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An infrared thermometer using PIR motion and Tmp36 temperature sensor

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Abstract

The novelty of the COVID-19 virus and the need for adequate knowledge on how to prevent and control it have made it challenging to prevent the disease. The aim of this applied experimental research is to create a more efficient and convenient thermometer that can be used to measure body temperatures. The Infrared Thermometer Using TMP36 Temperature and PIR Motion Sensor is a product made and experimented with by researchers. This product aids in detecting motion and determining one's estimated temperature whether they do possess fever or they do not. This research intended to determine also the efficiency and convenience of the Infrared Thermometer using TMP36 Temperature. It is executed first by constructing the product using TMP36 Temperature Sensor, PIR Motion Sensor, jumper wires, LCD (16x2), LED Lights, Piezo Buzzer, and Breadboard. A manually made program, with the help of first and second-hand information, was encoded and analyzed using descriptive and inferential statistical tools. After testing the product with voluntary respondents, the findings show that it can detect an individual's motion and display their temperature using the LCD (16x2). LED lights are also used to determine whether you have a normal temperature and respondents were able to witness it. The product worked well with the experimentation and it was observed to be functioning well. This study shows that there is effectiveness in creating an Infrared Thermometer using PIR Motion and TMP36 temperature sensor. Thus, it is recommended that certain codes and materials must be modified to produce a more precise and effective result.

Keywords: TMP36 temperature sensor, PIR motion sensor, infrared thermometer, effectiveness, applied experimental research

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1. Introduction

COVID-19 is a disease caused by SARS-CoV-2, which emerged in December 2019. It caused millions of deaths worldwide and left lasting health problems in some who survived the illness. (*https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus*, 2022). Safety protocols and guidelines should have been observed and practiced with the pandemic lingering everywhere. However, humans are social animals and cannot live without interacting with one another. Thus, widening the possibilities or options for enhancing protocols, safety measures, and guidelines to decrease the number of people affected by the virus will be the basis of our study. The number of patients and deaths with the disease has increased, and the mortality rate of this disease was reportedly 3.5% globally by the World Health Organization (WHO). According to WHO, on the 19th of April 2021, the total number of people infected with COVID-19 globally was 141 million, and the number of deaths was 3 million. The spread of the disease was so rapid that it affected all countries' economic, political, social, educational, and even military. The United States, India, and Brazil had the highest infection rates (SoleimanvandiAzar et al., 2021).

In the Philippines, from January 3, 2020, to October 7, 2022, there have been 3,961,349 confirmed cases of COVID-19, with 63,149 deaths reported by the World Health Organization (WHO) (World Health Organization, 2022). Negligence and poor health measures and protocols prevail as the driving force to achieving a safe environment. One of the many examples of such lacking prevention and comprehension is when it comes to workplaces. The novelty of the COVID-19 virus and the need for adequate knowledge on how to prevent and control it have made it challenging to prevent the disease. However, quarantine and maintaining health guidelines are significant ways to prevent this disease (SoleimanvandiAzar et al., 2021). Even if the World Health Organization (WHO) declared that the COVID-19 emergency all over the world, there are still active and confirmed cases of the virus in the Philippines (https://covid19.who.int/region/wpro/country/ph, 2023). This shows that we still need to practice prevention in order for the virus to not worsen and to the already lightening situation. According to the Department of Trade and Industry (DTI), government departments (e.g., Empower PH, Bida Solusyon Campaign, Laging Handa PH) have been implementing and establishing issuances and guidelines regarding the pandemic. One of these guidelines is using a non-contact infrared thermometer to detect COVID-19. It is frequently used for body fever screening, providing quick, wide-range body temperature assessment (Lai et al., 2022). Due to the enormous rise in diseases contracted through body contact, the need for non-contact thermometers is rising evenly in marketing (Mushahar & Zaini, 2021). However, this tool has its advantages and limitations.

