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Preface

This book contains the Proceedings of research articles presented at the 3rd International Conference on ICT for National Development and Its Sustainability held from Tuesday 21st – Friday 4th May 2024 at the University of Ilorin, Ilorin, Kwara State, Nigeria. The conference was organized by the Faculty of Communication and Information Sciences, University of Ilorin.

Over 50 research manuscripts were submitted for the conference. A keynote speech and two lead papers were presented at the conference. Apart from Nigeria, submissions were received from countries such as Niger, Malaysia and South Africa. All manuscripts were subjected to a double-blind peer review process. Before the review, every manuscript was subject to Turnitin plagiarism checker. Manuscripts with a **similarity index** of not more than 25% were processed for review. The articles which appear in this Proceedings are revised versions of the accepted manuscripts after the review process.

I wish to appreciate all who contributed in one form or the other towards making this Proceedings a success.

Thank you.

Prof. A. L. Azeez

Dean

Faculty of Communication and Information Sciences

University of Ilorin



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Application of Wireless Communication based Portable Electro-cardiology System for Enhancing Health Care in Rural Areas

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Abstract

This paper presents the design and development of a microcontroller-based heartbeat monitor using a body sensor. The device uses wireless technology to detect the flow of blood through the finger and offers the advantage of portability over conventional recording systems. This paper presents these challenges as well as solutions to these problems by proposing an architecture that allows a network to be formed between the patient and doctor to enable remote monitoring of patient by analyzing the data of patient received over a wireless system. The device consists of sensors, which are used to measure heartbeat and a central unit controls it. The readings from these sensors are further processed and sent via a GSM module to a remote location where it is displayed on a cell phone or central display board. The superiority of this device is shown in comparison to the traditional system.

Keywords: Microcontroller, Heartbeat, Body temperature, RF module, GSM module, Remote Monitoring and Fingertip Sensor

1. Introduction

Heartbeat is the number of heartbeats per unit of time, which is generally expressed in beats per minute (bpm). The rate at which the heart beats changes with the state of the heart at every instant. The rate increases during the exercise while reduce when resting. Medical professionals mostly use the measurement of heartbeat as a primary test to help in the diagnosis and tracking of the medical conditions (Choi, Lee et al. 2024). It is also used by the individuals who are involved in intense physical training, such as athletes who are greatly involved in monitoring of their heart rate to achieve maximum efficiency. Due to sudden change in lifestyle and unhealthy eating habits, the incidents of heart and vascular diseases are found to increase in a dramatic manner. Moreover, heart problems are being increasingly diagnosed on younger patients (Krittanawong, Kumar et al. 2020). Coronary heart disease is now considered as one of the leading cause of death around the globe. Thus, medical community always welcomes any kind of progress in this area, which

will improve the diagnosis, and treatment of patient. Heart rate is usually measured in controlled environment in clinics, but it is of great need that a system must be designed so that the patient will be able to monitor their health in their home as well. This will enhance the system performance while offering the advantage of portability over other conventional systems (Saha, Saha et al. 2022). A heart beat monitor (HBM) is a simple and economical device which calculates a sample of the heart rate signal and measures the beats per minute which allows utilization of the information for easy monitoring of heart condition. The HBM devices employ electrical and optical methods as means for detecting and achieving the heart signals. So, the wireless technology is utilized in order to meet the requirement of remote control and patient monitoring. The remote patient monitoring (Singh, Sinha et al. 2020) is a technology which provides us with the opportunity to monitor the patient outside the hospitals by reducing the need of visiting the patient which saves both the time and money of patient and doctor while increasing the efficiency along with the reliability of health services. With the advancement of technology, both quality of security (Subramanian, Bindhu et al. 2022) and health inhuman life is increasing day by day. This paper presents the design of a very low cost remote patient monitoring system, which will measure heart rate and body temperature of an individual, and the measured data will be sent to a remote end where the data will be displayed on a mobile device using GSM module. This device will help both the patient and doctor during emergency period by saving both time and cost of patient and physician.

2. System Hardware

The proposed heartbeat-monitoring device is intended to have the following features:

- Useful for remote areas.
- Real time monitoring of the patient is possible.
- The doctor does not need to visit the patient to monitor him/her.
- Time is saved for both patients and doctor and save both operational and maintenance cost.
- Routine checking of the patient can be done easily.
- Increases access to health care while decreasing the healthcare delivery costs.
- The device utilizes a GSM module to send the data in the form of SMS to a mobile device for better portability of the system.
- The device has a functionality of showing both the time and date of the measured data.



