Remote Monitoring of Heart Patient with Auto-Defibrillator

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***Abstract*—A biomedical instrument with automatic defibrillator monitors heart rate and temperature, transmitting data to hospital staff. When detecting a heart rate below 40, it applies a mild shock through auto defibrillator by sensing from IR sensors and ICs for demonstration purposes. This prototype aims to provide immediate treatment for slow heart rhythms, utilizing low voltage pulses. The defibrillator circuit, utilizing IC3524 and ferrite core transformer, delivers safe, high-frequency pulses to restore normal heart rhythm.**

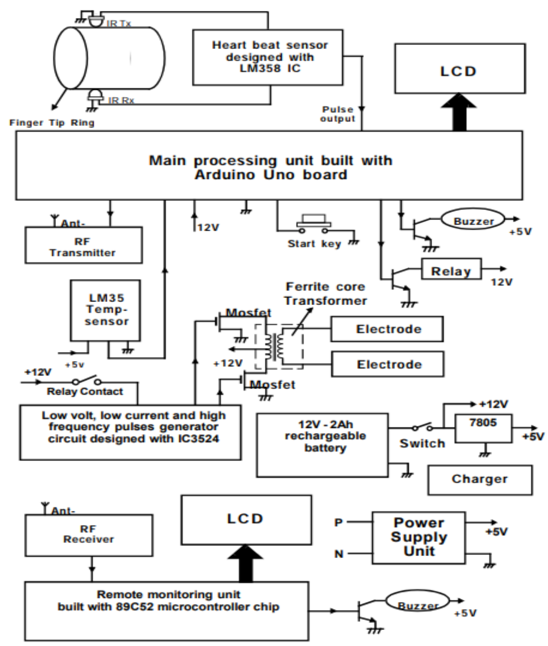
***Index Terms*—Biomedical instrument, automatic defibrillator, heart monitoring, temperature tracking, IR sensors, IC358, IC3524, ferrite core transformer.**

I. INTRODUCTION

Introducing a cutting-edge biomedical instrument equipped with an automatic defibrillator, revolutionizing heart patient care in hospital ICUs. This innovative device continuously monitors heart rate and body temperature, transmitting vital data to medical staff for immediate intervention. Utilizing advanced IR sensors and IC technology, it ensures accurate heart rhythm detection and temperature tracking. The prototype's defibrillator circuit, powered by IC3524 and a high-frequency ferrite core transformer, delivers safe, low-voltage pulses for prompt treatment of slow heart rhythms. This instrument promises to enhance patient outcomes and streamline critical care procedures.

II. BLOCK DIAGRAM

The main processing unit, centered on the Arduino Uno board, gathers and analyzes data from the heart beat sensing circuit composed of IR sensors and the LM358 Operational Amplifier IC. These sensors detect blood flow changes, converting them into electrical signals. Amplified and processed by the Arduino Uno, these signals are then used to calculate the patient's heart rate and body temperature. This information is displayed in real-time on an LCD screen for healthcare providers' easy monitoring.



Simultaneously, the remote monitoring unit supplements the main processing unit by wirelessly transmitting vital sign data to hospital staff. Equipped with an LCD display driven by a dedicated 89c52 Microcontroller chip, this unit communicates with the main unit via RF transmitter and receiver modules. This setup ensures seamless remote monitoring, allowing healthcare professionals to observe vital signs without physical proximity to the patient. This integration facilitates continuous monitoring and timely intervention, enhancing patient care and safety in critical care settings.

III. DEFIBRILLATOR USAGE

Defibrillators play a critical role in cardiopulmonary resuscitation (CPR), primarily indicated for ventricular fibrillation (VF) and pulseless ventricular tachycardia. Automated external defibrillators (AEDs) enable lay responders to deliver timely shocks, significantly improving outcomes for out-of-hospital cardiac arrests. Manual external defibrillators, used by healthcare professionals, offer precise control over voltage and timing, commonly found in hospitals and ambulances. Internal defibrillators, like implantable cardioverter-defibrillators (ICDs), constantly monitor and administer shocks for life-threatening arrhythmias. Wearable cardioverter defibrillators provide portable monitoring and intervention for at-risk patients. Electrodes, essential components of defibrillation systems, vary in type, including paddle electrodes and self-adhesive electrodes, each offering unique advantages in placement and application. The mechanisms underlying defibrillation remain complex, with ongoing research seeking to enhance understanding and efficacy in treating cardiac arrhythmias.