In a recent project, a device was made to detect body temperature to protect against COVID-19 using the same materials the researchers have. Enhancing this project serves as one of the aspirations of the desired outcome. An automatic door-opening system is included in this project to further improve it by reducing contact with the door and the subsequent propagation of the virus. Research has also shown that touch-based infection is relatively standard. Therefore, the researchers devised a tool that individuals will voluntarily undertake at different establishments; if their temperature is average, a green LED will switch on to signify an average temperature read and automatically open a door. However, if someone has a high body temperature, the red LED will light up, and the door will not open (El-Zarif, 2020). The proposed product is a byproduct of Tinkercad. Its components are Arduino Uno R3, PIR Motion Sensor, TMP36 Temperature Sensor, LCD 16 x 2, LED lights, resistors, piezo buzzer, and jumper wires. Unlike the ordinary infrared thermometer, the product will detect body temperature without contact and specify which body part it will focus on. Moreover, this product is called an infrared thermometer using a PIR Motion Sensor and TMP36 Temperature Sensor. Thus, this research focused on the efficiency and convenience of the proposed product for everyone to have contactless and less

time-consuming temperature checks. This study also aims to be essential and relevant to the present pandemic the world is experiencing.

Statement of the Problem - The study aimed to create and test the effectiveness of an infrared thermometer using a PIR Motion Sensor and TMP36 Temperature Sensor to determine body temperature. Specifically, the researchers sought to answer the following questions: (1) What is the level of accuracy of the infrared thermometer in terms of: the number of individuals and; the proximity of individuals? (2) Does the type of place or location affect the effectiveness of the infrared thermometer? (3) Is there a significant difference in the level of accuracy of the infrared thermometer in terms of: the number of individuals, and proximity of individuals? (4) Is the infrared thermometer using a PIR Motion Sensor and TMP36 Temperature Sensor effective?

Significance of the Study - The researchers believed that the result of the study is significant to the factors of the performance of the infrared thermometer using a PIR Motion Sensor and TMP36 Temperature Sensor in determining body temperature. This study was significant for the following: The safety of the employer and the employees is the first concern of an institution. Furthermore, it will fundamentally aid in detecting infections from people who would enter their workplace. Client, employee, and other worker assurance will be beneficial, as will workplace productivity and morale. The proposed product will be placed at the entrances of a workplace. To the Medical Centers, this may lessen the work of frontline workers to check the temperature of their clientele. Thus, contact with an individual will be lessened and will provide a safe workplace. As schools implemented face-to-face classes, the school staff, especially students' safety, was necessary. Interacting in the workplace is ineluctable. Since such violations cannot control certain circumstances, such as social distancing, educational institutions should firmly implement and practice safety protocols because it is crucial to have a safe learning environment and workplace for the environment. As such, infrared thermometers will lessen the workload of the school staff. It must be placed at school entrances. To the citizens, the experience of a convenient product can surely contribute to the motivation of creating products that are rooted in the researchers' infrared thermometer. To the community, this may bring more convenience and may contribute towards the rise of convenience and efficiency of products in society. This study will benefit future researchers because this could be used as a source of secondary data for respective future-related research studies.

Scope and Delimitation of the Study - This study commenced in December 2022. Trials determined body temperature using a PIR Motion Sensor and a TMP36 Temperature Sensor. The study was focused on the various sectors of the town of San Jose, Occidental Mindoro. The study did not cover other places with similar sectors that are not in San Jose, Occidental Mindoro. Conducting this study was performed individually and in groups. The research was focused on the efficiency of the infrared thermometer using a PIR Motion Sensor and a TMP36 Temperature Sensor, both on the two approaches - individually or in groups experimenting. This study has two procedures that were used to determine body temperature efficiently, that is, fabrication and application. The fabrication procedure is the creation of the proposed product. Further, the application procedure is the utilization that was carried out using the proposed product. This study used an infrared thermometer using a PIR Motion Sensor and a TMP36 Temperature Sensor.

2. Methodology

Research Design - This study used experimental research that aims to create a compelling and convenient infrared thermometer using Tinkercad components, fundamentally, the PIR Motion Sensor and TMP36 Temperature Sensor. It assisted individuals in specific environments unfamiliar with using an ordinary infrared thermometer. Furthermore, it will benefit a workplace's convenience and efficiency. Hence, the research paper implements an experimental design in which the relationship between the independent and dependent variables is significant. The experimental research design establishes a cause-and-effect relationship between two or groups of variables. Prior to the general knowledge of researchers and multiple studies, experimental design techniques are also becoming popular in statistical issues in the design and analysis of computer/simulation experiments.

