

Hypothermia First Aid Application using Android-based Monitoring System

Aplikasi Pertolongan Pertama terhadap Hipotermia menggunakan Sistem Monitoring

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ABSTRAK

Studi ini dilatarbelakangi oleh urgensi menangani hipotermia, kondisi serius yang dapat bersifat fatal akibat penurunan suhu tubuh secara drastis, terutama dalam konteks pendakian gunung dengan keterbatasan peralatan medis yang tidak mudah dibawa. Studi ini bertujuan membuat aplikasi pertolongan pertama hipotermia berbasis Android untuk menangani dan mencegah hipotermia saat beraktivitas di luar ruangan. Alat ini menggunakan NodeMCU, Esp8266, sensor detak jantung, dan sensor DSI8B20 untuk mengukur suhu tubuh, detak jantung, dan kandungan oksigen, dengan memanfaatkan selimut pemanas sebagai output utama. Metode yang digunakan adalah metode waterfall, mencakup analisis, desain, implementasi, pengujian, dan pemeliharaan. Alat telah diuji coba kepada pendaki gunung dan mampu mendeteksi hipotermia secara *real-time*, yakni memberikan pertolongan pertama dengan mengaktifkan blanket warming. Selain itu, penggunaan aplikasi sistem monitoring hipotermia berbasis mikrokontroler juga telah dilakukan dengan menu utama Home, Monitoring, dan Data, yang memudahkan pengguna untuk memantau kondisi tubuh dan mengambil tindakan pertolongan pertama yang tepat. Hasil menunjukkan bahwa aplikasi ini dapat meningkatkan teknologi medis, mengurangi tingkat kematian akibat hipotermia, serta memberikan kontribusi signifikan dalam efektivitas sistem pelaporan dan penanganan medis. Analisis terhadap 50 pendaki gunung sebagai partisipan dalam penggunaan aplikasi pertolongan pertama hipotermia berbasis Android menghasilkan tingkat kesesuaian sebesar 96%.

Kata kunci: Hipotermia, Metode Waterfall, Monitoring, Sensor, Suhu.

ABSTRACT

This study was motivated by the urgency to address hypothermia, a serious condition that can be fatal due to a drastic decrease in body temperature, especially in the context of mountain climbing with limited access to medical equipment that is not easily portable. This study aims to create an Android-based hypothermia first aid application for the management and prevention of hypothermia during outdoor activities. The device utilizes NodeMCU, Esp8266, pulse sensor, and DSI8B20 sensor to measure body temperature, heart rate, and oxygen levels, while employing a heating blanket as the main output. The Waterfall method was used, comprised analysis, designing, implementation, testing, and maintenance. The device was tested on mountain climbers and was declared capable of detecting hypothermia in real-time, providing first aid by activating blanket warming. Additionally, the use of a microcontroller-based hypothermia monitoring system application was implemented with main menu options such as Home, Monitoring, and Data, thus facilitating users to monitor body conditions and take appropriate first aid actions. These findings indicate that this application can advance medical technology, reduce the mortality rate due to hypothermia, and significantly contribute to the effectiveness of medical reporting and response systems. The analysis on 50 mountain climbers as participants regarding the use of Android-based hypothermia first aid application resulted in a conformity level of 96%.

Keywords: Hyperthermia, Waterfall Method, Monitoring, Sensor, Temperature

INTRODUCTION

Environmental aspects, such as ambient temperature, air temperature, and weather, play a crucial role in affecting human health. For example, during the dry season, air temperatures tend to become very dry, while intense sun exposure increases air temperatures significantly (Rahmatullah, 2022). According to a statement by World Health Organization (WHO), a normal human body has a body temperature of around 36–37.5°C. Human body that is affected by hypothermia will experience a decrease in the temperature. According to Gaurev Patel and Hieu Duong on the National Library of Medicine, an official website of the United States government, body temperature in the range of 32–35°C is classified as mild hypothermia, the range of 28–32°C is classified as moderate hypothermia, and body temperature lower than 28°C is classified as severe hypothermia. Several experts also categorize certain individuals who have a unique body temperature, namely lower than 24°C, which is categorized as severe hypothermia because it exhibits symptoms that are more serious than the previous categories (Savioli *et al.*, 2023). Human health is directly affected by these temperature fluctuations (Harioputro *et al.*, 2018). In summer or dry season, hot weather can significantly affect human productivity by increasing the production of cortisol hormone, which can potentially lead to stress, irritability, and overreaction (Putri *et al.*, 2022). Conversely, in rainy season, low temperatures can put additional strain on the heart, forcing this organ to work harder to keep the body temperature warm and stable (Saputro *et al.*, 2022).