IV. MAIN PROCESSING UNIT

A. Power Source

To ensure reliable operation, the system is powered by a 12V rechargeable battery, providing a stable power source for all components. The use of a rechargeable battery enhances portability and eliminates the need for external power supplies, making the system suitable for both clinical and remote monitoring applications. Additionally, voltage regulation circuitry, such as the 7805-voltage regulator chip, maintains a consistent +5V supply for sensitive electronic components, ensuring optimal performance.

B. Display Section

The display section utilizes a Liquid Crystal Display (LCD) module to present heart rate and temperature data in a user-friendly format. With its high contrast and readability, the LCD screen provides instant feedback to healthcare professionals or patients, enabling timely interventions or adjustments. The display can be customized to accommodate additional information or parameters, enhancing its utility in various healthcare settings.

C. Main Output Transformer

The driver stage, employing power Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs), amplifies signals before transmission to the output transformer. Configured in a class 'B' push-pull amplifier configuration, MOSFETs ensure efficient signal amplification while minimizing distortion and power dissipation. This driver stage enhances the overall performance and reliability of the system, ensuring accurate signal transmission to the output transformer.

D. Driver Stage Using Power MOSFETs

The main output transformer is designed to deliver a safe current of 40 milliamps at the secondary, suitable for biomedical applications. With its center-tapped primary winding and by-filler winding construction, the transformer maintains precise balance and equal current distribution, ensuring consistent performance and safety. The transformer serves as the final stage in signal processing, delivering amplified signals to the display unit for visualization and analysis.

E. Heart Rate Sensor

The heart rate sensor module plays a pivotal role in detecting the heartbeat by utilizing infrared (IR) sensors in conjunction with an LM358 operational amplifier (op-amp) integrated circuit. LM358 is configured to amplify the signals received from the IR sensors, allowing for accurate detection of blood flow through the fingertip. This optical heart rate monitoring system is non-invasive and offers a convenient method for continuous monitoring of heart rate.

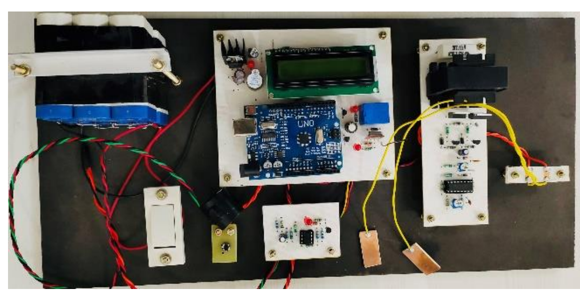


Figure 1: Main Processing Unit

F. Temperature Sensing Circuit

In tandem with heart rate monitoring, the project incorporates a temperature sensing circuit powered by the LM35 precision integrated-circuit temperature sensor. The LM35 provides a linear output voltage proportional to the Celsius temperature, making it ideal for measuring body temperature. By interfacing the LM35 output with the Arduino microcontroller, real-time temperature data can be captured and displayed alongside heart rate information.

G. Arduino Microcontroller

The Arduino microcontroller serves as the brains of the operation, facilitating data acquisition, processing, and display. Programmed using the Arduino IDE (Integrated Development Environment), the microcontroller interprets signals from the heart rate sensor and temperature sensing circuit, converts analog data to digital, and drives the display unit accordingly. With its versatility and ease of use, Arduino enables rapid prototyping and development of biomedical instrumentation projects.