Data Gathering Procedure **-** This study used voluntary sampling during conducting of the experiment. This means that anyone can take part in testing the prototype's effectiveness. There was no age, occupation, height, or physical attributes limit because everyone could benefit from this prototype. There are 6 respondents who participated in the experiments and 15 participants/respondents in this study who tested the product if it is working. The experiment targets the convenience of respondents in entering facilities, structures, or places that will not need to stop for a temperature check. The infrared thermometer is placed in an entrance such as a doorway or small gate; while the chosen people are passing by, the thermometer will alert each temperature that exceeds or fails to enter the standard temperature of an individual. The sample is instructed to pass through the prototype to detect its temperature. The experiment was divided into categories based on the proximity and number of entries. After the experiment, which includes the prototype testing, the respondents are handed questionnaires via survey to see the sample's response to the experiment.

Research Process; Stage 1 Preparation and Gathering of Materials **-** In producing an effective result, the project demands innovative materials. The researchers chose precise, low-cost materials. The materials are listed below: and the following pictures came from https://www.sciencedirect.com/topics/computer-science;https://www.sciencedirect.com/topics/computer-science/

Figure 1. TMP36 Temperature Sensor

Figure 2. Arduino Uno R3

Figure 3. PIR Motion Sensor

Figure 4. LCD (16x12)

Figure 5. Piezo Buzzer

Figure 6. Jumper wires

Figure 7. LED Light

Figure 8. Resistor

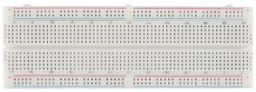

Figure 9. Breadboard

The materials were purchased online by the researchers. The supplies for this experiment will cost approximately (1,500 PHP).

Stage 2: Construction and Development of the Product **-** To implement health protocols during the COVID-19 pandemic, an infrared thermometer using a PIR motion sensor and a TMP36 temperature sensor precisely measure temperature from a distance without touching the thing being measured. Thus, it enables the research study to withstand the current condition of COVID-19. This innovation only uses low-cost products capable of producing simple and enjoyable projects while teaching the fundamentals of programming. Furthermore, the aforementioned sensor has few parts and is a type of monitoring that could be part of a larger

system that assists in determining people's current body temperature. The design of the project is simple yet effective. It consists of a PIR motion sensor and a TMP36 temperature sensor, both connected to an Arduino Uno board via jumper wires. The PIR motion sensor detects changes in infrared light while emitting its own infrared rays, which are interpreted by the Arduino board as changes in light intensity via its analog-to-digital converter (ADC). The voltage reading from this ADC is then used to interpret how much-infrared light has been absorbed by objects within range of the sensor's lens. Additionally, a resistor was utilized as it is an electrical component that limits or controls the passage of electrical current in an electronic circuit. It can be used to supply a specified voltage to an active device like a transistor. Moreover, the body temperature in the thermometer was displayed on the LCD. The temperature readings are located in this section. The LCD screen is usually placed on the front, where it is easy to read. The color turns green if the temperature is normal and red if the temperature is above normal. In addition, when the TMP36 Temperature Sensor detects a higher body temperature, the Piezo Buzzer acts as an alert system. This will help with warning people, especially those who are deaf or hard of hearing, that their body temperature is rising dangerously high. The Piezo Buzzer can be heard from as far as meters away from the TMP36 Temperature Sensor in a quiet room. As a result, an Infrared Thermometer using a PIR Motion Sensor and TMP36 Temperature Sensor was convenient and helped in reducing the risk of spreading diseases between people. By using this device, people can quickly check on the temperature of a person and can prevent them from getting sick.

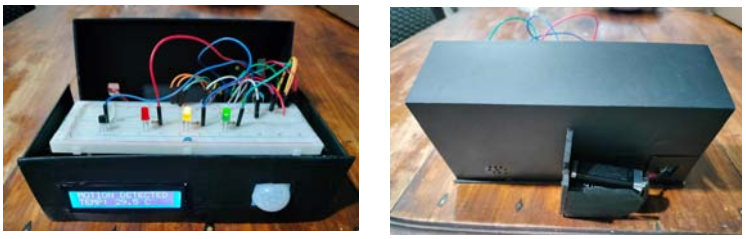

Figure 10. Front view and back view of the actual product

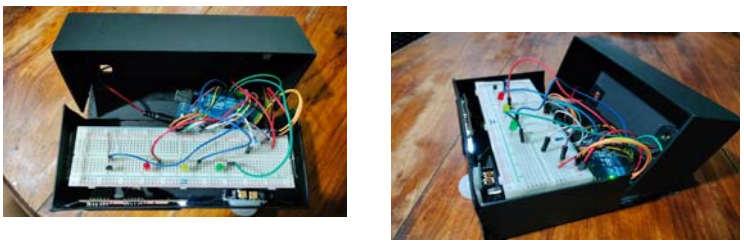

Figure 11. Actual Product of an Infrared Thermometer using Pir Motion and Tmp36 Temperature Sensor

Stage 3: Experimental Stage - The researchers were to experiment and observe whether the proposed product is an essential and more convenient tool for detecting body temperature. Initially, the device was tested in an open area; respondents were to form a line and walk one by one where the PIR motion sensor detected them. The researchers used different strategies (respondents performing in groups or individually) to determine our product's accuracy. The researchers used six to fifteen participants or respondents who participated in this study. They also record the findings and observations during the actual testing.