According to an official classification by WHO, hypothermia is categorized into mild, moderate, and severe, with body temperature below 24°C is categorized as severe hypothermia, as it exhibits the most serious symptoms (Aba *et al.*, 2020). Heart rate varies according to age. The heart rate of newborns is approximately 130–150 beats per minute (bpm), in toddlers ranges from 100–120 bpm, in children ranges from 90–110 bpm, and in adults ranges from 60–100 bpm (Widadi, 2022). There are three types of heart rate, namely bradycardia, normal, and tachycardia. Tachycardia occurs when the heart rate is more than 100 bpm, while bradycardia occurs when the heart rate is less than 60 bpm. Normal heart rate is also classified into several groups, where when a person exercises, the heart rate ranges from 95–170 bpm for people aged 20–35 years old, 85–155 bpm for people aged 35–50 years old, and 80–130 bpm for people over 60 years old (Saputro *et al.*, 2022). A very low heart rate can cause several negative effects, namely increased blood pumping, vasoconstriction, decreased oxygen supply to the heart, and increasing the risk of various serious conditions, such as heart attack, stroke, frostnip, or hypothermia with fatal consequences. Hypothermia is a condition that occurs when the body loses more heat than it can generate or absorb, and it poses a serious threat to health (Cahyadi *et al.*, 2021).

Based on the above background, in this context, this study attempted to answer several important issues as follows: i) how can environmental temperature fluctuations affect human health, especially in the context of hypothermia risk? ii) what are the health risks that can arise due to extreme weather conditions and temperature fluctuations? and iii) how can Internet of Things (IoT) technology be applied to monitor and address these health risks, especially for the management of hypothermia?

This study aims to design and create a hypothermia first aid application with a system that uses IoT technology to detect body temperature and heart rate. In addition, this application will be equipped with medical intervention features to help hypothermia

patients as a form of first aid. By focusing on the designing and implementation of the hypothermia first aid application, this study is expected to promote an advance in medical technology, reduce mortality due to delayed intervention, and provide more effective solutions in emergency situations. In addition, this study was also conducted after considering the challenges faced in the current health reporting system and the delays in medical aid with special emphasis on portability. The application developed in this study also uses several hardware, such as Esp8266, NodeMCU, pulse sensor, and DS18B20 sensor, while utilizing the heating blanket as the main output. By combining knowledge of the environmental impact on health, the risk of hypothermia, and the utilization of IoT technology, this study is expected to contribute significantly to the development of medical solutions that are more efficient and responsive to health emergencies.

MATERIALS AND METHODS

The method used in this study involved several strategic steps, including careful analysis, to answer the research inquiries. The following is a brief summary of the methods conducted.

Tools

Hardware

The hardware used in this study included various elements, namely computer, smartphone, NodeMCU, Esp8266, DS18B20 sensor, pulse sensor, blanket warming, oled display, USB step sown, PowerBatt battery, and Lipo battery.

Software

Android studio

Android provides an open platform for developers to create their own compatible applications using smartphones (Afriliana *et al.*, 2019). In this study, Android was used to present the results of the devices made into an application, which will then be entered into an Android smartphone and displayed in the form of numbers in real-time using the Arduino IDE (Integrated Development Environment).

Firebase

Google Firebase is a service that allows application developers to build applications more easily and conveniently. Firebase Real-Time Database is a cloud-based database (Budihartono *et al.*, 2022). The data were stored in JavaScript Object Notation (JSON) and were synchronized in real-time with each client and connected data device.

Research Location

This study was conducted at Permadi Guci Basecamp, a starting point that is often used as a preparation place for climbers before starting the climb. At this basecamp, researchers carried out a series of procedures, including health checks using equipment that were already available at the basecamp. This mainly aimed to ensure the safety of the climbers from potential health problems, such as asthma, stomach diseases, and other conditions that could trigger hypothermia symptoms during the climb. The data obtained from this health check were then used as the basis for designing and creating an IoT-based hypothermia first aid application. The existing equipment at the base camp were used as a reference to understand the initial health conditions of the climbers before starting their

journey so that this study can focus and be tailored to the health monitoring needs at this climbing location.

