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DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF LAMPUNG

PROCEEDINGS ICCTEIE 2021

2021 International Conference on Converging Technology in Electrical and Informatic Engineering
Bandar Lampung, October 27-28, 2021

Converging Technology for Sustainable Society

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Foreword from Rector of University of Lampung

Assalamu'alaikum warrahmatullahi wabarakatuh

All praise be to Allah SWT who has given us all salvation and blessing in Life. The Lord who created this word.

I'll never forget to sholawat and salam to our beloved Prophet Muhammad SAW who really loved by ALLAH SWT and saved the human life from destruction in the safety, that's the right path of ALLAH SWT.

I would like to say welcome to the First International Conference on Converging Technology in Electrical and Information Engineering (1st ICCTEIE 2021) with the theme: "Converging Technology for a Sustainable Society ".

The University of Lampung is very committed to advancing research and international collaboration as an effort to advance world civilization. ICCTEIE is an international conference co-sponsored by The IEEE Indonesian Section and organized by the Department of Electrical Engineering and Informatics – University of Lampung. The conference is held on October 27-28, 2021, in Bandar Lampung, Indonesia, on a virtual meeting base. This event provides a good platform for researchers, scientists, and the entire engineering community to meet virtually and exchange their ideas on electrical engineering, control engineering, electronics, telecommunications, computer science and engineering, cyber-physical system, informatics, sustainable energy and environment-related fields and their applications.

I do expect this conference will give imperative contributions to the development on the aspects of researches, academics, and industries nationally and globally. I hope that all participants have fruitful and technical discussions and please enjoy the meeting.

See you on next 2nd ICCTEIE 2023.

Thank you for your excellent attention.

Prof. Karomani – Rector of University of Lampung

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Welcome message from General Chair of 1st ICCTEIE 2021

Assalamu'alaikum Warrahmatullahi Wabarakatuh

Peace be upon you and God's mercy and blessings

On behalf of the committee, I am very pleased to welcome you to the 1st ICCTEIE 2021, The International Conference on Converging Technology in Electrical and Information Engineering, 2021.

We are very grateful for all the support from the Rector of the University of Lampung, all vice-rectors, director of the research institute and dean of faculty of engineering. I would also like to extend my sincere gratitude to IEEE Indonesia Section, Advisory Committee, Technical Program Committee, Steering Committee, and Organizing Committee for their support and efforts so that this event can be successfully conducted.

I welcome all the eminent speakers and guests from all over the countries from different walks of life you had come here virtually to share the knowledge and experience among the scientific community.

The conference will highlight recent and significant advances, the state-of-the-art, current status and future challenges on all aspects related to the research and development in the field of Electrical and Information Engineering including:

- Communication, Networking & Broadcasting,
- Components, Circuits, Devices & Systems,
- Computing & Processing (Hardware/Software),
- Engineered Materials, Dielectrics & Plasmas,
- Power, Energy, & Industry Applications,
- Robotics & Control Systems,
- Signal Processing & Analysis,
- Information Technology,
- Internet of Things, and
- Artificial Intelligence

The call for the paper was issued on the 25th of May, 2021 and closed on the 15th of October 2021. There are 46 submissions papers during that time. 31 papers are presented today. After this conference, the reviewing process will continue to ensure each article is ready for submission in the IEEXplore or otherwise it will be excluded.

As The University of Lampung is progressively expanding its research network and contributions to the world of science and technology, it is expected that the conference will significantly provide means to both UNILA's researchers and other researchers to engage in a fruitful discussion during and after the conference.

