

Arduino Based Health Monitoring System

Abstract— The proposed project is a health monitoring system using Arduino that measures key health parameters such as heart rate, blood oxygen level, and body temperature. The system consists of sensors such as DHT11 for temperature, MAX30100 for heart rate and blood oxygen level, and an Arduino Nano for processing the data. The measured results are displayed on an LCD screen and a buzzer sounds when the results are ready. The system has been designed with simplicity and ease-of-use in mind, making it accessible for personal use. While the system has limitations such as sensor accuracy and lack of IoT functionality, it still has potential for improving individual health monitoring and wellness. In the future, potential areas for development include the inclusion of more sensors, IoT functionality, and machine learning algorithms for personalized insights and recommendations. Overall, the proposed health monitoring system is a promising step towards empowering individuals to take a more active role in monitoring their health and wellness.

Keywords—*arduino; microcontroller; sensor; functionality; health monitoring*

I. INTRODUCTION

Health monitoring is an essential aspect of maintaining good health and wellness. With the advancement of technology, it has become easier for individuals to monitor their health parameters at home. This project aims to develop a health monitoring system using Arduino, which is affordable, accessible, and easy-to-use for personal health monitoring. The motivation for this project is to empower individuals to take a more active role in monitoring their health, detect any potential health issues early, and take appropriate actions to maintain good health. The proposed health monitoring system could also be beneficial for individuals with chronic health conditions or those who need to monitor their health parameters regularly. By providing individuals with real-time health data, this system could help improve health outcomes, reduce healthcare costs, and promote overall wellness [1][2][3].

A. Objectives of the Project

The primary objective of this project is to design and develop a health monitoring system using Arduino that can measure key health parameters such as heart rate, blood oxygen level, and body temperature. The system should be affordable, accessible, and easy-to-use for personal health monitoring. Additionally, the system should be able to display real-time health data on an LCD screen and sound a buzzer when the results are ready. The system should also have the capability to be powered by a simple bus bar to reduce the complexity of the system. The secondary objectives of this project are to test and validate the system's accuracy by comparing the results with standard medical devices, simulate and analyze the system's performance under different conditions, and identify potential areas for future development, such as the inclusion of more sensors or IoT functionality. Overall, the project objectives aim to develop a reliable and user-friendly health monitoring system that can improve individual health outcomes and promote overall wellness [3].

B. Organization of the Report

The report begins with an introduction that provides an overview of the project background, objectives, and scope.

The literature review section presents the existing literature related to health monitoring systems and their components. The methodology and modeling section describe the components used in the project, their working principle, and the process of work. The results and discussion section present the measured response and experimental results and compares the numerical and experimental results. The limitations and future work section discuss the limitations of the project and potential areas for future development. Finally, the conclusion and future endeavors section provide a summary of the project and suggest possible avenues for future work [4][5].

II. LITERATURE REVIEW

There are several research papers on "Patient Health Monitoring using ESP8266 & Arduino". Prof. P.H. Kadam, Yogesh R. Tetwar, Shubham R. Langade, Gayatri N. Nalge, Ketaki N. Shete, Mohanish C. Jadhao, Lavkush M. Sable, Chandrakant B. Borkar published "A Review Paper on Monitoring System using Arduino" in 2023 where they proposed a temperature sensor which is a Celsius temperature heat exchanger that can effortlessly take Celsius measurements without the need for transmitting large, continuous power interruptions [2].

In 2023, "Design and Implementation of Health Care Monitoring System using Cloud and Mobile Applications" was published by P. Suryanarayana, R. Kalyankumar, S. Bhaskarakrishna, R. Chinnu, where they proposed a model that will display body temperature, heartrate, glucose level, blood pressure, room temperature, oxygen saturation as well as track the patient's location using Arduino Uno and several sensors [1]. In the paper of Sowjanya Masna, Ashwini Gadusu named "ICU Patient Health Monitoring System over IoT using Arduino", a health monitoring system concept is suggested, which utilizes temperature, heartbeat, and humidity sensors to track human body health parameters. The data is then displayed on an LCD screen and transmitted to an IoT server. For ensuring the health and safety issues of the ICU patients Shirisha et al published "Arduino Based ICU Patient Health Monitoring System over IOT" [3]. The proposal involves a health monitoring system incorporating temperature sensors, heartbeat sensors, and humidity sensors to track human body health parameters. The data is displayed on an LCD and sent to an IoT server. If there are fluctuations in the heart rate, indicating low or high blood pressure, the system triggers a buzzer alert, and the corresponding information is also updated on the server. To reduce the hassles of going outside for health checkup during pandemic in 2021, Mohammad Monirujjaman Khan et al published "IoT-Based Smart Health Monitoring System for COVID-19 Patients" and submitted a proposal to keep a track of the patient by using mobile application and Arduino Uno where there will be doctor's interface and patients' interface and if something goes wrong with the patient, the doctor will be notified through a sensor [6][7][8]. In addition, the doctor can see the patients' health report and condition.

