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Design to Build an Arduino-Based Heart Rate Detection Device

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ABSTRACT

The development of technology in the modern era is currently taking place very rapidly and has had a significant impact on various aspects of human life, one of which is in the health sector. Advances in electronics technology and embedded systems have allowed the creation of various health devices that are portable, practical, and easy to use by the wider community. In the health sector, monitoring the condition of the human body is very important, especially in knowing a person's vital condition. One of the vital parameters that is often used as an indicator of health is heart rate. However, in reality, heart rate detection devices available on the market generally have relatively expensive prices and not all people have access to these tools. The researcher designed an Arduino Uno-based heart rate detection device that is simple, economical, and easy to use This research designed a biometric system that measures heart rate and body temperature while based on Arduino Uno and heart rate sensors. The system is designed to be low cost, easy to use, and can be upgraded again in the future.

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1. Introduction

The development of technology in the modern era is currently taking place very rapidly and has had a significant impact on various aspects of human life, one of which is in the health sector. Advances in electronics technology and embedded systems have allowed the creation of various health devices that are portable, practical, and easy to use by the wider community. The use of this technology is not only limited to health facilities such as hospitals or clinics, but also begins to be used independently for the purpose of monitoring daily body conditions.

One of the vital parameters that is very important in human health monitoring is heart rate [3], [5]. Heart rate reflects the working conditions of the heart in pumping blood throughout the body. Changes in heart rate, whether too fast or too slow, can be an early indication of a health problem, such as fatigue, stress, heart rhythm disorders, and cardiovascular disease more serious. Therefore, regular heart rate monitoring is very necessary as a preventive measure to maintain health and detect potential disorders early.

In the health sector, monitoring the condition of the human body is very important, especially in knowing a person's vital condition. One of the vital parameters that is often used as an indicator of health is heart rate. Heart rate can provide information about a person's physical condition, such as fitness level, stress conditions, fatigue, and early indications of certain health conditions [3]. A heart rate that is outside normal limits, either too high or too low, can be a sign of a health problem that needs further attention.

However, in reality, heart rate detection devices available on the market are generally relatively expensive[2], [4] and not all people have access to them. In addition, some professional medical devices require special handling and are not easy for the general public to use. This is an obstacle in itself, especially for students and beginner researchers who want to learn technology-based health monitoring systems at a limited cost. In the design of a heart rate detection system, a data processing medium and information viewer are needed. Arduino Uno acts as a data processing center that receives signals from the heart pulse sensor, then processes it into heart rate values in Beat Per Minute (BPM) units. In order for the measurement results to be easily read by the user, a 0.96-inch OLED screen [1] is used as the display medium. OLED screens have the advantages of small size, low power consumption,
as well as a clear display, so it is very suitable for use in embedded systems.

In addition to displaying data, the system is also equipped with a buzzer as a warning indicator. The buzzer functions to provide a sound notification when the heart rate value is outside the predetermined normal limit. With this indicator, users can immediately know if an abnormal heart rate condition occurs without having to constantly pay attention to the screen. Based on this description, a design of an Arduino Uno-based heart rate detection device that is simple, economical, and easy to use is needed. This tool is expected to not only be used as a learning tool for students in understanding the concept of microcontrollers and sensors, but also can be an initial solution in monitoring heart rate independently. Therefore, the author raised the title "Design and Construction of Arduino Uno-Based Heart Rate Detection Device" as a topic in the preparation of this final pre-project.

2. Research Methods

The research method used in this pre-final project is a prototype method with a system design approach. The prototype method is a system development method that is carried out by making an initial model of the system [27] [11] to be developed, then testing and evaluation are carried out in stages to obtain a system that is in accordance with the research needs. This method was chosen because the research is focused on the design and manufacture of Arduino Uno-based heart rate detection devices that require repeated testing and refinement processes.

