

The Design of Heart Rate Detector and Body Temperature Measurement Device Using ATmega16

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Abstract— The research discussed health services in the role of diagnostics and life support. The designed system was a system able to provide information on the user's health condition, in this case, a measure of heart rate and body temperature using a heart rate sensor (finger-tip sensor). It took the data from the blood flow on the index finger for 60 seconds, then displayed it on the LCD. The LM35 temperature sensor was used for body temperature data collection. Changes in the sensor heat would be converted into electricity, translated into digital form through a 10-bit ADC, processed by the ATmega 16 microcontroller, and displayed on the LCD. The results showed that the error of each parameter of heart rate and body temperature was <1.702% and <0.55%.

Keywords— *finger-tip, body temperature, microcontroller*

I. INTRODUCTION

Physical health is measured from the basic parameters of normal values of the body's vital signs, including heart rate and body temperature. The heart is the most important organ in the human body because it is the main organ to circulate blood throughout the body. People usually utilize a stethoscope and thermometer to measure them. In fact, because of the high price but less practical, few people use such devices. Hence, a device that can test the body's state in a practical and portable way is required.

Some researchers have researched on temperature sensors and microcontrollers such as Yilei and Airong who designed a real-time temperature monitoring based on the operating system [1]. The system consisted of a DS18B20 sensor, an nRF24L01 wireless module, and a STM32F103ZET6 microcontroller. Fuady et al studied extreme machine learning and neural network to control the temperature and humidity of oysters based on microcontrollers [2]. The system consisted of a microcontroller and a DHT 11 sensor. Wang and Chi investigated the Arduino Uno platform wireless temperature and humidity monitoring system consisting of an Arduino microcontroller, a temperature sensor and humidity sensor, a 128641 LCD, and an nRF24L0 wireless module [3].

Other temperature measurement research includes an experiment to precise temperature measurement using platinum RTD PT1000 temperature sensor and Matlab by Chauhan and Neelakantan [4], a unit design for measuring the temperature of moving parts of the crank mechanism by Elkhutov using a temperature sensor and accelerometer [5], and Arduino-based temperature and humidity controls for condensation on engineered surface wettability by Gupta et al using a temperature sensor, a humidity sensor, and an Arduino Uno microcontroller [6].

Some other researchers have conducted research on body temperature. Saha, Raun, and Saha monitored the health of patients with smart ambulance systems using the Internet of Things (IOTs) [7]. The system consisted of a heart rate sensor, a temperature sensor, a microcontroller using Arduino, and a Raspberry Pi. Priyadharshini developed an embedded web server for health care systems using E-cards consisting of a heart rate sensor, a blood sugar sensor, a blood pressure sensor, a weight sensor, and an ATMEGA16 microcontroller [8]. Jayswal, Gupta and Gupta studied patient health monitoring systems based on the Internet of Things including a heart rate sensor, a temperature sensor, an ATMEGA328 microcontroller, and a Wi-Fi module [9].

Asmidar et al developed infant incubators for clinics in rural areas of Malaysia [10]. The system consisted of an ATMEGA2560 microcontroller, a DHT11 incubator temperature and humidity sensor, a DS18B20 baby body temperature sensor, a weight sensor, and an LM35 heating element temperature sensor. Sudha et al designed a system for patient monitoring in hospital management using Li-Fi [11]. The system consisted of a heart rate sensor, a blood sugar sensor, a temperature sensor, a respiratory sensor, a PIC 16F844 microcontroller, and a LIFI transmitter. Aziz et al developed a smart real-time health monitoring and tracking system using GSM/GPS technology that included a GPS position sensor, a microcontroller, a pulse sensor, a temperature sensor, and a GSM module [12]. Ganesh et al designed low-cost smart chairs for telemedicine and IoT-



Based on the Figure 3, the temperature sensor works by utilizing changes in temperature converted into electrical signals. The IC ATmega 16 serves as the main control in processing data. In the application of the system, the PORTB.0 is as the input from BPM (Heart Rate Gauge) and PORTA.0 as the temperature (Temperature Gauge) input. The main system schematic was shown in Figure 4.

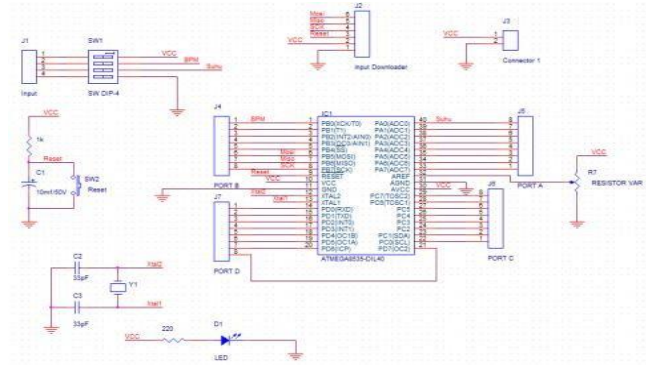


Fig. 4. Example of a figure caption.

b. Firmware design

The workflow of the system illustrated in Figure 5 shows that the sensor starts to work (counting the number of the heartbeats and body temperature) when the start button is activated. The reset button works to repeat the counting from the beginning.

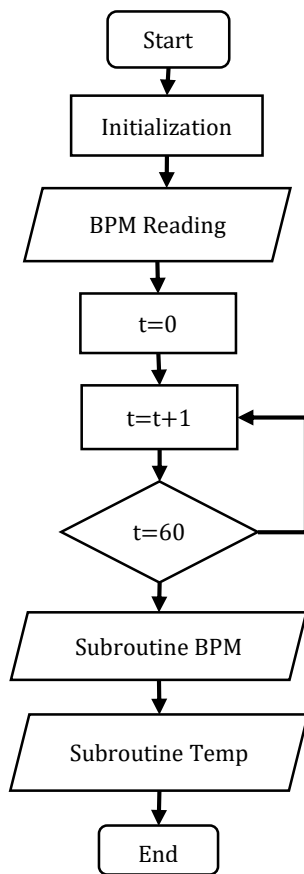


Fig. 5. System workflow

III. SYSTEM TEST

a. Heart rate measurement

In the heart rate measurement test, the device calculated the frequency of blood flow flowing of two patients for 60 seconds five times. The other device used as a comparison was Mindray Oximeter. The results of the test were presented in Table 1.

TABLE I. HEART RATE MEASUREMENT RESULT

No. measurement	Patient 1		Patient 2	
	Tested (BPM)	Standart (BPM)	Tested (BPM)	Standart (BPM)
1	77	80	71	70
2	72	76	75	73
3	73	76	71	71
4	73	74	71	73
5	75	76	72	73
Mean	74	76.4	72	72
Standard deviation	2.7		1.4	
UA	1.2%		0.6	
% error	3.1		0	

b. Body temperature measurement

Table 2 present the body temperature measurement results by using the tested device and a thermometer as the comparator.

TABLE II. BODY TEMPERATURE MEASUREMENT RESULT

No. measurement	Measurement device	
	Tested (BPM)	Standard (BPM)
1	36	36
2	36	37
3	36	36
4	36	36
5	36	36
Mean	36	36
Standard deviation	0.4	
UA	0.2%	
% error	0.6	

IV. CONCLUSIONS

The error value of the LM35 sensor measurement compared to the thermometer is 1.903%. This sensor is very sensitive to vibration and light. If one pulse is lost in monitoring, it will cause a loss of six beats counting. The error of the BPM measurement compared to the calibration devices 0.55%.

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