III. METHODOLOGY

The Arduino-based health monitoring system is a nonreal-time monitoring system that can measure and record vital health parameters like blood oxygen levels, body temperature, and heart rate. It uses an Arduino microcontroller, along with sensors like the pulse oximeter, temperature sensor, and heart

rate sensor, to measure these parameters. The system then displays this data on an LCD screen for the user to view. This health monitoring system can be used in hospitals, clinics, and even at home to monitor the health of patients.

A. Block Diagram

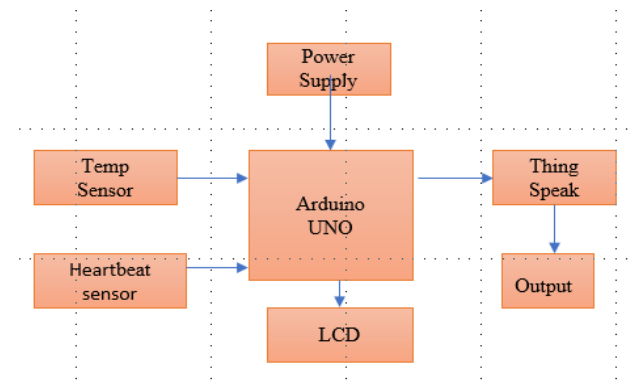


Fig. 1. Block diagram of an Arduino based health monitoring system.

B. Working Principle

Temperature Measurement: The DHT11 temperature sensor measures the ambient temperature of the surroundings and sends analog signals to the Arduino Nano microcontroller. **Heart Rate and Blood Oxygen Measurement:** The MAX30100 sensor measures the heart rate and blood oxygen levels by shining a light through the skin and measuring the reflected light. The sensor sends analog signals to the Arduino Nano microcontroller. The Arduino Nano microcontroller converts the analog signals received from the temperature sensor and the MAX30100 sensor into digital signals for further processing. The processed data is then displayed on the LCD screen, which shows the measured temperature, heart rate, and blood oxygen levels in real-time. The buzzer is used as an alert system that notifies the user when the results are ready. For example, when the measured data is displayed on the LCD screen, the buzzer will sound like it is alerting the user that the results are ready.

Power Supply: The bus bar is used to provide power to each of the components in the system, ensuring that they function correctly.

Overall, the system works by measuring the ambient temperature, heart rate, and blood oxygen levels using the DHT11 and MAX30100 sensors, processing the data using the Arduino Nano microcontroller, and displaying the results on the LCD screen. The buzzer is used to notify the user when the results are ready, and the busbar provides power to the components.

C. Components

The components used in the system are widely available, easy, and cheap to implement.

1) Arduino UNO

It is a prototyping platform that is based on ATmega 328p microcontroller. It is an easy-to-use platform that is used to test and automate various tasks. It can be programmed with C, C++ or in Assembly language using the open-source Arduino IDE. Arduino can be paired with various sensors or modules to perform various tasks based on needs.

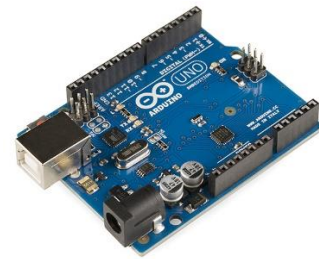


Fig. 2. Arduino UNO [9].

2) DHT11 Temperature Sensor

The DHT11 is a digital sensor designed to gauge the temperature and humidity of the environment it is placed in. It has a measuring range of 0-50 °C and an accuracy of ±2 °C. The sensor uses a single-wire communication interface and provides a digital output signal that can be read by the Arduino Nano microcontroller.

