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Research Article

Arduino Based System Design for Measuring Heart Rate and Body Temperature

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ABSTRACT

The aim of this study is to develop a multi-sensor and low-cost biosensor system using Arduino Uno microcontroller board. With this system, heart rate and body temperature can be measured digitally. In this way, the vital values of those with health problems will be monitored regularly, and sudden changes in vital values will be detected immediately. While developing the system, Arduino Uno control card, heart rate sensor and temperature sensor were used. In addition, a software sensitive to detecting changes in heart rate and body temperature has been developed. The system created is open to future additions and improvements. The data obtained through the sensors on the system can be easily tracked by transferring them to the computer over wi-fi. At the same time, it can be improved by placing more sensors in the system according to the purpose of use. As a result of the tests, it has been seen that the system successfully transmits the information received from the sensors to the users in the desired time and gives an audible warning at the determined critical values. Thanks to this system, vital changes in heart rate and body temperature can be accessed remotely and instantly, and it is thought that this will contribute to the field of medicine.

1. Introduction

In recent years, rapid developments in computer and electronic technologies are widely used in the field of health, as in all areas of life. Robotic systems are rapidly replacing humans, especially in performing repetitive tasks [1-4]. The fact that the work to be done in this context is different requires the realization of systems that can fulfill different tasks. Electronic systems designed for such tasks generally consist of three parts. These; The hardware part where the electronic cards are located, the sensor and sensor peripherals that provide data acquisition, and the software part that enables the data processing and decision making [5-7].

Arduino based electronic control cards are widely used microcontrollers in this direction. These electronic cards offer researchers a flexible, easy-to-use and complete hardware and software environment with different features. Arduino based systems are developed using the Arduino language based on C/C ++ programming. In addition, Arduino's integrated development environment (IDE) for Windows, OS X and Linux systems is also available [8].

In this study, it is aimed to develop a multi-sensor and low-cost biosensor system using the arduino microcontroller card. Digital measurement of heart rate and body temperature of people was investigated with the established system. In this way, it is ensured that vital body values of people with health problems can be followed regularly and sudden changes in values are determined. It is considered that the developed arduino based biosensor system can be used to access information consisting of heart rate and body temperature, which are vital for humans, remotely and instantaneously, and will contribute to the field of medicine in this context.

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2. Material and Methods

2.1. Materials

Arduino Uno Control Card: Arduino Uno is an Arduino board containing an ATmega328 microcontroller. It can be said that Arduino is the most widely used board. Arduino Uno contains all the necessary components to support a microcontroller. Arduino Uno can be powered by connecting the computer with a USB cable, adapter or battery. It requires DC 7~12V as working voltage.

I^2C Serial Interface and LCD Module: The LCD I^2C module is a module that works with the I^2C serial communication protocol. It is used to visually transmit the outputs of the Arduino system to the users. The 16x2 character LCD screen normally operates according to the 4/8 bit parallel data communication system.

Warning System (Buzzer): The buzzer card is used to transmit audible warnings to the user. The module works between 3.3V-5V. It is connected to the digital output of the microcontrollers and generates a warning tone at the specified tone.

Heart Rate Pulse Sensor: Arduino pulse sensor is used to determine the heart rate. The sensor is designed for scientific research. The pulse sensor can be attached to the finger or the earlobe. There is an optical amplifier and noise suppressor electronic circuit on the pulse sensor. The sensor outputs analog signals. The module is basically based on the principle of whether the oxygen flow in the blood transmits IR (infrared) signal.

Temperature and Humidity Sensor: Since DHT22 pulse sensor ise widely preferred in Arduino systems with its ready to use library this sensor was used in this project.

L293 Motor Driver: L293 ICs, which are quad and half H drivers, are designed to provide bidirectional driver currents of up to 1 A at voltages between 4.5 and 36 V.

2.2. Method

This study we have done is an experimental work and while developing the system, Arduino Uno control card, heart rate sensor and temperature sensor were used together. A general operating scheme was created by developing software for detecting changes in heart rate and body temperature with these tools. The system created is also open to future additions and improvements. The data obtained through the sensors on the system can be transferred to the computer environment via wi-fi and monitored over the internet. In addition to these, more sensors can be placed in the system depending on the intended use.