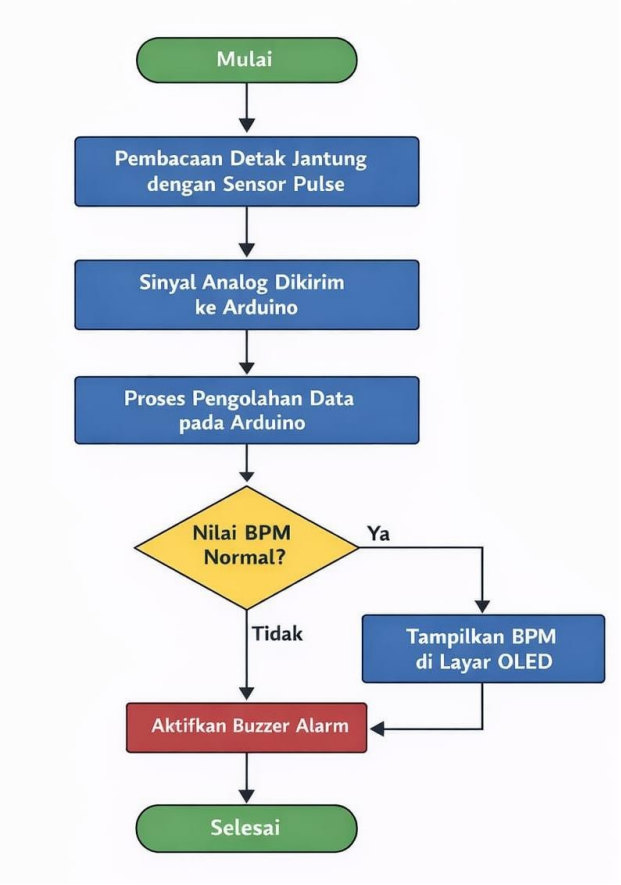

Figure 1. Research flow diagram

The first stage in the prototype method is the identification of system requirements. At this stage, information is collected through literature studies and needs analysis to determine the specifications of the tool to be designed. Identification of needs includes determining the main function of the device, which is to detect and display the user's heart rate [15] [22], as well as providing alerts via buzzers if the heart rate value is outside the normal limit. In addition, at this stage, the components used are also determined, such as Arduino Uno, heart pulse sensor, 0.96-inch OLED, buzzer, and other supporting components.

The second stage is the initial design and prototyping. At this stage, the researcher begins to design the system as a whole, both in terms of hardware and software. Hardware design is carried out by arranging a series of systems that connect heart pulse sensors [21]

[26] with Arduino Uno as the main controller, as well as integrating OLED and buzzer as output devices [29]. Meanwhile, software design is done by compiling flowcharts and program algorithms that describe the system's workflow. The initial prototype that was made was still simple and focused on the basic functions of the system

The third stage is prototype testing. Testing is carried out to find out if the initial prototype can function according to the set goals. At this stage, heart rate reading testing was carried out using a heart pulse sensor, testing the display of BPM values on OLED screens [30], and buzzer testing as a warning indicator. The test results are observed and recorded to determine the reliability and stability of the system in reading and displaying heart rate data.

The fourth stage is the evaluation and improvement of the system. Based on the results of the initial prototype test, an analysis was carried out on the weaknesses and shortcomings of the system, such as unstable sensor readings, delays in data display, or suboptimal buzzer response. The results of this evaluation are then used as a basis for making improvements, both on the hardware and software sides. The evaluation and refinement process can be carried out more than once until a system is obtained that works well and is in accordance with research needs.

The final stage is the creation of the final prototype and documentation. At this stage, the refined prototype is used as a final prototype that is ready for thorough testing. System tested back to ensure that all components can work in an integrated and stable manner. The entire research process, from the identification of needs to the testing of the final prototype, is then systematically documented in the form of a pre-project report. This documentation aims to provide a clear picture of the methods used as well as the results obtained during the research process.

3. Results and Discussion

The research approach is carried out systematically by combining theoretical and practical aspects. The theoretical aspect is obtained through the study of the literature related to the concept of heart rate, the principle of the work of the heart pulse sensor [26], as well as the characteristics of the Arduino Uno microcontroller. The practical aspect is carried out through the design and implementation of the system directly in the form of a prototype. By combining these two aspects, this research approach is expected to be able to produce a system that not only functions technically, but also has a clear theoretical basis and can be scientifically accounted for.