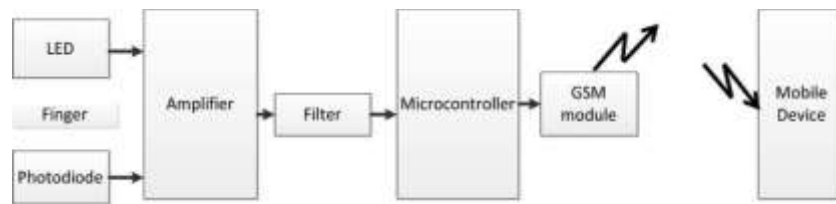


Figure 1. Block Diagram of the Complete System

Figure 1 shows the block diagram of the complete system in which the device consists of a PIC16F73 microcontroller for measuring and transmitting the data to a remote end on a mobile device. The measured data of heartbeat and body is sent to a remote end with the help of a GSM module. For measuring heartbeat, the device utilizes a photo diode and a bright LED along with an amplifier and a filter circuit. For measuring the body temperature, the device uses LM35 IC. The device measures heartbeat and transmits the data wirelessly with the help of the GSM module. The data, which consists of heartbeat is received at a mobile device and can be transferred to a pc using Nokia PC suite. Thus the data can be stored and viewed for future reference.

2.1. Heartbeat Measuring Unit

Heartbeat is measured with the help of fingertip sensor, which consists of an infra-red (IR) light emitting diode transmitter and an IR photo-detecting receiver passes through the tissues and variations in the volume of blood within the finger determine the amount of light that is incident on the IR detector. The device utilizes optical technology to measure heartbeat of patient, both the IR transmitter and receiver could be placed on the same plane and the finger would function as a reflector of the incident light. The IR receiver monitors the reflected signal in this case. The IR filter of the phototransistor reduces interference from the mains 50Hz noise. The IR LED is forward biased through a resistor to create a current flow. The values of resistors are chosen so that they can produce the maximum amount of light output. The photo-resistor is placed in series with the resistor to reduce the current drawn by the detection system and to prevent short-circuiting of the power supply when the photo resistor detects no light.

2.2 Amplification and Filtering

The photodiode detects the infra-red light reflected by the finger. It detects the variation in the blood volume with respect to the heartbeat and finally generates a pulse at the output of the photodiode. The signal produced from photodiode is very weak and small which is required to be increased in magnitude. This signal is very weak that it cannot be detected by the microcontroller directly. Thus, the signal is amplified



using an operational amplifier. The operational amplifier used for this purpose is LM358. This operational amplifier is provided with two of the independent high gain, frequency compensated operational amplifier which is designed to function from a single supply over a wide range of voltages which means that this amplifier is capable of amplifying the signal in two stages making the device able to detect the signal and in turn measure the heartbeat. This device uses non-inverting amplifier for amplifying purpose in both the stages. The operational amplifier can be considered as a low power quad operational amplifier. The signal is amplified to an appropriate voltage level so that the pulses can be counted by the microcontroller. The signal generated from the photo diode also contains noise which is required to be filtered otherwise the obtained signal will contain noise of some types making the measurement complex. Moreover, the interference produced due to the movement of artefacts and the mains supply of 50Hz can also affect the signal. The standard ECG signal of heartbeat has frequency component which varies in the range of 0.05-200Hz. When this signal is filtered, the frequency component varies in the range of 0-50Hz. Thus, the filtration does not affect the quality of the signal and also no information is lost. The circuit arrangement for amplification and filter stage is shown in Figure 2. The filter arrangement that is used in this research is low pass filter that eliminates higher frequency components. Here the resistors and the capacitors are arranged in such a way that the combination acts as a low pass filter and blocks higher frequency noise components that is present in the signal. The capacitor is used at the input terminal of the amplifier to block the dc component in the signal. Finally, a red LED is placed at the output of the amplifier and filter stage to show that the device is working for the measurement of heartbeat. Here, the resistance of R5 is equal to the resistance of R1 while the resistance of R2 is equal to the resistance of R4. The gain of each stage is found to be 101 after calculation while cut-off frequency is found to be 2.4Hz. This value is optimum to measure the heartbeat without any problem.

