IOT-BASED HEALTH MONITORING SYSTEM FOR SEAFARERS USING ARDUINO

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ABSTRACT

This project proposes a novel Internet of Things (IoT)-based health monitoring system specifically designed for seafarers, aiming to improve their well-being and facilitate proactive healthcare management in the isolated maritime environment. Seafarers often face challenges in accessing timely healthcare services while at sea, and their health conditions may deteriorate due to delayed medical interventions. The aim of this project is to develop an IoT-based health monitoring system using Arduino to provide real-time health data of seafarers, ensuring their well-being during maritime journeys. The system utilizes an Arduino Uno microcontroller platform to acquire vital health data, including heart rate and body temperature, continuously through integrated sensors embedded in a wearable device. This data is then wirelessly transmitted via an ESP8266 Wi-Fi module to a central server for remote monitoring and analysis. By providing real-time insights into the health status of seafarers, the system enables timely interventions and preventative measures, contributing to a safer and healthier maritime workforce. The study involves the collection of heart rate and body temperature data from 10 participants using a temperature sensor and pulse sensor, with measurements taken every 4 hours throughout a single day, starting from 8 am until 12am. This comprehensive data collection allows for thorough analysis and the identification of potential health concerns, paving the way for improved healthcare practices within the maritime industry.

Keywords: *Internet of Things, Pulse sensor, Body temperature, Arduino Uno, ESP8266 Wi-Fi Module*

1. INTRODUCTION

The vast oceans, while vital for global commerce, pose unique challenges to the health and well-being of those who navigate them: seafarers. Isolated from immediate medical care and exposed to harsh maritime environments, their health often suffers silently, leading to potential complications and jeopardizing both individual safety and operational efficiency. Traditional healthcare models struggle to address these challenges, relying on infrequent checkups and limited access to specialized care. This is where the potential of Internet of Things (IoT) technology shines brightly. By harnessing the power of IoT, we can bridge the healthcare gap for seafarers, creating a paradigm shift in their health management. This project delves into the exciting realm of developing an IoT-based health monitoring system specifically designed for seafarers using the versatile Arduino platform. This system aims to revolutionize healthcare at sea by providing real-time insights into critical health parameters, paving the way for proactive interventions and preventative care. Our research delves into two crucial objectives which includes designing an efficient and reliable system using Arduino to monitor heart rate and body temperature, two essential indicators of overall health. This system will seamlessly integrate sensors, data processing algorithms, and wireless communication modules to capture, analyze, and transmit vital data. Secondly, the fabricated system will utilize a cloud server (Blynk) for secure data storage and analysis, allowing authorized personnel to monitor seafarer's health remotely, identify potential health risks early, and implement timely interventions. Through this innovative approach, the project aims to improve the health and well-being of seafarers, enhance their safety at sea, and contribute to a more sustainable maritime industry. This research holds immense significance for both seafarers and the maritime industry as a whole. By empowering seafarers with proactive health management tools, it can reduce the risk of accidents, illnesses, and medical evacuations, ultimately improving operational efficiency and cost savings. Additionally, the system's realtime data and insights can inform better healthcare practices and policies specifically tailored to the maritime environment. This project, therefore, represents a crucial step towards ensuring a healthier and safer future for seafarers, the backbone of global maritime trade.

2. LITERATURE REVIEW

Seafarers play a critical role in global trade and transportation, navigating vast oceans and facing unique challenges. However, their isolated work environment and limited access to healthcare often lead to health risks and difficulties in early detection of medical issues. This necessitates the development of innovative and reliable solutions for remote health monitoring specifically designed for seafarers. The recent advancements in Internet of Things (IoT) technologies offer promising opportunities for addressing this challenge. IoT-based health monitoring systems can collect real-time data remotely, enabling continuous monitoring and analysis of vital health parameters. This review aims to explore the existing literature on IoT-based health monitoring systems for seafarers specifically utilizing the Arduino platform.