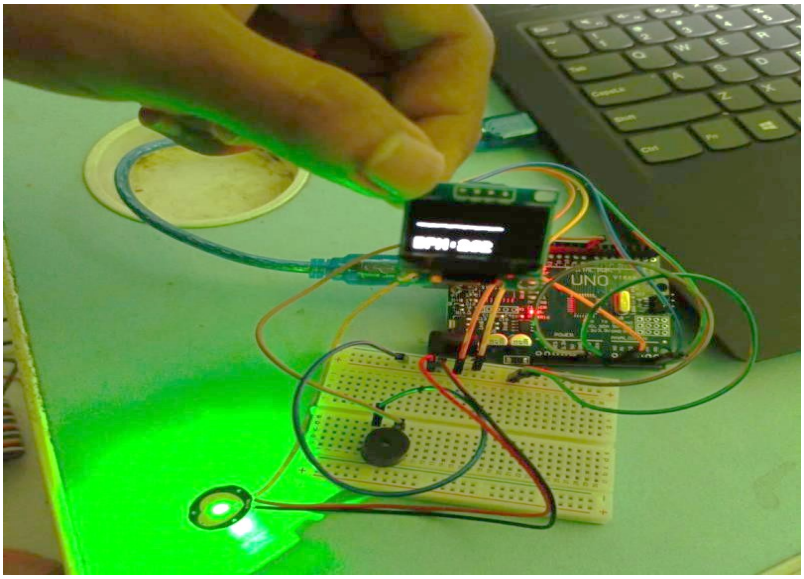

Figure 2. The set of tools and hardware used in the Heart Rate Detection Device Design and Build system.

The developed IoT-based heart rate monitoring Smart Health Monitoring tool works through several stages of an integrated process. The process begins with a Heart Pulse Sensor which functions to detect the user's heart rate when the finger is placed on the sensor surface [8], [10]. The sensor reading data is then sent to an Arduino microcontroller to be processed and processed into heart rate values in beats per minute (BPM) [23].

In the prototype approach, system development is carried out iteratively or iteratively. This means that the system is not immediately created in its final form, but rather starts from a simple initial prototype [25]. This initial prototype was used to test basic concepts of the system, such as the sensor's ability to detect heart rate and Arduino's ability to process data. Results from initial prototype testing were then analyzed to identify deficiencies in the existing system [27] [28].

This research approach also emphasizes the process of continuous evaluation [21]. Each stage of prototype testing is followed by an evaluation of the results to determine the necessary improvement steps. Evaluations were conducted on hardware performance, such as the stability of the heart pulse sensor readings and the clarity of the OLED display, as well as on the software, such as the accuracy of BPM calculations [24] and the system's response to data changes. With this evaluation process, the system can be developed gradually until it reaches the expected performance. In addition, the approach of this study is both applicative and contextual [17], as the designed tool is tested directly under actual conditions of use. The test was done by trying the tool on the user to see how the system responds to different heart rates [20]. This approach allows researchers to understand the behavior of the system in real life [19] as well as adjust the design to make it easier to use and more effective. Overall, this prototype-based research approach provides flexibility in the process of developing heart rate detection devices.

This approach allows researchers to conduct exploration, testing, and refinement of the system in stages [16]. Thus, the results of the research are expected to be in the form of a prototype of an Arduino Uno-based heart rate detection device [18] that functions well, is easy to understand, and can be further developed in future research. Here's a comparison of the ages and each normal BPM:

Table 1. Fuel comparison for each age

Age	BPM Normal
Infant = 0-11 months	80-160 BPM
Toddler = 1-2 Years	80-130 BPM
Young Children = 3-12 Years	75-120 BPM
Teenager = 13-17 years old	60-100 BPM
Adults = 18-60 years old	60-100 BPM
Trained Athletes	40-60 BPM
Senior = 61> years old	Average 60-100 BPM

Results

This study developed a heart rate monitoring tool using MAX30102 sensors [12]
which connects to Arduino Uno and OLED for real-time display. The test results showed high accuracy (~98-99%) [5] compared to standard pulse oximeters when measuring resting conditions and after running. This sensor is able to provide a BPM value that is very close to a medical device.
This research designed a biometric system that measures heart rate and body temperature based on Arduino Uno and heart rate sensors [9]. The system is designed to be low cost[1], [7], easy to use, and can be upgraded again in the future.