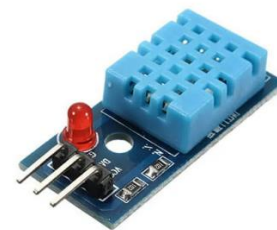


Fig. 3. DHT11 temperature sensor [10].

3) Max30100 Pulse Oximeter and Heart-Rate Sensor

The MAX30100 sensor functions as a pulse oximeter and heart-rate sensor. It measures the oxygen saturation in the blood and the heart rate by shining a light through the skin and measuring the reflected light. The sensor has an integrated LED and photo detector and provides analog output signals that can be read by the Arduino Nano microcontroller.

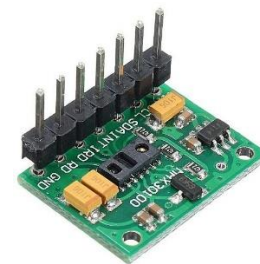


Fig. 4. Max30100 pulse oximeter and heart-rate sensor [11].

4) Power Supply

The power supply consists of an LM7805 5V voltage regulator and a 9V battery. Additionally, the Arduino can be powered using a 9V supply or from a connected computer through USB.



Fig. 5. Battery [12].

5) *LCD Display*

The LCD display is a 16x2 character display that is used to display the measured temperature, heart rate, and blood oxygen levels in real-time. It communicates with the Arduino Nano microcontroller using the I2C protocol, which requires only two wires for data transmission.



Fig. 6. LCD display [13].

6) *Buzzer*

The buzzer is a small electronic component that produces sound when an electric current is passed through it. It is used to provide an audible alert when the measured data is ready to be displayed on the LCD display. The buzzer is connected to one of the digital pins of the Arduino Nano microcontroller.



Fig. 7. Buzzer [14].

D. *Operation Flowchart*

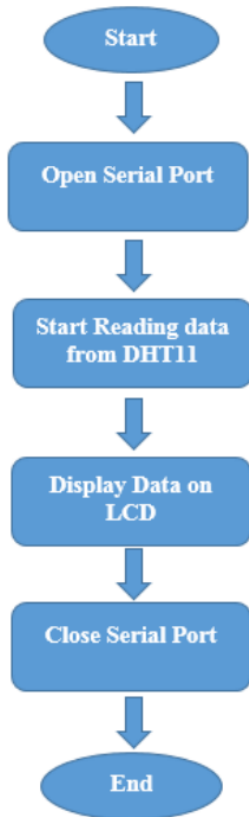


Fig. 8. General flowchart of using DHT11 temperature & humidity sensor.

IV. TEST/EXPERIMENTAL SETUP

The experimental setup for the proposed Arduino based health monitoring system involved connecting various components through a busbar to the Arduino Nano. We used the DHT11 temperature sensor to measure the ambient temperature, and the MAX30100 sensor to measure heart rate and blood oxygen levels. We also used an LCD display with I2C interface to show the real-time results, and a buzzer to provide an audible alert when the measurements were complete. All of the sensors and displays were properly connected and wired to the busbar and Arduino Nano, with the system being powered by an external power supply. We tested the system by placing the MAX30100 sensor on a fingertip or earlobe and measuring the heart rate and blood oxygen levels. The temperature sensor also provided accurate measurements of the ambient temperature. Overall, the experimental setup helped us validate the functionality and accuracy of the proposed health monitoring system.

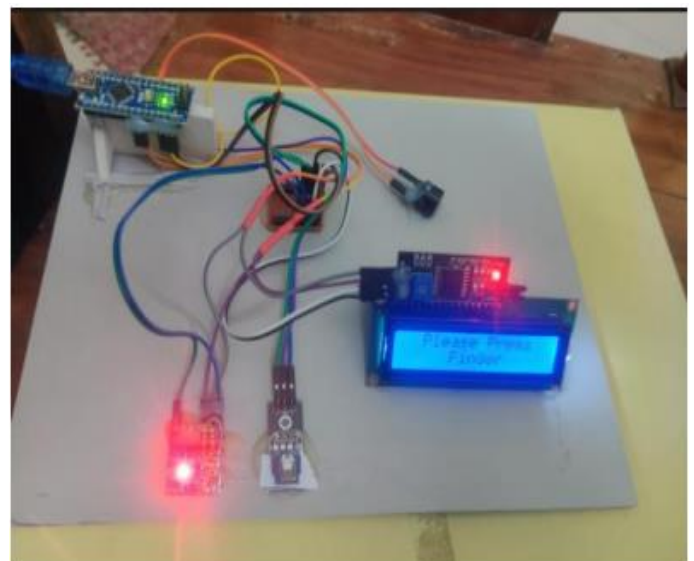


Fig. 9. Experimental setup (1).