The 1st ICCTEIE is starting this year as the 1st year and it is projected to continue every 2 years. Hopefully, the Covid-19 pandemic soon subsides so the next conferences would be able to commence in the real meeting. This year our theme is Converging Technology for a Sustainable Society, and we are very happy the experts from the field of electrical and information as well as computer technology are with us today. We cordially welcome our keynote speakers:

1. Dr Laksana Tri Handoko, M.Sc., as the Head of National Research and Innovation Agency Republic of Indonesia,
2. Ir. Bob Saril, M.Eng.Sc., Director of Commerce and Consumer Management Indonesian National Grid Company,
3. Prof. Yasunori Mitani, The President of Kyushu Institute of Technology, Japan,
4. Prof. Prashant Pillai, University of Wolverhampton, England,
5. Prof. Jing-Ming Guo, National Taiwan University of Science and Technology, Taiwan, and
6. Dr Daniel Eghbal, Manager Future Network Strategy at Energy Queensland Australia and Australia Council Chair Institute of Electrical and Electronics Engineers (IEEE)

Also, let me inform you that all of our local committees are now registered as IEEE members as well as 15 of our electrical and informatics students are now also registered. Next month we plan to launch the IEEE Student Branch of Lampung, we hope through this endeavour will be able to broaden their horizons to the international society.

Before coming to a close with these remarks, I would also like to remind you and especially our moderators to strictly stick to our schedule and not to let any session overrun. I sincerely hope you will enjoy today of discussion, debate and networking.

I am sure you will have fruitful and rewarding exchanges on this conference day. I wish you all the best and success.

Thank you.

Dr. Khairudin – General Chair 1st ICCTEIE 2021

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Temperature Measurement Using An Automatic Thermogun

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***Abstract*—One of the characteristics of a person having a high fever or being in an unhealthy condition is a high body temperature. To find out what body temperature is, measuring human body temperature can use a body temperature measuring device or a thermogun. Thermogun is a tool that is able to measure temperature or temperature without touching the object. This research makes an automatic thermogun that could measure the temperature of the object in the right position, therefore added some equipment, namely a camera, ultrasonic sensor, and also a stepper motor. The ultrasonic sensor detects the distance to the object then the stepper motor moves according to that distance, then the temperature will appear on the LCD. If the temperature is too high, the camera will automatically take a photo of the object and the photos will be stored on a memory card. This thermometer uses infrared radiation which can measure temperature quickly and accurately 0.5% compared to commonly used factory-made thermogun.**

Keywords—body temperature, automatic thermogun, stepper motor, camera, ultrasonic sensor

I. Introduction

Health is more than just the lack of illness or weakness; it is an entire state of physical, mental, and social well-being. Over time, people's perceptions of health have evolved. With the advancement of digital-based health technology, everyone can now analyze themselves and actively engage in the health promotion movement. Individual behavior, social situations, genetics and biology, health care, and the physical environment are all social variables that influence health problems.

One way to see if a normal body temperature is being maintained is through body temperature. If the body temperature is being kept following the standards that have been determined, then the person can be said not to experience symptoms of pain or can even be said to be healthy. Conversely, if the person's temperature is below and above the predetermined standard, then the person is said to be less healthy.

This research aims to make innovations in body temperature measurement tools by combining existing technology, namely by modifying the human body temperature measuring instrument commonly used today, namely the thermogun, with automatic operation without the help of humans. By using microcontrollers and sensors, the tool can work as desired and work automatically.

II. Literature Review

A. Previous Related Study

There were three main sources of reference in this study. The first reference was in the form of a research journal entitled "Design of Monitoring Equipment for Human Health Conditions". Produces a human body temperature, heart rate, and breath detection device with Arduino nano-based microcontrollers. The device was designed using a DS18B20 sensor, pulse sensor, sound sensor, Arduino nano as a microcontroller, and an LCD to display sensor measurement data. Through measurements, the study results obtained three tables of measurement results in numerical values from heart rate, temperature, and breath by comparing the research results using Arduino-based tools and standard tools used by medical personnel. After statistical calculations, it can be concluded that there was no significant difference in measurement results between measurement results using standard tools used by medical personnel with Arduino nano-based tools [1].

The second reference was in the form of a research journal entitled "Design and Build a Drip Infusion Monitoring Device and Body Temperature with Arduino Uno-based Digital Display". It produced a tool that had two functions: to monitor the patient's infusion drops and compared them to the dose of standard tools and monitor the patient's body temperature periodically. It also comes with a reminder alarm. It aims to do so if the infusion drops or the patient's body temperature is in a critical condition or exceeds the tolerance that has been set. The alarm installed as an indicator will remind the nurse to take action quickly. The study results mentioned that the study succeeded in realizing infusion drip monitoring devices and patient body temperature with a digital display [2].