Method Implementation

This study adopted the system development life cycle (SDLC) or Waterfall method, consisting of five stages: planning, analysis, designing, implementation, and testing. Planning involved collecting the data (through observation, interviews, and literature reviews), processing ideas for application development, and selecting key components. Analysis focused on evaluating the data and components to be used. Designing focused on portability. Implementation involved trialling the effectiveness of the system while correcting any encountered errors. Testing aimed to identify potential problems before widespread use (Gumilang, 2022). Testing was carried out after the system implementation stage to ensure the quality and reliability of the hypothermia monitoring application (Sahir, 2021).

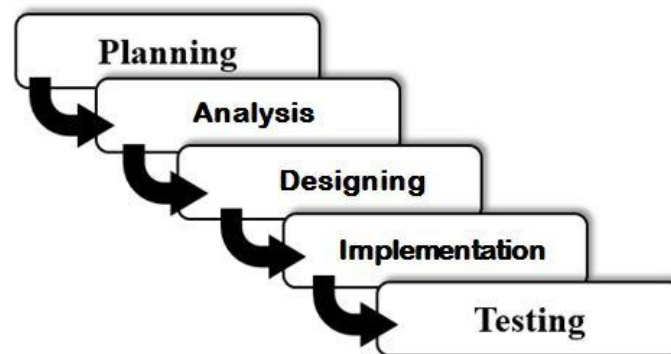


Figure 1. The Waterfall method

RESULTS AND DISCUSSION

System Designing

Block diagram designing

The block diagram illustrates the workflow of the system, where inputs from pulse sensor and DS18B20 sensor are processed using NodeMCU and Esp8266. NodeMCU acts as a microcontroller that manages the data. If an abnormal heart rate and low body temperature are detected, the system will activate blanket warming using relays and Lipo batteries as a power source.

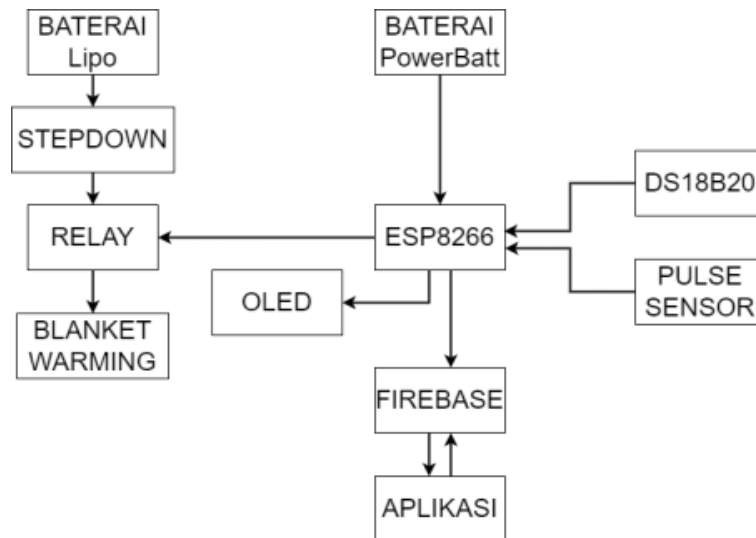


Figure 2. Block diagram

Installation of application system

The system involves five heater sheets on the warming blanket, of which four sheets are installed on the bottom inside and one sheet is installed on the top inside. This aims to evenly distribute the heat temperature to all parts of the warming blanket.

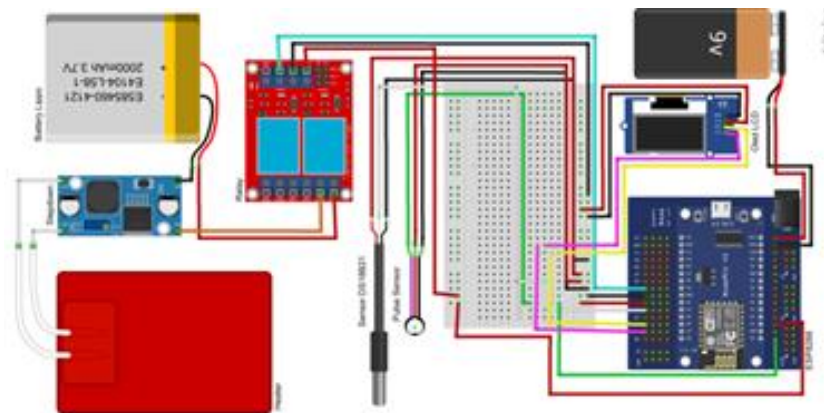


Figure 3. Installation of application system

Flowchart

The flowchart illustrates the steps of the system, starting from the activation of the NodeMCU, Esp8266, and sensor readings, to the activation of blanket warming if an abnormal heart rate and low body temperature are detected (Julianto *et al.*, 2021). This process also includes looping sensor readings to data acquisition and processing.