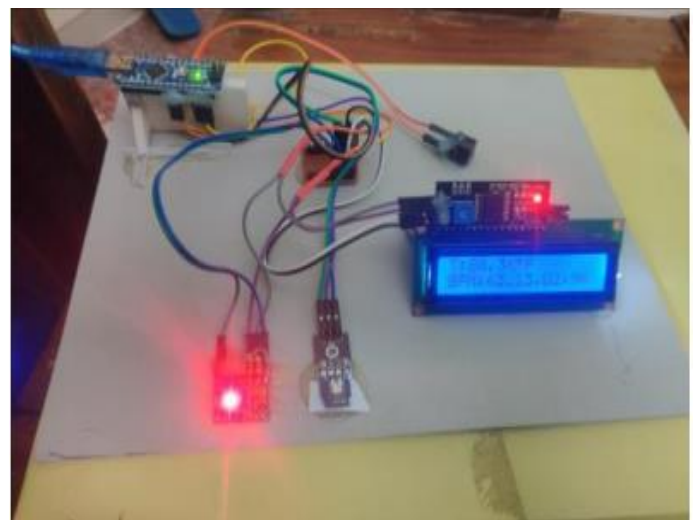


Fig. 10. Experimental setup (2).

V. RESULTS AND DISCUSSIONS

A. Simulation/Numerical Analysis

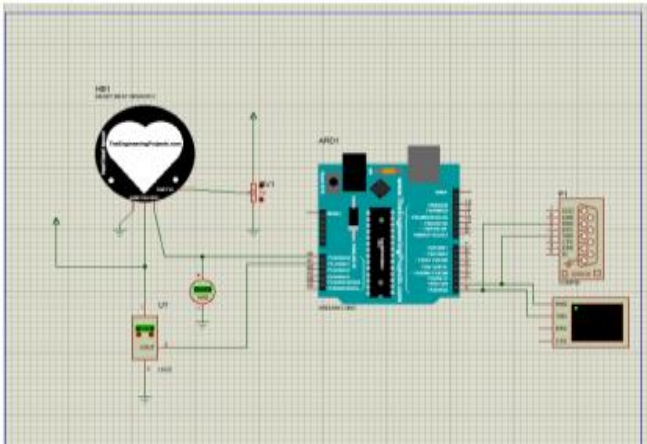


Fig. 11. Simulation of the project.

While simulation and numerical analysis can be useful tools for testing and validating the functionality of a proposed health monitoring system, they have their limitations. Simulations are based on mathematical models and assumptions that may not accurately represent real-world scenarios. Therefore, it is important to conduct real-world testing to validate the performance and accuracy of the system. In the case of a health monitoring system, real-world testing involves collecting data from an actual individual and comparing the results to the measurements obtained from the system. This helps to ensure that the system is providing accurate measurements and functioning properly in a real-world environment. While simulation can be a useful tool for initial testing and design, real-world testing is necessary to fully validate the system's performance and accuracy.

B. Measured Response/Experimental Results

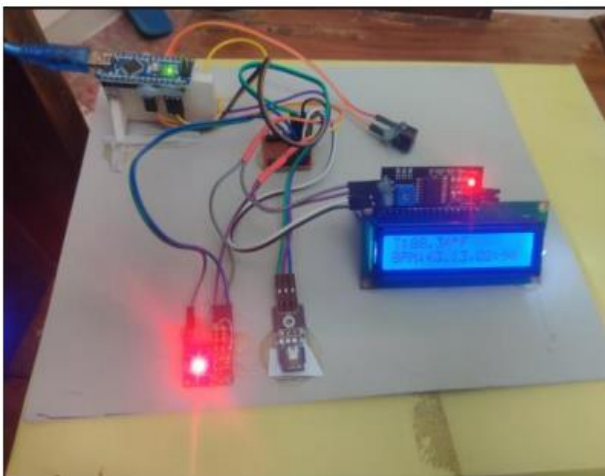


Fig. 12. Experimental results (1).