This study uses a pulse sensor with Arduino as an alternative to an affordable heart rate test device compared to a hospital examination. The main emphasis is on the implementation of simple pulse sensors and Arduino for BPM readings [3], [10]. This study used a PPG (Photoplethysmogram) sensor connected to an Arduino and sent to an Android application via Bluetooth [4], [6]. Android displays graphs and BPM data, so measurements can be monitored on your phone wirelessly.

Based on the study of several related studies, it can be concluded that Arduino-based heart rate detection devices have been developed with various approaches and features. Some studies have used optical-based heart rate sensors such as the Pulse Sensor, MAX30100, and MAX30102 [11], [12] which are capable of producing real-time heart rate readings with a fairly good level of accuracy. In addition, several studies have developed advanced monitoring systems such as OLED displays, connections to smartphones, and Internet of Things (IoT)-based monitoring [5]. However, most existing systems still have some limitations, including network complexity, relatively high device costs, and suboptimal early warning features to detect abnormal heart rate conditions directly [13]. Some systems also require additional devices such as internet networks or dedicated applications, making them less practical for simple use.

Therefore, this study designed and built a simpler, economical, and easy-to-use Arduino-based heart rate detection device [8], [14], and easy to use by utilizing heart rate sensors, OLED displays as information media, and buzzers as early warning systems. It is hoped that the designed device can be a practical and affordable alternative to heart rate monitoring [4], [15].

The results of the research in 2025 include designing and building an Arduino Uno-based heart rate detection device with a heart pulse sensor, 0.96-inch OLED, and a buzzer. The implementation of the research includes system design, tool assembly, Arduino programming, and functional testing. The presentation of data from the results of the research was shown showing the schematic of the Heart Rate Building Device design system consisting of an Arduino Uno microcontroller, a Heart Pulse Sensor, and other supporting components. This schematic describes the relationships between the hardware components used in the study.

4. Conclusion

This research successfully designed and built an Arduino Uno-based heart rate detection device by utilizing a heart pulse sensor, a 0.96-inch OLED, and a buzzer. This tool is created with a prototype approach, which allows for the development of the system gradually from design, assembly, programming, to functional testing. With this method, researchers can evaluate and improve repeatedly, so that the resulting tool is more stable and in accordance with the research objectives.

The test results showed that the device was able to accurately read the user's pulse, display the BPM value in real-time on the OLED screen, and provide alerts via buzzer when the heart rate is outside the normal limit. The system works in an integrated, responsive, and easy-to-use manner, although there are still some limitations such as the sensor's sensitivity to finger position and ambient light.

Overall, this study proves that the use of the prototype method is very effective in the development of microcontroller-based design tools. The resulting tool not only functions according to its purpose, but also has the potential to be further developed, both in terms of sensor accuracy, data display, and the addition of remote monitoring features. Thus, this research makes a real contribution to the creation of a simple medical device that can be applied practically, as well as being the basis for further research and development in the field of heart rate monitoring.

Acknowledgments

Based on the results of research and testing of Arduino Uno-based heart rate detection devices that have been carried out, there are several suggestions that can be given for the development and improvement of the tool in the future.

1. It is recommended to improve the accuracy of the heart rate sensor. Although the heart pulse sensor used in this study was able to read the pulse quite well, the sensitivity was still affected by the position of the finger and the ambient light conditions. The use of more advanced sensors or additional calibration can help obtain more stable and accurate readings under a wide range of user conditions.
2. The system can be developed with improved OLED displays and features. Currently, OLEDs only display the numerical value of BPM. In the next development, additional graphical displays or visual indicators can be added to make it easier for users to understand the condition of the heart rate directly, as well as facilitate long-term monitoring.
3. It is recommended to conduct more extensive trials on a variety of user conditions and ages. This is important to ensure that the tool can work consistently and accurately in a variety of situations, as well as provide higher validity for tool development in a wider range of healthcare applications.

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