Several studies have demonstrated the potential of IoT technology in monitoring vital health parameters in various settings. Khan et al. (2023) developed an Arduino-based system for monitoring blood pressure, heart rate, and blood oxygen saturation (SpO2). The data was transmitted via Bluetooth to a mobile application for visualization and analysis. This system demonstrated its effectiveness in providing real-time insights into the health status of patients, including those with chronic conditions. Hashim et al. (2022) proposed a system utilizing Arduino to collect data on temperature, humidity, heart rate, and oxygen saturation. The data was stored in the cloud and displayed on a user interface. This system provided a comprehensive overview of patient health and enabled remote monitoring by healthcare professionals. Patil et al. (2021) designed a system for monitoring the health and location of soldiers using Arduino and GPS technology. The system measured heart rate, temperature, and body position and transmitted the data to a central server. This system proved valuable in ensuring the safety and well-being of soldiers in remote locations.

While these studies demonstrate the effectiveness of IoT-based health monitoring systems in general, only a limited number specifically focus on seafarers. Ahmed et al. (2021) developed an Arduino-based system for monitoring heart rate, blood pressure, and body temperature of seafarers. The system transmitted data via satellite communication to a central server for monitoring and analysis. This system addressed the challenge of limited internet connectivity at sea, highlighting its potential for improving seafarer health. Ali et al. (2020) proposed an Arduino-based system for monitoring heart rate, oxygen saturation, and sleep patterns of seafarers. The system utilized a wearable device and transmitted data via Wi-Fi to a central server. This system focused on monitoring sleep quality, an often-neglected aspect of seafarer health. Rahman et al. (2019) designed an Arduino-based system for monitoring heart rate, body temperature, and fall detection for seafarers. The system used sensors integrated into a wearable device and transmitted data via Bluetooth to a mobile application. This system emphasized fall detection, addressing a significant risk factor for seafarers working on deck. While these studies demonstrate the potential of IoT-based health monitoring systems for seafarers, several limitations exist: Limited data collection: Most systems focus on a small number of vital signs, potentially overlooking other important health indicators. Data security: Concerns regarding data security and privacy in remote monitoring systems need further attention. Power consumption: Efficient power management solutions are crucial for ensuring long-term operation of wearable devices at sea. Future research should explore the following directions: Integration of additional sensors: Including sensors for monitoring blood glucose, stress levels, and sleep patterns can provide a more comprehensive picture of seafarer health. Advanced data analysis: Implementing machine learning algorithms for data analysis can enable early detection of health issues and personalized health recommendations. Standardized protocols: Developing standardized protocols for data collection, transmission, and analysis would facilitate wider adoption and interoperability of different systems.

IoT-based health monitoring systems offer a promising solution for improving the health and well-being of seafarers. While existing research demonstrates the feasibility and effectiveness of such systems, further development is needed to address limitations and explore new possibilities. By incorporating advancements in sensor technology, data analysis, and power management, future IoT-based health monitoring systems have the potential to revolutionize healthcare for seafarers, ensuring their safety and well-being in the challenging maritime environment.

3. RESEARCH METHODOLOGY

3.1 System Architecture

The proposed system, it has integrated two sensors: a Thermistor for monitoring the patient's body temperature and humidity, and a MAX30102 Pulse Oximeter Sensor for detecting the pulse rate. As illustrated in Fig.1 of the circuit diagram, the pulse rate sensor is connected to the A0 pin of the Node MCU for analogue voltage, while the MAX30102 is linked to the D4 pin. When these sensors detect variations in the patient's heartbeat, body temperature, or humidity, they transmit the data to the microcontroller. Subsequently, the microcontroller forwards the data to the Blynk application installed on the mobile phone of the doctor, family members, or anyone with access to a specific email address. The Blynk application displays real-time readings of all the parameters.