The third reference was in the form of a research journal entitled "Prototype of Monitoring and Early Warning System of Human Body Condition Based on Temperature and Pulse Rate Based on 328p Microcontroller". The device was designed using pulse sensors, temperature sensors, and a Real-Time Clock (RTC). The data detect on the prototype was then processed by a 328p microcontroller and displayed on a Liquid Crystal Display (LCD) screen. The study results mentioned that the tool could help monitor and warn a person's body state early. Blue LEDs will be active when the pulse exceeds the minimum, and the white LED will be active when the pulse exceeds the maximum. At the same time, the buzzer will sound faster if the body temperature exceeds the minimum limit, and the buzzer will sound more slowly if the body temperature exceeds the maximum limit [3].

B. Human Body Temperature

Human body temperature can rise and fall by 0.5 degrees every day. That can be influenced by the activities carried out. In general, the body temperature in the morning is lower than at night. Normal human body temperature itself generally ranges from 36.0 - 37.0 ° C. For adults, the World Health Organization (WHO) says that 36.0 – 37.0 °C is normal. The normal body temperature in each person is also different. The results of measuring body temperature through the armpits, mouth, or rectal, but most things that are done to measure body temperature is through the area around the face or forehead. Body temperature can depend on age, what is done, where to measure body temperature itself, and many others [4].

C. Themogun

A Thermogun is a tool that can measure temperature without touching objects. These thermometers use infrared radiation to measure temperatures quickly and accurately. Meaning that, closer the tool to the object, the more accurate the result. Its small size makes the thermogun easy to carry everywhere [5].

D. Microcontroller, Sensor, Motor Stepper Electronics Module

An electronics module is a device formed from several electronic components, and each of these components has its functions in an electronic circuit. Here are the microcontrollers, sensors, and electronics modules used in the study.

This module is an ATMega328P-based microcontroller. In this study, the Arduino Uno was used to detect the distance from the ultrasonic sensor to the object. Then it ordered the stepper motor to move following the distance that had been detected. The temperature sensor detects the object's temperature and displays it on the OLED LCD SH1106 0.96" 128x64 [6].

The HC-SR04 sensor module converts a physical quantity (sound) into an electric quantity and vice versa. This sensor is a detect-made ultrasonic sensor that consists of the sender, receiver, and ultrasonic wave controller. This tool can measure the distance of objects from 2 cm to 4 m with an accuracy of 3 mm. It has four pins, VCC pins, GND, Trigger, and Echo. The VCC pin is for positive electricity, and the GND pin is for grounding. Trigger pins to trigger the exit signal from the sensor and the Echo pin to capture the reflecting signal from the object [7].

The MLX90614 sensor is an infrared thermometer used to measure temperature without coming into contact with an object. The sensor consists of an infrared-based temperature-sensitive detector chip and an ASSP signal coding that integrates with TO-39 [5].

OLED SH1106 0.96" 128x64 is a display module with a size of 0.96" with a resolution of 128x64. This module uses a drive voltage of 3.3-5v with an IIC type interface. This module is used to display information about the measurement results of the RST phase [5].

A stepper motor is one type of motor that works by converting electronic pulses into discrete mechanical movements. The movement of the stepper motor is based on the sequence of pulses entering the motor. Therefore, driving the stepper motor requires a motor controller that generates periodic pulses. The stepper motor has the following advantages:

- The rotation angle of the motor is proportional to the input pulse so that it is easier to set.
- When the motor starts moving, it can immediately provide full torque.
- The position and movement of the reps can be determined with precision.
- Have a quick reaction time when starting, stopping, and turning (turnaround) and It can generate a slow rotation, lifting the load directly into the shaft [8].