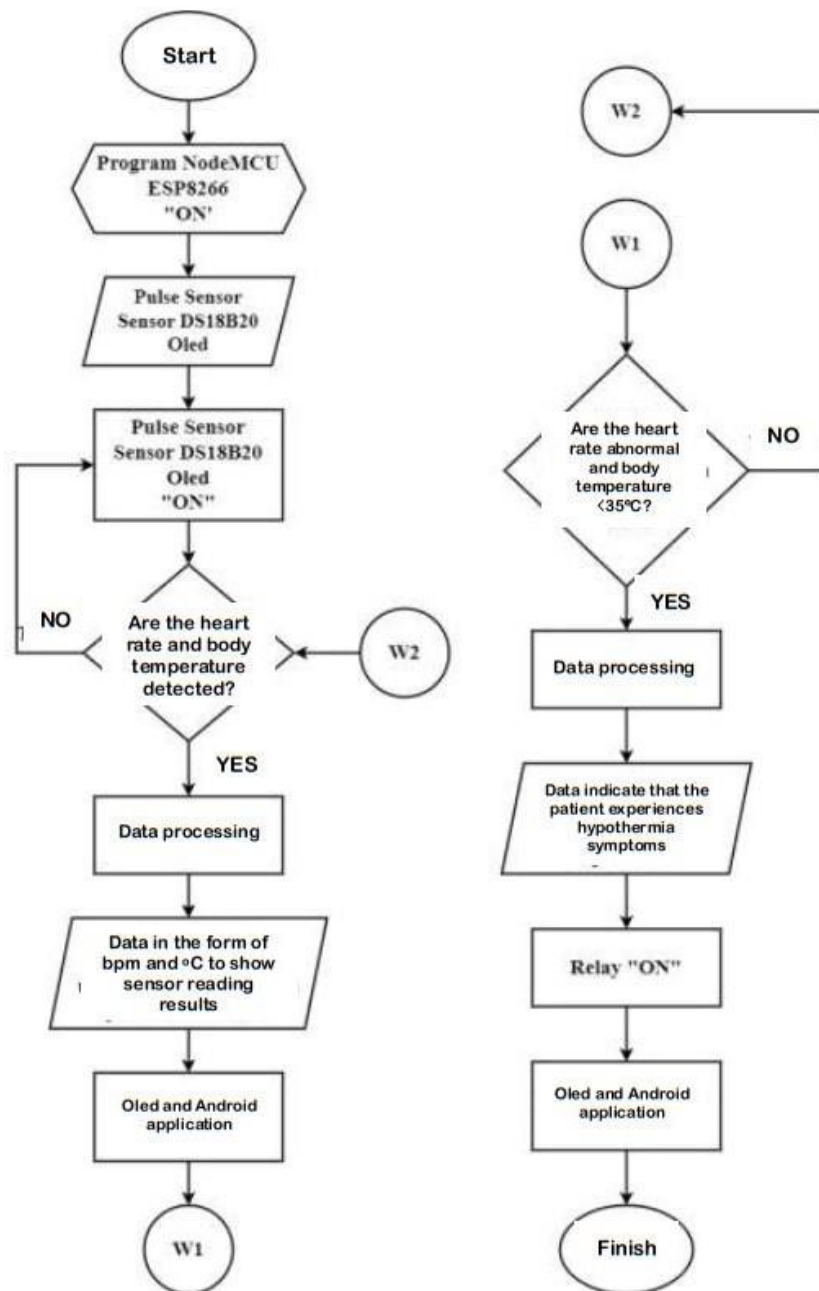


Figure 4. The system flowchart

Input-Output Designing

The input-output designing includes the application display and toolbox as well as the side of the application. The user can monitor the sensor results and blanket warming status through the oled display.