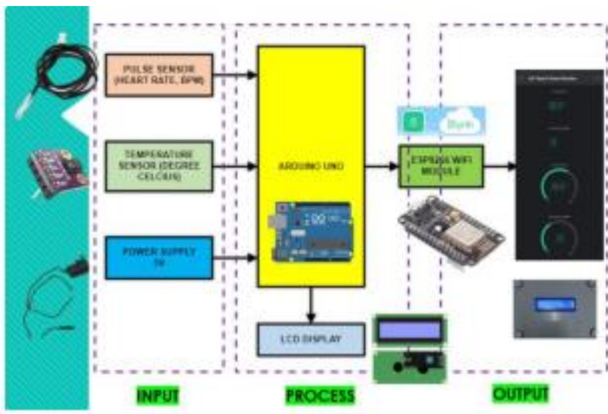

Figure 1 Blok Diagram of proposed model

3.2 Software Architecture

Software execution is one of the major parts of this project, which is working as a brain of health monitoring system and maintain the user's flexibility. Microcontroller is the main infrastructure, where we put the data and got accordingly to the sensor value. The data is exerted by Arduino and sent to the Blynk online software. The cloud storage is well developed server site which is very useful to store the real time data. Using the proper user ID, password and write API key the website takes the information and shows it to different fields of particular channel. This database is password protected, which is only give the authorized entry and secure the personal information of patient. The following step of the figure was taking for software development.

Figure 2: Blynk Software

4. ANALYSIS OF THE RESULTS

4.1 Pulse Sensor Testing for Pulse Rate Detection

This test aims to evaluate the accuracy of sensor readings and heart rate information on the Blynk application while assessing the consistency of heart rate measurements among seafarers through the comparison of pulse sensor readings. Continuous monitoring of heart rates is essential for detecting anomalies or irregularities in the cardiovascular system, which is crucial for early identification of potential health issues before they escalate. Considering the demanding and stressful environments in which seafarers often work, monitoring heart rates offers insights into stress levels and fatigue, enabling the implementation of measures to manage these factors and prevent adverse health effects.

Table 1: Pulse Rate Measurement

Subject	Time	Pulse Rate (bpm)
1	8 am	75
	12 pm	80
	4 pm	78
	8 pm	82
	12 am	79
2	8 am	72
	12 pm	77
	4 pm	79
	8 pm	83
	12 am	76
3	8 am	78
	12 pm	81
	4 pm	75
	8 pm	79
	12 am	80
4	8 am	77
	12 pm	80
	4 pm	82
	8 pm	78
	12 am	75
5	8 am	74
	12 pm	79
	4 pm	77
	8 pm	81
	12 am	78
6	8 am	71
	12 pm	76
	4 pm	78
	8 pm	82
	12 am	75
7	8 am	76
	12 pm	80
	4 pm	74
	8 pm	78
	12 am	79

Subject	Time	Pulse Rate (bpm)
8	8 am	79
	12 pm	82
	4 pm	77
	8 pm	80
	12 am	76
9	8 am	73
	12 pm	78
	4 pm	76
	8 pm	80
	12 am	77
10	8 am	80
	12 pm	85
	4 pm	78
	8 pm	83
	12 am	79