The stepper motor working principle is similar to that of a DC motor, where to produce a magnetic field on the motor, there needs to be an incoming voltage. DC motors have fixed magnets on the stator, while stepper motors have fixed motors on the rotor. The stepper motor works by converting input bits into rotor movement. The bits come from the input terminals on the stepper motor that become the magnetic poles in the motor. Some of the equations on the stepper motor include:

$$n = 60\frac{pps}{Np} \tag{1}$$

where, n is Motor rev speed (rpm), Np is number of steps per spin, pps is pulses per second.

The torque that the stepper motor can produce can be calculated based on the ratio of the working power of the motor to its rotation speed or can be formulated as follows.

$$\tau = W \times r \tag{2}$$

where τ is Torque (Nm), W is gravitational force (N), r is radial distance (m)

While the formula for finding gravitational force (W) is

$$W = m.g \tag{3}$$

where W is gravitational force (N), m is mass of an object (kg), and g is gravitational acceleration ($^{m}/_{s^2}$).

The power needed on the stepper motor can be known by calculating the angular velocity (ω) first with the following formula.

$$\omega = \frac{(2\pi.n)}{60} \tag{4}$$

where ω is angular velocity (rad/sec), π is constant value approximately equal to 3.14, n is Motor rev speed (rpm).

So that it can be determined the power of the motor needed is to use the following formula.

$$P = \tau\,.\,\omega \tag{5}$$

where P is Power (Watt), τ is Torque (Nm), ω is angular velocity (rad/sec).

Leadscrews, or screws, also known as electrical screws, are screws used to convert spin motion into linear motion. The screw shape used in this study was the Acme screw shape, which had a screw angle of 29° and was easier to use than other screw forms. The diameter of the screw used was 8mm, and the distance between each screw was 2mm. The leadscrew edge connected to the stepper motor cannot change the movement of the rotation into linear movement or be used to support the temperature sensor so that it can move up and down according to the regulation [9].

ESP32-CAM is a Good Quality Camera Version Module that includes the OV2640 camera. With a low-consumption WIFI + Bluetooth connection and a Micro-SD slot, users can create a system that conceptualizes the Internet of Things, such as an online CCTV that can be programmed using the Arduino IDE. This module is used to photograph objects with temperature measurement results greater than normal limits [10].

Relay module can be used as a switch to run a variety of electronic equipment. For examples are electric lights, electric motors, and various other electronic equipment. Control of the ON/OFF switch (relay) is fully determined by the output value of the sensor, which after processing by the microcontroller, will generate a command to the relay to perform the ON/OFF function. In this study, the relay serves to activate the camera [11].

III. Research Methods

A. *Time and Place of Research*

The implementation and work on this final task were carried out at the Integrated Laboratory, Department of Electrical Engineering, University of Lampung in September 2020—July 2021.

B. *Tools and Materials*

The tools and materials used in this research i.e. PC, Arduino Uno, Arduino IDE Software, Ultrasonic Sensor, MLX90614 Temperature Sensor, OLED SH1106 0.96", ESP32-CAM Module, Relay, Screw, Stepper Motor, and USB cable.

C. *Research Procedure*

Research stages ranging from literature studies to test results analysis can be presented by creating an overall research flow diagram (Fig. 1).

