block diagram of the circuit for designing an automatic defibrillator is shown below. The main sections of this block diagram are now described below.

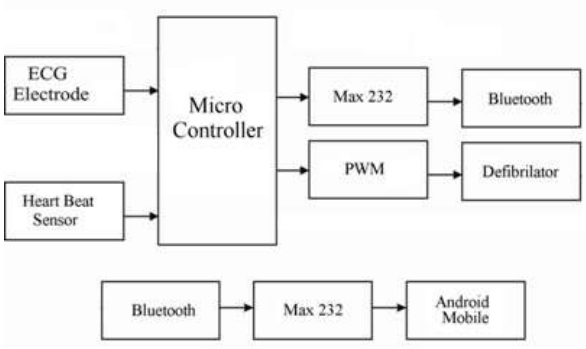

Figure Block Diagram of automatic defibrillator circuit

B. BLOCK DESCRIPTION

1. ECG ELECTRODE BLOCK

Here we used phototransistor and photo receiver to sense Heart pulse. The basic principle of IR sensor is based on an IR emitter and an IR receiver. IR emitter will emit infrared continuously when power is supplied to it. On the other hand, the IR receiver will be connected and perform the task of a voltage divider. IR receiver can be imagined as a transistor with its base current determined by the intensity of IR light received. The lower the intensity of IR light cause higher resistance between collector-emitter terminals of transistor, and limiting current from collector to emitter.

2. HEART RATE

Heart rate is a term used to describe the frequency of the cardiac cycle. It is considered one of the four vital signs. Usually it is calculated as the number of contractions (heart beats) of the heart in one minute and expressed as

"beats per minute" (bpm). See "Heart" for information on embryo fetal heart rates. The heart beats up to 120 times per minute in childhood. When resting, the adult human heart beats at about 70 bpm (males) and 75 bpm (females), but this rate varies among people. However, the reference range is normally between 60 bpm (if less termed bradycardia) and 100 bpm (if greater, termed tachycardia). Resting heart rates can be significantly lower in athletes. The infant/neonatal rate of heartbeat is around 130-150 bpm, the toddler's about 100–130 bpm, the older child's about 90–110 bpm, and the adolescent's about 80–100 bpm.

V. RESULTS AND DISCUSSIONS

A. RESULT

The following table represents the conditions when the defibrillator should be switched ON.

HEART RATE	LEVEL	CONDITION
<20 BPM	ABNORMAL	ON
68 BPM	NORMAL	OFF
72 BPM	NORMAL	OFF
78 BPM	NORMAL	OFF
>90 BPM	ABNORMAL	OFF

Table Defibrillator conditions

1. ECG WAVE FOR NORMAL PERSONS

The below figure represents the pulse output for a normal person whose heart rate is 72 bpm. This normal wave is taken as the reference wave for find out the abnormal ECG waveforms.

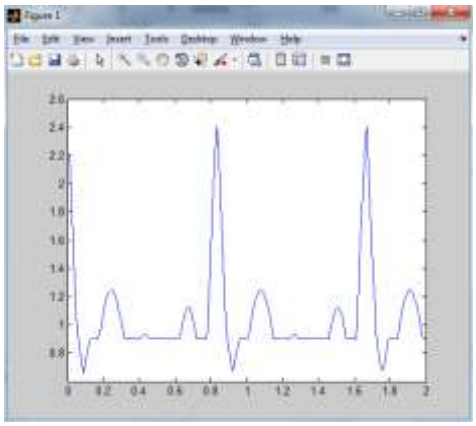

Figure ECG wave for normal persons (Reference Wave)

2. ECG WAVE FOR PERSON 1

The figure shows the ECG wave output of the person 1 whose heart rate is 80 bpm. This heart rate is somewhat high. But, this heart rate may be occurred during the time of hard works. So, this type of sudden higher heart rates will not affect the person or will not make major causes.

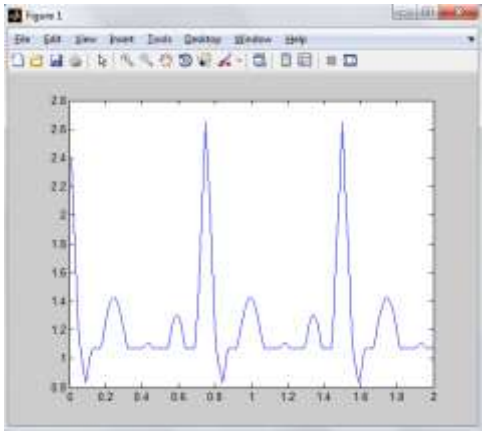

Figure ECG wave for person 1

3. ECG WAVE FOR PERSON 2 (ABNORMAL)

The figure shows the abnormal ECG wave of a person whose heart rate is 20 bpm. For this kind of heart rates the amplitude and time periods will be different from the normal rates. This type of persons required the defibrillator shocks for temporary rectifications.

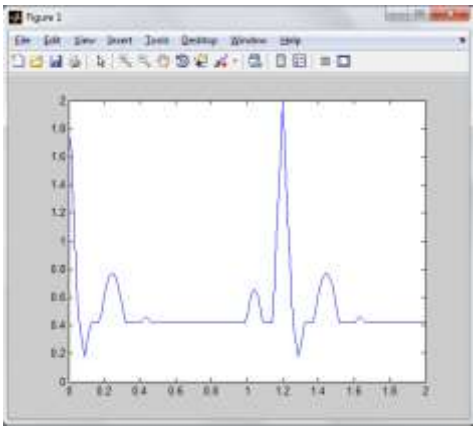

Figure ECG wave for person 2 (abnormal)

B. DISCUSSION

This paper presents an automatic defibrillator which can be used with the remote cardiac patients. The monitoring system describes the Bluetooth technology used in the android devices. The heart rate can be easily shown by the patients themselves and by the clinical areas too. The automatic defibrillator can keep the patients from some sudden attacks temporarily. Similarly, the defibrillator

will be switched off automatically when the patient returns to normal conditions.

Simulation results have shown that the normal ECG wave outputs which is acquired from the normal persons. The abnormal result also shows the difference between the normal and abnormal levels. The defibrillator was studied and explained that where to use them.

Experimental results have been used to verify the operations of defibrillators in nature. These results help to develop them in working environments. The comparison of ECG signals and the heart rate is used to improve the accuracy of the system which was not discussed in the existing models.

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