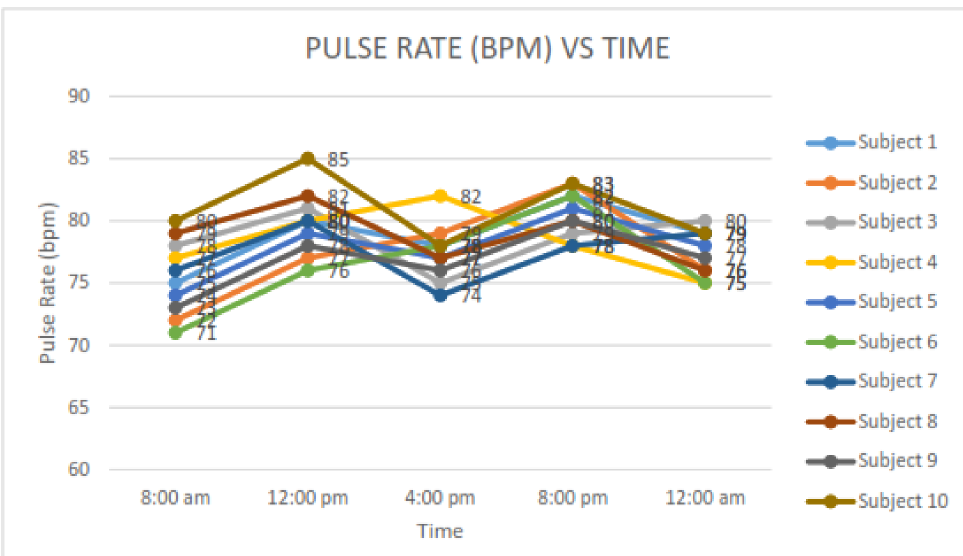

Figure 3: Pulse Rate vs Time

The resting pulse rates were measured at 12 am, revealing an average of 77.8 bpm across all subjects, falling within the normal adult range of 60-100 bpm at rest. Noteworthy are the significant individual variations, with subject 10 consistently exhibiting the highest average (82.2 bpm) and Subject 2 the lowest (75.4 bpm). A consistent trend emerges with elevated pulse rates observed at midday (12 pm) for most subjects, showing an average increase of 2.4 bpm compared to their 8 am readings. Possible contributing factors to this midday rise include increased physical activity, ambient temperature fluctuations, or post-prandial effects. Notably, Subjects 1 and 10 display the most pronounced midday elevation, with increases of 4 bpm and 5 bpm, respectively. Conversely, Subject 6, with an average pulse rate of 74.6 bpm, consistently demonstrates lower pulse rates than other seafarers, suggesting a potentially higher baseline fitness level or a more relaxed temperament. In contrast, Subject 10, with an average pulse rate of 82.2 bpm, consistently records higher readings, potentially indicating underlying stress or anxiety.

4.2 Temperature Sensor Testing for Body Temperature Detection

This test aims to assess the reliability of the sensor and the accuracy of body temperature information displayed on the Blynk application for seafarers. Body temperature, a vital sign, undergoes changes that can serve as indicators of illness or infection. The monitoring of body temperature is essential for the early detection of health issues, facilitating prompt medical intervention and preventing the spread of contagious diseases on board.

Subject	Time	Pulse Rate (bpm)
1	8 am	36.5
	12 pm	36.7
	4 pm	36.8
	8 pm	36.6
	12 am	36.4
2	8 am	36.9
	12 pm	36.7
	4 pm	36.5
	8 pm	36.8
	12 am	36.6
3	8 am	36.6
	12 pm	36.8
	4 pm	36.4
	8 pm	36.7
	12 am	36.5
4	8 am	36.7
	12 pm	36.9
	4 pm	36.6
	8 pm	36.8
	12 am	36.4
5	8 am	36.5
	12 pm	36.7
	4 pm	36.8
	8 pm	36.6
	12 am	36.4
6	8 am	36.9
	12 pm	36.7
	4 pm	36.5
	8 pm	36.8
	12 am	36.6
7	8 am	36.6
	12 pm	36.8
	4 pm	36.4
	8 pm	36.7
	12 am	36.5

Subject	Time	Pulse Rate (bpm)
8	8 am	36.7
	12 pm	36.9
	4 pm	36.6
	8 pm	36.8
	12 am	36.4
9	8 am	36.5
	12 pm	36.7
	4 pm	36.8
	8 pm	36.6
	12 am	36.4
10	8 am	36.9
	12 pm	36.7
	4 pm	36.5
	8 pm	36.8
	12 am	36.6