$$R5=R1, R2=R4$$

$$\text{Gain of each stage} = 1 + (R5/R4)$$

$$= 1 + (680k/6.8k) = 101$$

$$\text{Cut-off frequency} = 1 / (2\pi RC)$$

$$= 2.4\text{Hz}$$



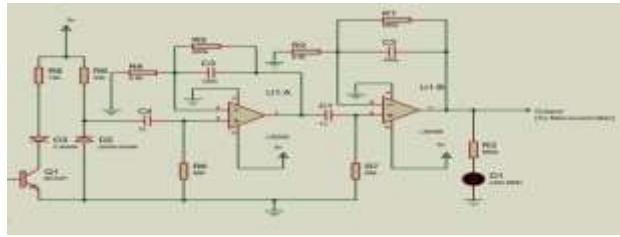


Figure 2: Circuit Arrangement of Amplifier and Filter Stages

2.3 GSM Module

The GSM module used in this project is SIM 908-C. This module is designed for covering global market. It is combined with a high performance GSM engine. It works at a frequency of GSM 850MHz. It offers best class acquisition and tracing sensitivity features, Time to first fix (TTFF) and accuracy. The size of this module is 50mm x 33mm x 8.8mm. It can meet almost all the requirements for space in user applications, such as M2M devices. This module has a 60-PIN DIP connector and provides all hardware interfaces between the module and the customer board. It consists of a serial port and a debug port that can help users to easily develop the user's applications. Moreover, this module comes with power saving technique so that the consumption of current is as low as 1 mA during sleep mode.

3. Circuit Implementation



Figure 3. Circuit Implementation

The implemented circuit is as shown in Figure 3. These figures show all the circuit components, which are required to monitor the patient remotely. It consists of the devices that, measures heartbeat. The use of this device is very simple. At first, the cord is connected to the dc power supply. Wait for the device to be ready. It may take some time depending upon the availability of the network. When the device is ready, put your index finger on the heartbeat sensor and the LM35 sensor. Then, type "STATUS" on the mobile device and



send to this device. After you send the message, wait for the device to respond. The device will receive the message and send the measured data of heartbeat.

4. Results and Discussion:

The output from sensor and amplifier circuit was connected to the microcontroller. The observed output signal was periodic ac signal with amplitude varying from peak to peak according to person. A model sinusoidal signal and the output from sensor were fed to microcontroller and the counted pulse rate was successfully sent via GSM module. The counted signal from the sensor to measure the heartbeat was relatively a weak signal, which needed to be amplified and filtered before it was sent to the microcontroller. So, the signal was amplified using an operational amplifier. LM328 was used to amplify the signal. The amplified signal was then filtered to get the desired output of heartbeat, which was then sent to the microcontroller for further processing. The microcontroller then sent the received data of both heartbeat and temperature of a patient to a remote end via GSM module. A SMS takes about 4 KB space on a memory card. So, a memory card of 512 MB will be able to store about 1,31,072 messages. The messages will show both the date and time, so it will be easy to distinguish among the messages according to day, week or month. The heartbeat were found to be varying between 70 to 84 for the age of 19 to 54. For the same age group, the heartbeat and body temperature can be different. As the heartbeat ranges from 60 to 100 for normal resting adult. The heartbeat was found to be maximum for the people of less age in comparison to the elderly people. This project makes a use of optical sensor. Optical sensor is used for providing electrical isolation for the user. Also, operational amplifier was used in non-inverting configurations to amplify and filter the signal from the sensor, which makes the detection of the heartbeat easier. It utilized a low pass filter, which removes the higher unwanted frequency components while passing the desired signal. PIC16F73 microcontroller was used to measure and send the data of heartbeat and temperature to a mobile device. This microcontroller is provided with an analog to digital converter. So, it reduces the size of circuitry making the design more reliable. Replacing RF module as it has several advantages over RF module used GSM module. The RF module becomes expensive when it is used to send the measured data to a remote end. Also, it consists of garbage value that makes the reading unreliable while sending via wireless media. But, GSM module surpasses these drawbacks.



5. Conclusion

This research led to the development of a system, which measured heartbeat and temperature of a patient and sent it to a remote end by the use of a microcontroller at a reasonable cost with great effect. It utilized remote patient monitoring system technology, which enabled the monitoring of patients outside of clinical settings and leads to increasing access to health care as well as decreasing the health care delivery costs. Nowadays, most of the systems work in offline mode. The research utilized two sensors for measuring heartbeat and temperature of a body. These sensors are controlled by the microcontroller. The result obtained when this design is implemented shows that the heartbeat of any users can be monitored remotely although the RF module worked only for limited range, which can be improved upon in further research work by using GSM module.

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