The development phase of the system consists of two parts: hardware and software. In the realization of electronic design; A general diagram was created using the arduino uno control card, heart rate sensor and temperature sensor. The software part developed within the system undertakes two different tasks. The first is the determination of the heart rhythm (pulse) and the calculation of the heart rate (BPM), the second is the measurement of the body temperature with the help of a sensor. The calculated heart rate and body temperature values are then visually presented to the user with the help of the LCD screen. The software also analyzes whether the data obtained is at vital or critical levels and this situation is announced to the user with audible alerts. The flow diagram that includes the operation of the system is shown in Figure 1

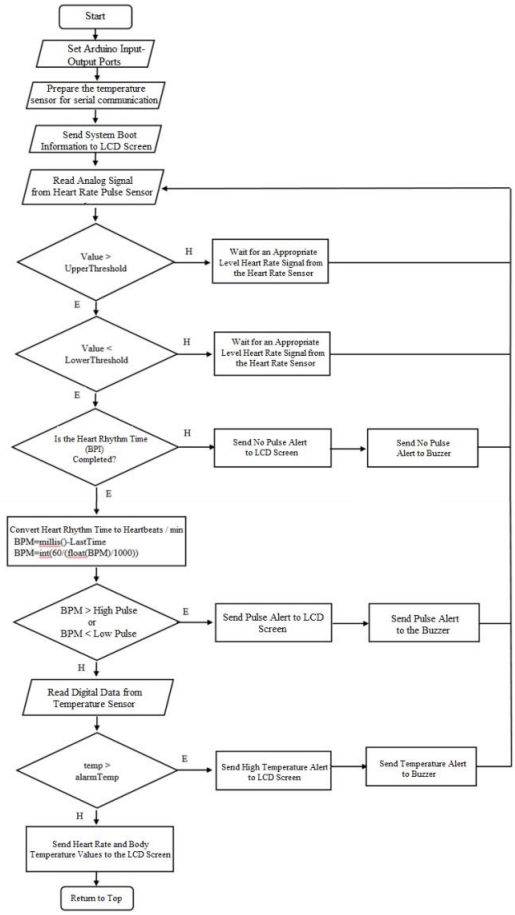

Figure 1. Flow diagram of the software developed for the biosensor system

For instance, Lagrangian function states the difference between system kinetic energy and potential energy as in Equation (1) in which L, T and V refer to Lagrange function, kinetic energy and potential energy of system, respectively.

3. Results

The software developed for the Arduino biosensor system has several functions. With the software, the input / output port properties of the Arduino electronic control card are set first. Then, I2C serial communication information is loaded with the temperature sensor and finally, the system opening screen is prepared by loading Turkish characters on the LCD screen.

In the general cycle part of the software, firstly the analog signals coming from the heart rate (pulse) sensor are analyzed and the heart rhythm is tried to be determined. When the pulse level is determined in milliseconds, the heart rate (Heart Beat/Pulse Rate, BPM) is calculated. The following conversion formula is used to determine the heart rate from the heart rate.

BPM = millis () - LastTime

BPM = int (60 / (float (BPM) / 1000))

In the temperature measurement part of the biosensor software, digital data communication is made with the temperature sensor. Digital heat values from the heat sensor are automatically converted in the Arduino library. The heat data of the system is obtained as ºC.

The heart rate and temperature values determined lastly with the biosensor software are sent to the LCD screen to be visually transmitted to the user. In this way, whether the heart rate and temperature values obtained through the sensors are within the specified threshold values are communicated to the user visually through the LCD screen and audibly with the buzzer. If there is any abnormal value, the user is warned.

First of all, the general hardware design of the developed biosensor system has been completed. Then, the electronic part was formed by placing microcontrollers and sensors. Finally, the programming of the arduino system has been made and tested to perform the intended functions. The simplified general diagram of the designed biosensor system is shown in Figure 2. As seen in Figure 2, the information obtained from the heart rate (pulse) sensor and temperature sensors is sent to the arduino uno module. These measurements can be monitored instantly as analogue and digital. Whether the data obtained through the sensors are within the specified threshold values is communicated to the user visually through the LCD screen and audibly through the buzzer.

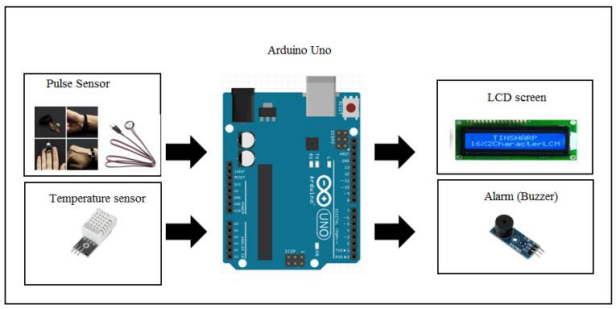

Figure 2. General diagram of Arduino based biosensor system

Arduino Uno control card, heart rate measurement sensor (pulse sensor) and DHT22 temperature and humidity sensor are used in the electronic design of the system. Only the temperature feature of the DHT22 temperature and humidity sensor in the system was used. The electronic design of the biosensor system is shown in Figure 3.