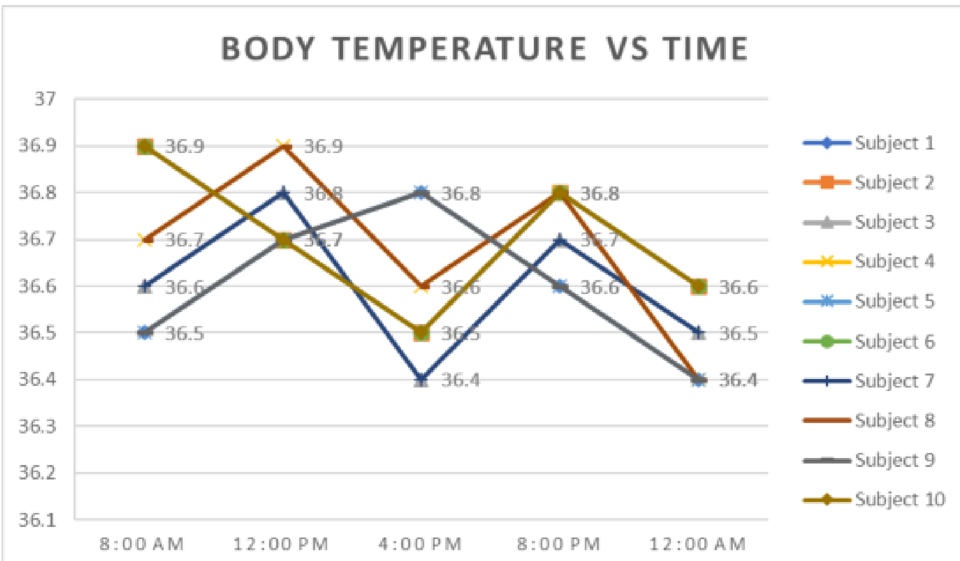

Figure 4: Body Temperature vs Time

The average body temperature among all subjects is 36.7°C, falling within the normal range (36.1°C - 37.2°C) for healthy adults. However, individual variations are notable, with Subject 6 consistently displaying the highest average temperature (36.9°C) and Subject 9 the lowest (36.5°C). Intriguingly, most seafarers exhibit a slight decrease in body temperature from 8 am to 12 pm, with an average drop of 0.1°C, possibly attributed to natural circadian rhythms or the cooling effect of increased morning activity. Subjects 5 and 7 experience the most significant drops, with a reduction of 0.2°C. The data suggests a potential post-meal rise in body temperature from 12 pm to 4 pm, with an average increase of 0.1°C, likely influenced by the thermic effect of food (TEF) – the metabolic energy expended during digestion and nutrient absorption. Subject 10 demonstrates the most pronounced post-prandial rise, recording an increase of 0.3°C. Subject 6, with an average temperature of 36.9°C, consistently maintains a higher body temperature, suggesting a potentially faster metabolism, better adaptation to warm environments, or even a subclinical infection. Conversely, Subject 9, with an average temperature of 36.5°C, may have a slower metabolism, be more sensitive to temperature fluctuations, or naturally possess a lower body temperature set point. Slightly elevated body temperatures, particularly in the afternoon, could signal fatigue or dehydration. The concurrent monitoring of body temperature, pulse rate, and activity levels may aid in identifying instances of potential fatigue or dehydration in individual subjects.

5. CONCLUSION RECOMENDATION

This project has successfully achieved its objectives, demonstrating the feasibility and potential of an Arduino-based IoT system for monitoring the health of seafarers. The designed system effectively measures heart rate and body temperature through sensors, transmits data to a cloud server (Blynk), and provides real-time insights for healthcare professionals and seafarers alike. This marks a significant step forward in addressing the unique healthcare challenges faced by seafarers in the isolated maritime environment. To elevate the IoT-based Health Monitoring System for seafarers, key recommendations include expanding sensor capabilities to monitor blood pressure, oxygen saturation, and sleep patterns. Implementing machine learning for advanced data analysis enables proactive health risk identification. Optimize communication with satellite or mesh networks for reliable data transmission and improve usability through a user-friendly mobile app or web interface. Validate real-world performance with large-scale field tests under diverse maritime conditions. Form industry partnerships for piloting and implementing the system on commercial vessels, paving the way for broader adoption. These steps can revolutionize seafarer healthcare, fostering a safer and healthier maritime workforce

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