Stage 4: Observation and Recording - Since the researchers would obtain firsthand information, it was considered primary data. Direct observations, testing, self-constructed questionnaires, and experimentation were used to gather data. The researchers carefully examine the device and ensure that the information gathered is reliable and unbiased. Additionally, they recorded all the crucial data regarding the device's progress. Collecting data makes it possible to predict the device's ideal performance regarding suitability, accuracy, and usability.

Statistical Treatment of the Data - For Statistical data analysis, the researchers used descriptive and inferential statistics. According to Kaur et al. (2018), descriptive statistics are a good way to summarize data

collected from a sample. The researchers can calculate the percentage of successful and unsuccessful attempts made by people passing by the infrared thermometer after the researchers identified factors that affected the results (vicinity, range of individuals passing through). After identifying the factors influencing the results, the researchers can make inferential statistics based on the findings. According to Kuhar (2010), Inferential Statistics can help form a broad picture of the possible outcomes for a larger population. Because the sampling was voluntary, the researchers can put this into practice, and it can apply to anyone, regardless of age or height. Statistical analysis was used by the researchers conducting this study to determine the accuracy of a motion sensor and temperature sensor, wherein Regression Analysis serves as the statistical tool. The analysis aimed to measure how strongly the relation between the two variables was correlated. The relationship between the independent and dependent variables may vary according to the materials used.

3. Results and Discussions

Table 1

Level of the accuracy of the Infrared Thermometer

	Individuals		By Group	
	No. of Respondents	Percentage	No. of Respondents	Percentage
Strongly Agree	6	100%	0	0
Agree	0	0	0	0
Disagree	0	0	6	100%
Strongly Disagree	0	0	0	0
Total	6	100%	6	100%

Based on the experiments, Table 1 shows that 100% of the respondents who participated in the experiment rated the product strongly agree that it accurately sensed the body temperature when one individual passed by. Meanwhile, all of them also rated the product disagree that it can sense the individual passing by. This demonstrates that, similar to the study of Goh et al. (2021), examining just one person can yield more accurate measurements of temperature over a limited distance range. This implies that the Infrared Thermometer is more accurate to use by individuals rather than by group.

Table 2

Level of the accuracy of the Infrared Thermometer in terms of the proximity

Proximity of Individual	Strongly Agree	Agree	Disagree	Strongly Disagree	Weighted Mean	Descriptive Interpretation
	-4	-3	-2	-1		
Long Range	8	3	6	0	2.83	Agree
Short Range	24	0	0	0	4	Strongly Agree

Based on Table 2 in dealing with the accuracy of the Infrared Thermometer in terms of the proximity of individuals utilizing the Infrared Thermometer using PIR Motion and TMP36 Temperature Sensor. This device can accurately detect the temperature in a long-range with an average of 2.38 and has a descriptive interpretation of the agreement. On the other hand in terms of short- or long-range, it has an average of 4 which means that the respondents strongly agree, and the short-range is that the infrared thermometer can accurately measure the temperature. According to Mushahar and Zaini (2021), their conducted study uses a more advanced method - thermal camera with imaging. Just like the infrared thermometer, this method has the constraint where the temperature is usually detected as a whole and does not differentiate the temperature of the human body and other nearby objects. In this way, a person's body temperature can be separated and will not be affected by the temperature of other objects.

Tables 1 and 2 present the results of the analysis and interpretation of the data from the frequency, mean, and percentage used to describe the respondents' thoughts on the infrared Thermometer's level of accuracy in terms of the number and proximity of people it can detect. Following the trial, an analysis of surveys of this infrared

thermometer implementation was presented.