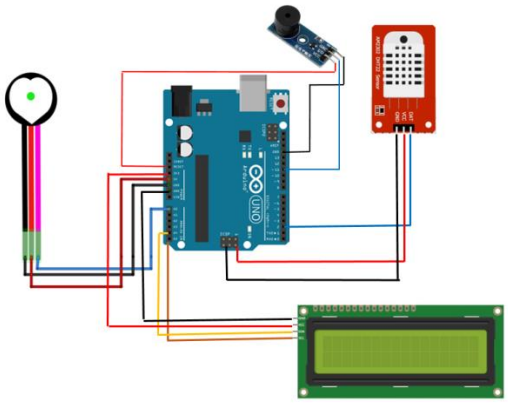

Figure 3. Electronic design of the biosensor system

Two important sensor modules are used in the Arduino based biosensor system. Heart rate beat (pulse) sensor works according to the principle of reflection of the level of oxygen in the blood from the IR (infrared) signal depending on the heartbeat. The purpose here is to determine the heart rhythm for each beat and to calculate the time between two rhythms in milliseconds. With the heart rate sensor (Pulse sensor) working analogically, the heartbeat is determined as BPM (Heart Beat/Pulse Rate) per minute. The other sensor module of the system is the heat sensor (DHT22). The digitally operating temperature sensor performs very accurate measurement. Body temperature is determined in °C. Both data are then successfully transmitted to the user via the LCD screen. The display of the biosensor system's heart rate and body temperature value to the user is shown in Figure 4.

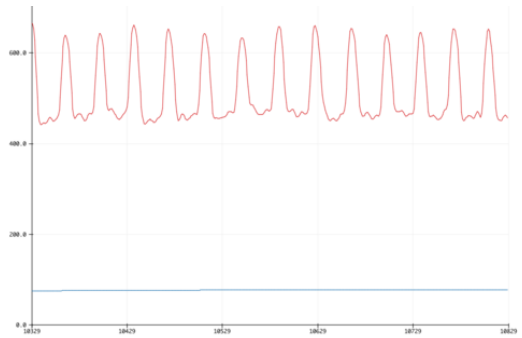

Figure 4. Heart rate sensor graphic

The heart rate and temperature values determined lastly with the biosensor software are sent to the LCD screen to be visually transmitted to the user. In this way, whether the heart rate and temperature values obtained through the sensors are within the specified threshold values are communicated to the user visually through the LCD screen and audibly with the buzzer. If there is any abnormal value, the user is warned (Figure 5).

Figure 5. The display of body temperature and heart rate with biosensor system

The computer application first reads 600 consecutive samples sent by the Arduino Uno. Since the sampling rate is 5 ms, it takes 3 seconds to read 6000 samples. The sample interval is calculated after the DC component (minimum 600 samples) is subtracted from the samples. If the sample spacing is less than 50, the received waveform is extremely weak. This can happen when the finger sleep cannot receive the signal. Since two consecutive samples are 5 ms apart, the time difference between any two peaks can be easily calculated from the indices. Two heart rates can be calculated from three consecutive wave peaks, the average value of which is displayed as the instantaneous heart rate.

When the temperature value exceeds 27°C, and when the pulse sensor cannot detect a heartbeat the buzzer gives an alarm . In the project we designed, the Pulse sensor sends analog data to the system, while the DHT22 sensor sends digital data. Thanks to the USB port on the Arduino Uno microcontroller, the system can be connected to the computer and the data can transfer to the computer. Thus, data on daily temperature and heartbeat rhythm can be easily accessed at any time. This is extremely important in terms of instant monitoring of the health status of the person

4. Conclusions

Biomedical engineering is an engineering field that combines the design and problem-solving skills of engineering with biological sciences and medicine in order to improve the health care and quality of life of patients. Therefore, its importance is increasing day by day. The monitoring of body temperature and heart rate, which are among the important indicators in the diagnosis of diseases and in the follow-up of patients, is of vital importance in this context. Thanks to this system we have designed, heart rate and body temperature can be measured with fingertips.

In this study, a multi-sensor and low-cost biosensor system has been developed using the Arduino microcontroller board. With the established system, the heart rate and body temperature of people were measured digitally. In this way, it is possible to regularly monitor the vital body values of people with health problems and to detect any sudden changes that may occur in values.

In this project we have designed, heart rate is measured by pulse sensor and body temperature is measured by temperature sensor. The measured values are displayed on the LCD screen via the Arduino Uno control card. If the heart rate and body temperature value are abnormally high, the alarm (buzzer) is activated and gives a warning.

The arduino-based biosensor system, which has been developed, can monitor the heart rate and body temperature information, which is vital for humans, remotely and instantaneously. As a result of the applications and tests, it has been observed that the system works quickly and successfully.

In addition, the developed system includes an infrastructure ready for future additions and improvements. It is thought that more sensors or sensors with different features can be added to the biosensor tracking system in accordance with the intended use.

As a result, it is evaluated that the developed biosensor system will contribute to the field of medicine and health with its features, it can be used in the follow-up of people working for military purposes or in dangerous work environments by mounting on wearable clothes.

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