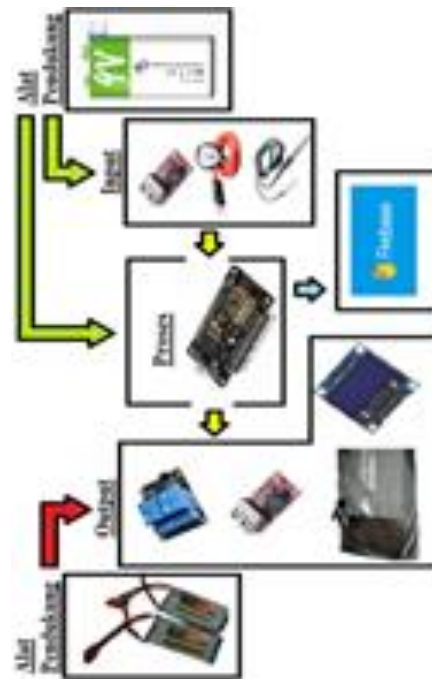


Figure 5. Input-output designing

System Implementation

Application designing

The hypothermia monitoring system application was built by utilizing the Unified Modeling Language (UML). UML was used to design various aspects of the application, including actor identification and use case diagram (Kusnadi *et al.*, 2020), as displayed in Figure 6.

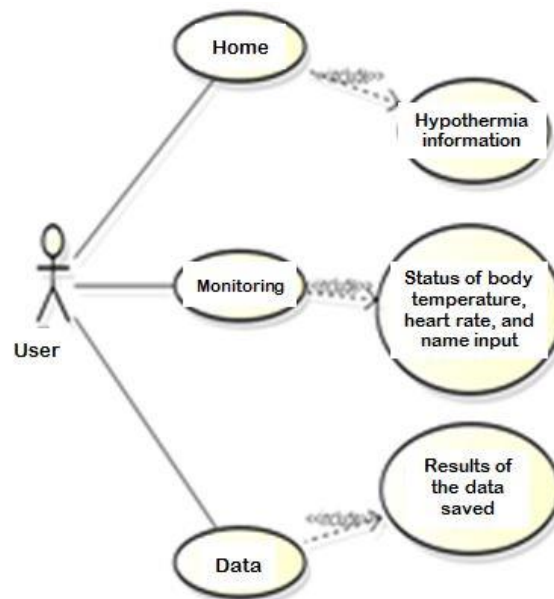


Figure 6. Use case diagram

Application page

The hypothermia first aid application using Android monitoring system has three main pages: Home, Monitoring, and Data.

a. Home Page

The home page provides brief information about hypothermia conditions, as shown in Figure 7.

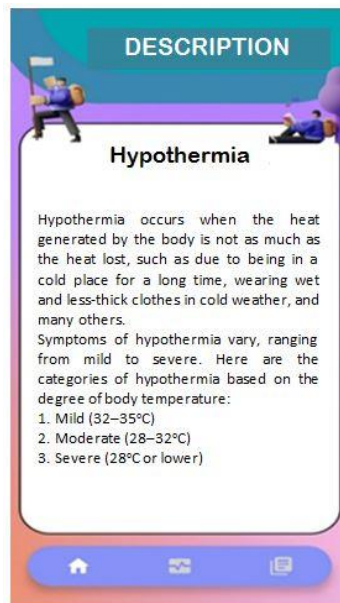


Figure 7. Home page of Android-based hypothermia first aid application

b. Monitoring page

The monitoring page allows real-time monitoring of body temperature and heart rate, with a description of hypothermia symptoms based on their degree: mild, moderate, and severe, as shown in Figure 8.

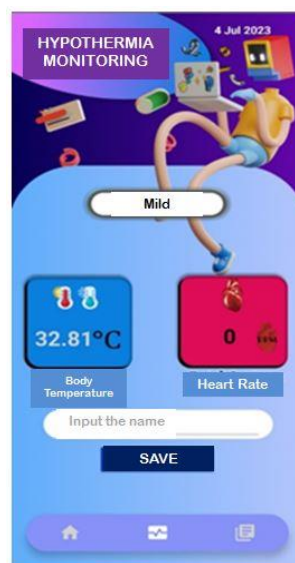


Figure 8. Monitoring page of Android-based hypothermia first aid application

c. Data page

The data page displays the saved data, including the examiner's name, body temperature reading, heart rate, caption, and date of examination, as shown in Figure 9.



Figure 9. Data page of Android-based hypothermia first aid application.

Testing Results

Application component testing

The application component testing used a black box. This testing was carried out in accordance with planned procedures by utilizing the results of the design concept (Wicaksono, 2021). This stage aimed to test the performance of the application that had been developed. After passing the application test process, the next step is to conduct a thorough analysis on the test results. This testing was carried out to evaluate whether the application runs optimally based on the predetermined objectives and whether the application functions properly or exhibits malfunctions. Table 1 presents the test results.