Table 3

Perceptions of Respondents whether the type of place affects the effectiveness of the infrared thermometer

Respondents	Indoor	Outdoor
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
	Average mean: 1 or 100	Average mean: 1 or 100

Legend: 1 - Can detect accurately; 0- Cannot detect accurately

Table 3 displays tabulated data from experiments involving the placement of two sensors indoors and outdoors to determine how it affects the proximity of individuals. On the data, 1 represents yes that the kind of location affects the effectiveness of the product. On the contrary, when the Infrared Thermometer using PIR motion and TMP36 temperature sensors were placed indoors, the researchers obtained an average of 1 or 100 for its mean. When the device was outdoors, the researchers obtained an average mean of 1 or 100 from all attempts. Thus, this indicates that the device placed indoors and outdoors would have accurate recognition and detection as they both detect 1 or 100 on the average mean. Since both sensors are vital factors of our proposed product, according to Doctor (1994), a PIR Motion Sensor is very intriguing because it demonstrates the possibility of extensive commercial IR technology applications by the number of systems created and the costs of the level of performance required. The foundation and operating principles of a staring motion sensor system was developed using technical analysis in this study. The target's motion is modeled, and its motion is contrasted with that of the background. The TMP36 temperature sensor has a low voltage, which provides an accurate centigrade temperature sensor and measures output voltage. Therefore, it can be done without output to get the range and scale temperature accuracies. However, the TMP36 temperature sensor is easy and accurate to measure and use with Arduino Uno.

Table 4

T-test results comparing the level of accuracy, either detecting individually or by Group

t-Test: Two-Sample Assuming Unequal Variances	Individual	Group
Mean	6	3
Variance	144	36
Observations	4	4
Hypothesized Mean Difference	0	
df	4	
t Stat	0.4472136	
P(T<=t) one-tail	0.33893441	
t Critical one-tail	2.13184679	
P(T<=t) two-tail	0.67786883	
t Critical two-tail	2.77644511	

In table 4, the t critical value is 2.78 while the computed t value is 0.4, indicating that the t computed is less than the t critical value, thus, there is no difference in the level of accuracy of the Infrared Thermometer in terms of the number of participants. Furthermore, the p-value is 0.34 and is higher than 0.05 indicating that the null hypothesis is to be accepted. Because the null is accepted, this shows that the number nor the proximity affects how the infrared thermometer detects motion and temperature. Similar to the study by Goh et al. (2021), focusing on an individual can result in more precise temperature readings over a constrained range of distances, indicating that the infrared thermometer is more precise when used on a person as opposed to a group.

As indicated in Table 5, the computed t-value which is 0.28 is less than the critical value which is 2.776. This implies that there is enough evidence that the null hypothesis is to be accepted. Therefore, there is no significant difference in the level of accuracy of the Infrared Thermometer in terms of the proximity of the

individual. The null being accepted means that it can detect motion and an individual's temperature whether how far each is. This shows, similar to the study of Dell'Isola et al. (2021) that the target (or spot) dimension, which needs to match the surface that is intended to be detected, is a special measurement challenge for infrared thermometers. The distance between the thermometer and the detecting target is, in reality, inversely proportional to the target's dimensions. The measurement of the spot increases as this long distance. Consequently, the thermometer should be kept close to the target itself when detecting small targets.

Table 5

T-test results assessing the level of accuracy in relation to a person's proximity

t-Test: Two-Sample Assuming Unequal Variances	Variable 1	Variable 2
Mean	4.25	6
Variance	12.25	144
Observations	4	4
Hypothesized Mean Difference	0	
df	4	
t Stat	-0.28	
P(T<=t) one-tail	0.39668043	
t Critical one-tail	2.13184679	
P(T<=t) two-tail	0.79336086	
t Critical two-tail	2.77644511	

Table 6

Mean level of the respondent's perception about the effectiveness of the infrared thermometer

Indicators	Overall		Percentile Rank
	Weighted Mean	Descriptive Equivalent (D.E)	
1. The product sensed the participant/s motion.	4	Strongly Agree	1
2. The product accurately detects the temperature of the participant.	3.33	Strongly Agree	6
3. The pace of the participant/s affects the outcome of the thermometer.	3.4	Strongly Agree	5
4. The product is suitable for different environmental settings.	3.47	Strongly Agree	4
5. The distance between individuals did not affect the efficiency of the product.	3.6	Strongly Agree	3
6. The product was an overall efficient infrared thermometer prototype.	3.73	Strongly Agree	2
Overall Weighted Mean	3.59	Strongly Agree	