V. RF COMMUNICATION SYSTEM

The remote monitoring system employs an 89c52 controller chip to receive digital data wirelessly via RF transmission from a data transmitting unit, enabled by an RF receiver. Integrated with an Arduino processor, it effectively transmits pulse rate and temperature data through an RF transmitter. Radio communication, central to the project, utilizes electromagnetic waves for wireless data transmission, traveling at the speed of light. Digital communication ensures efficient data transfer by representing information as discrete messages. Modulation techniques like amplitude modulation (AM) or frequency modulation (FM) encode digital information onto a carrier wave for transmission. The system generates a carrier frequency of around 433MHz for transmitting modulated data, decoded and displayed via an LCD interfaced with the controller chip at the receiving end. This setup allows for seamless remote monitoring of vital signs in real-time, enhancing healthcare efficiency and patient care in hospital settings.

VI. REMOTE MONITORING SYSTEM

The remote monitoring unit exemplifies the convergence of advanced wireless communication technology and embedded systems to enable remote patient monitoring and care. By leveraging RF communication, microcontroller-based data processing, and sensor interfacing, the system offers a comprehensive solution for continuous surveillance of vital signs. With its ability to transmit and receive data wirelessly, the remote monitoring unit provides healthcare professionals with real-time access to patient data, facilitating timely interventions and improving patient outcomes. Moreover, the integration of alarm systems ensures that critical events are promptly detected and addressed, further enhancing the effectiveness of remote patient monitoring.

The remote monitoring unit incorporates a robust wireless communication system utilizing RF modules operating at a frequency of 433.92 MHz RF modules enable bidirectional communication between the main unit and the remote monitoring unit without requiring line-of-sight transmission. This wireless communication system ensures seamless data exchange between the patient's location and the monitoring station, facilitating continuous monitoring of vital signs and timely interventions when necessary.

Figure 2: Remote Monitoring System

The transmitter section is responsible for generating an 8-bit binary code representing vital signs data collected from sensors. Powered by a stable +5V DC supply derived from a voltage regulator, the microcontroller continuously transmits the encoded data through an RF transmitter module. The transmitted data is modulated and radiated into the air via an antenna for reception by the remote monitoring unit. The transmitter operates autonomously, delivering vital signs data in real-time to ensure accurate remote monitoring of the patient's condition.

At the remote monitoring unit, the RF signal transmitted by the main unit is received and processed by the receiver section. The RF receiver module, such as the RWS-434, detects the incoming RF signal and converts it into an intermediate frequency (IF) signal for further processing. The receiver includes components like a low-noise amplifier, intermediate frequency stages, and a data recovery stage to ensure reliable signal reception and decoding. The decoded data is then provided to the microcontroller for display and analysis.

Both the main unit and the remote monitoring unit are equipped with microcontrollers, such as the ATMEL 89C51, which serve as the central processing units for data handling and control functions. The microcontroller at the remote unit decodes the received data from the RF signal and interfaces with peripheral devices like LCDs and alarms for data display and alert generation. Programmed to monitor vital signs continuously, the microcontroller triggers alarms and activates devices like defibrillators based on predefined thresholds, ensuring prompt responses to changes in the patient's condition.

VI. CONCLUSION

The project work "Remote monitoring of heart patient with auto defibrillator" is completed successfully and results are found to be satisfactory. During our trail runs we found that, making heartbeat monitoring system is very difficult because we won't get any suitable sensors available readily. In this regard we have made our own sensor using IR sensors and IC358. In this combination the blood flow through fingertip must be monitored through IR sensors. After making so many trails, we came to know that we need very sensitive sensors to monitor the blood flow. The output of sensors is amplified and triggered to generate a logic pulse for every wave of blood flow through fingertip. Now the controller is programmed to read and display the pulses produced by the heartbeat sensing circuit.

The main concept involved in the system is to activate the defibrillating mechanism automatically when pulse rate reduces to less than 40. For this purpose and to count and display the heartbeat pulses, Arduino Uno board is used, and it is treated as main processing unit. This unit is also programmed to transmit the information to the remote monitoring unit through the RF communication system. The remote monitoring unit is constructed with 89c52 controller chip and hence two different software's are developed for two different processors.

Regarding defibrillator circuits, we designed a PWM based low voltage, low current pulses inverter that generates nearly 30 - 40 volts ac pulses at high frequency. This circuit is constructed with IC3524 and this circuit is automated such that when the system detects low heartbeat, immediately this circuit will be activated automatically through relay.

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