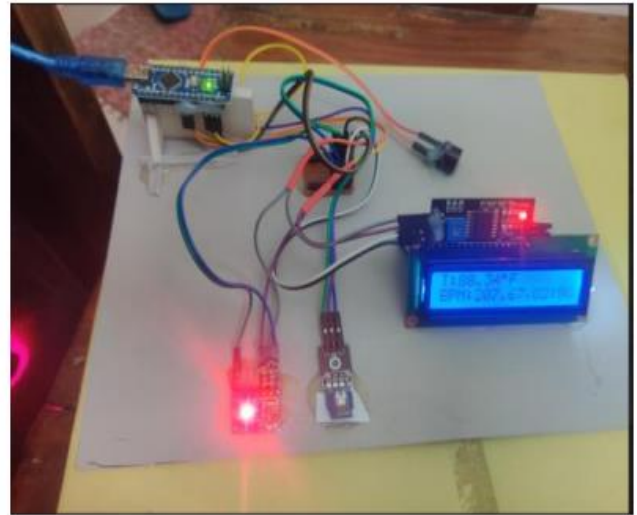


Fig. 13. Experimental results (2).

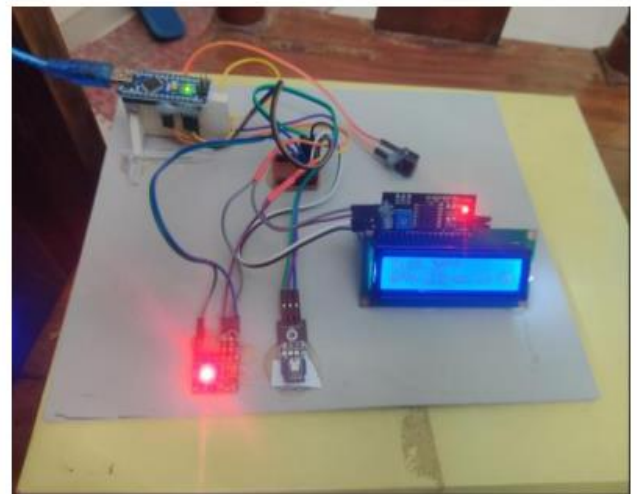


Fig. 14. Experimental results (3).

During real-world testing of a health monitoring system, it's important to account for individual variability to ensure that the system is accurately measuring and monitoring an individual's health. Differences in physiology, health status, and other factors can affect the measured response for different people and can therefore impact the accuracy of the health monitoring system. Additionally, it's important to establish baseline values for normal ranges for each measurement to properly interpret the results. The normal range of measurements can vary depending on factors such as age, gender, and health status. Consulting with a healthcare professional can help to establish these normal ranges and interpret the results of the health monitoring system. By accounting for individual variability and establishing baseline values, a health monitoring system can provide accurate and useful information to individuals and healthcare professionals alike.

C. Comparison Between Numerical & Experimental Results

It is not possible to directly compare numerical and experimental results for a health monitoring system due to the limitations of simulation. While simulation can be a useful tool for testing and design, it cannot replicate real-world

scenarios with 100% accuracy. In the case of a health monitoring system, real-world testing involves collecting data from an actual individual and comparing the results to the measurements obtained from the system. This helps to ensure that the system is providing accurate measurements and functioning properly in a real-world environment. While simulation allows for the manipulation of data, it cannot replicate the complexity and variability of real-world data. Therefore, it is not possible to directly compare numerical and experimental results for a health monitoring system. However, simulation can be used to identify potential issues and refine the design before real-world testing is conducted.

VI. FUTURE POTENTIAL

In the future, there will be several areas of development for the health monitoring system. One potential area for improvement is the inclusion of more sensors to monitor additional health parameters such as blood pressure or respiratory rate. Additionally, incorporating IoT functionality could allow for real time data transmission to healthcare professionals or caregivers, enabling remote monitoring and support.

Another potential area for development is the integration of machine learning algorithms to analyze the collected data and provide personalized insights and recommendations for individuals. Overall, the proposed health monitoring system is a promising step towards empowering individuals to take a more active role in monitoring their health and wellness.

VII. CONCLUSION

In conclusion, critical health metrics like heart rate, blood oxygen level, and body temperature have been measured and monitored using the suggested health monitoring system using Arduino, with encouraging results. The system is usable for personal use because it has been created with simplicity and usability in mind. Although the system has some drawbacks, such as sensor inaccuracy and a lack of IoT functionality, it nevertheless has the potential to enhance personal health monitoring and wellness.

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