Legend: 4- Strongly Agree (SA), 3- Agree (A), 2-Disagree (D), 1- Strongly Disagree (SD)
Descriptive Equivalent: 4- 3.26- 4.00 (SA), 3- 2.51- 3.25 (A), 2- 1.76- 2.50 (DA), 1- 1.00- 1.75 (SDA)

As reflected in Table 6 below, the overall mean in the effectiveness of the Infrared Thermometer is 3.59 which has a descriptive interpretation of strongly agree. Of all the indicators, the Infrared Thermometer using a PIR Motion and TMP36 Temperature sensor sensed the participant/s motion has the highest average or weighted mean of 4. It is followed by the Infrared Thermometer using PIR Motion and TMP36 Temperature sensor as an overall efficient infrared thermometer prototype, The distance between individuals did not affect the efficiency of the product, The product is suitable for different environmental settings, The pace of the participant/s affects the outcome of the thermometer, and on the question number 2, The product accurately detects the temperature of the participant. The following has a weighted mean of 3.73, 3.6, 3.47, 3.4, 3.33, respectively. They all have strongly agreed descriptive interpretations. This means that the Infrared Thermometer is highly effective as assessed by the respondents.

The Infrared thermometer using a PIR Motion and TMP36 Temperature Sensor accurately detects the temperature of the participant. According to the research of Yong et al. (2012), in Applied Mechanics and Materials study, the 8051 series SCM was used to create high reliability and high precision division operation; the algorithm circumvented the system's unsigned division constraints by iteratively multiplying.

Combining the experiment with the TMP36 temperature sensor application shows that the outcome is

accurate, and that the method has the benefits of being straightforward, adaptable, highly reliable, and practical. According to the study of Liebmann (2008), coherence asserts that it is advantageous to measure temperature with an infrared thermometer. It provides advantages over contact thermometers. These advantages often include the capacity to measure a system without interfering with it and a quicker response time. However, contact thermometry is typically less accurate. There is a variation in accuracy because IR thermometers are less accurate than contact thermometers. According to data-bridge market research, even after the pandemic is over, contactless temperature detection will remain the best method for halting the spread of viruses like COVID-19 due to the increased advantages of contactless treatments and the availability of cutting-edge technological devices. Furthermore, as the world accepts that COVID-19 will be a seasonal viral infection with vaccines available yearly, the demand for temperature-checking equipment will stabilize manufacturers' market in the coming years. In addition, our recommended product will improve the speed and efficiency of the temperature reading. Therefore, it is advantageous in crowded public places like malls, schools, and hospitals throughout the year.

4. Conclusions and Recommendation

Based on the study's findings, the researcher came to the following conclusions; The level of accuracy of the Infrared Thermometer using PIR Motion and TMP36 Temperature Sensor individually is better compared to the group. The level of accuracy of the Infrared Thermometer using PIR Motion and TMP36 Temperature Sensor is not affected by the proximity of an individual. The type of place does not affect the effectiveness of the Infrared Thermometer using PIR Motion and TMP36 Temperature Sensor. It means that it is effectively independent on the type of place. There is no significant difference in the level of accuracy in terms of the number of individuals and the proximity of individuals. The Infrared Thermometer using PIR Motion and TMP36 Temperature Sensor is highly effective as perceived by the respondents.

Under the work undertaken during this investigation and the previous results, researchers suggest the following suggestions are made for future researchers interested in this type of device. Adjustment to environmental settings such as temperature and location, the Infrared Thermometer using a PIR Motion and TMP36 Temperature Sensor must be placed in an environment, whether it is indoor or outdoor with a neutral temperature (37°C). Since the TMP36 Temperature Sensor have a different threshold - mainly used for appliances, the researchers must calibrate the sensor to body temperature. Visibility of LCD, the degree of viewing angle dependence may vary between different types of LCD panels. Since the viewing angle might have an impact on an LCD screen's visibility. This is so that the polarization of light that passes through a liquid crystal layer can be controlled in LCDs. The LCD we utilized cannot precisely display such symbols when viewed from a specific angle. Given that the information will be more precise and easier to see, some of the respondents came to the conclusion that using a different type of LCD is preferable. Motion Sensor Delay and the use of PIR Motion Sensor, the researchers prefer using motion sensors with a more comprehensive detection range and PIR Motion Sensors that can distinguish between various temperatures. This will make it easier to recognize an individual's specific temperature. Specific codes and materials. Certain codes and materials must be modified to produce a more precise and effective result. For future researchers. That this study may be used by future researchers in the field of science and technology. Future researchers may also add features or improve the current research output for better purposes.

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