Table 1. Application Component Testing.

No.	Tested Component	Testing Description	Result
1.	Pulse sensor	Read the heart rate through blood circulation and display the results in beats per minute (bpm) on the oled screen and application.	Conform
2.	DS18B20 Sensor	Read body temperature by direct physical contact on the human body and display the results in units of °C on the oled screen and application.	Conform
3.	Esp8266	Processing data from sensor readings and displaying data processing results on the oled screen and application.	Conform
4.	Oled	Display the readings from each sensor in the form of text.	Conform

5.	Relay	Switching the warming blanket on and off by opening and closing the switch contacts of the electric current from the Lipo battery connected to the warming blanket.	Conform
6.	Step Down	Lowering the large voltage into a small voltage on the battery electric current (DC to DC) by converting the large voltage on the battery electric current of 9V and 11V into a small voltage of 5V.	Conform
7.	PowerBatt battery power supply	Supply power to the main hardware components (sensors, relays, and Esp8266), ensuring the sensors, relays, and Esp8266 get enough power supply to function.	Conform
8.	Lipo battery power supply	Supply power to the hardware output components (blanket warming), ensuring the blanket warming gets enough power supply to function.	Conform

Application system testing

Testing of the application system and features was applied to 50 mountain climbers as participants. This stage aimed to verify the performance of the application and to ensure that each system component in the application operates in accordance with the expectations and functions that had been set. This testing used a black box, which examined several menus on the application system, as shown in Table 2.

Tabel 2. Application System Testing.

No.	Tested Feature	Testing Description	Result
1.	Home Page	The home page displays information about hypothermia clearly and accurately.	Conform
2.	Monitoring Page	The Monitoring page can monitor body temperature, heart rate, and information retrieved from the database properly.	Conform
3.	Save Button	Test the Save button function on the monitoring menu to ensure that when adding a name on the Monitoring page, the Save button can accurately save the data into the database. The data include the name of the individual being examined, body temperature, heart rate, description, and date of examination.	Conform

4.	Data Page	Test the performance of the Data page in displaying the data that had been saved in the database. The data presented contain information about the examined individual, including name, body temperature, heart rate, description, and date of examination that had been stored in the database.	Conform
5.	Data Searching	Verify that the search feature available on the Data page can retrieve data based on the name of the individual being examined.	Conform
6.	Delete Button	Verify the performance of the delete button on the Data page to delete the selected data, test the appearance of the confirmation when the Delete button is pressed to avoid deletion errors, and check whether the selected data was successfully deleted from the database and is no longer displayed on the Data page.	Conform
7.	Navbar Menu	Verify the user's ability to access the Home, Monitoring, and Data pages by clicking on the navbar menu available in the application.	Conform

Analysis results

The analysis results on 50 mountain climbers as participants regarding the use of android-based hypothermia first aid application are presented in Table 3.

Table 3. Analysis Results.

No.	Result	Number of Respondent	Conformity Detail		Percentage (%)
			Conform	Less Conform	
1.	Less conform	50		2	4
2.	Conform	50	48		96

CONCLUSIONS

Based on the test results, it can be concluded that fluctuations in ambient temperature can significant affect human health, especially when the temperature reaches extreme levels. One of the health risks that can arise from temperature fluctuations, particularly low temperature, is hypothermia. Hypothermia occurs when the body loses more heat than it can generate, causing the body temperature to drop below the normal limit (around 37°C). This symptom usually occurs due to extreme weather conditions, such as low temperatures or exposure to cold water. Temperature fluctuations and extreme weather conditions can cause various health risks, including hypothermia, respiratory illnesses, heart problems, dehydration, weather-related injuries, and physical

exhaustion from strenuous outdoor work. To address these health risks, Internet of Things (IoT) technologies can be applied to monitor environmental conditions and mitigate their effects. IoT can help address hypothermia and extreme weather-related health risks. Through the integration of this IoT technology, it is expected that the response to health risks due to temperature fluctuations and extreme weather conditions can be faster and more effective.

The results of this applied study are expected to promote the advance in medical technology, reduce the death rate due to hypothermia, and contribute significantly to the effectiveness of the reporting system and medical treatment. The analysis on 50 mountain climbers as participants regarding the use of android-based hypothermia first aid application resulted in a conformity level of 96%.

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