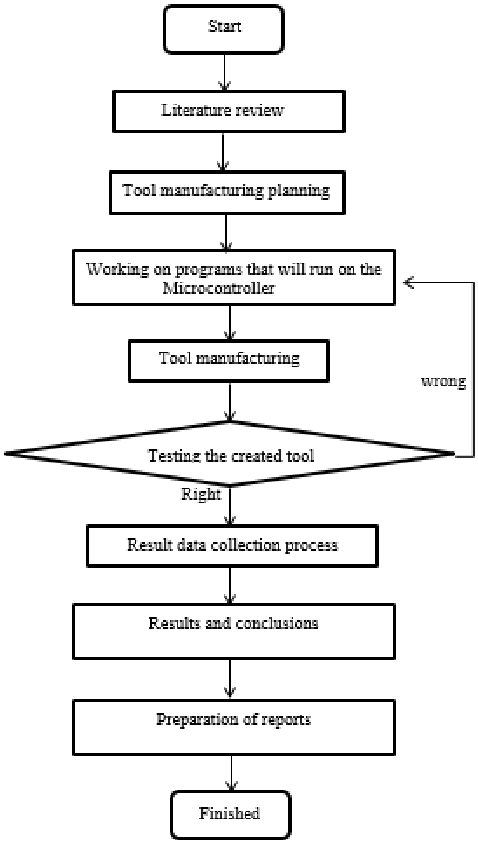

Fig. 1 Flow chart of this research

Fig. 2 explained the sequence of block diagrams in this study was that when a human (object) stands at a predetermined point to measure body temperature, an ultrasonic ping sensor will detect its distance to the human head. Then the ping sensor will provide input to the microcontroller about how far the sensor is from the top of the human head, which will then be processed by a microcontroller which will then move the thermogun through the stepper motor by adjusting the target that has been intended. Design or form the tools of this research could be seen in Fig. 3.

IV. Result and Discussion

A. *Working principles*

The study designed a system of measuring human body temperature using Arduino microcontrollers and temperature sensors to be displayed on LCD by automatically adjusting to the human body's height that took body temperature measurements. In the beginning, this tool was equipped with ultrasonic sensors detecting the distance between the human head and the sensor. Then the legible distance made the stepper motor rotated clockwise and move with the screw iron placed on the stepper motor and installed with a temperature sensor and LCD. After the stepper motor rotates clockwise for a predetermined distance, the temperature sensor detects the surface temperature or object in front of it or the human face.

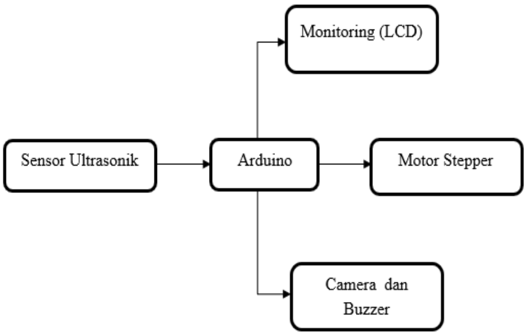

Fig. 2 Block Diagram System

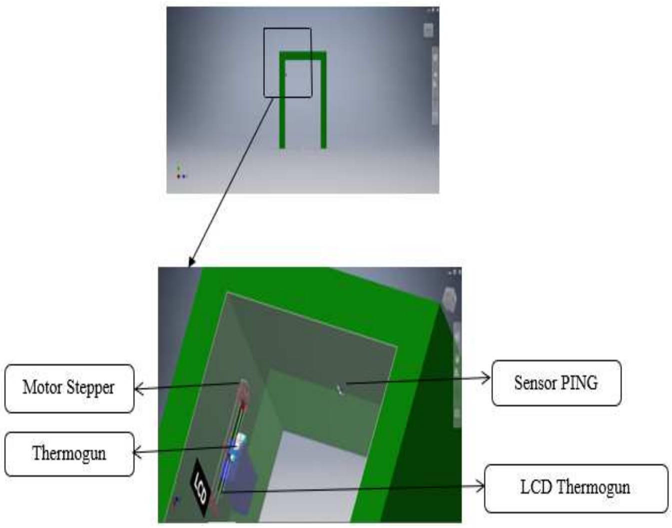

Fig. 3 Tools design of the research

After the temperature sensor worked, it would display the results on the LCD. Then if the body temperature were normal, the stepper motor would return to its initial position counterclockwise. However, if the body temperature exceeded the normal limit determined, the buzzer would sound. The relay module would activate the camera to photograph objects taking temperature measurements with excess temperature. The photo results would be stored on the memory card that has been installed on the camera.

B. *System Design and Testing*

The design of this human body temperature measuring system used the Arduino Uno microcontroller, ESP-32CAM, MLX90614 temperature sensor, OLED SH1106 0.96", 128x64, relay, ultrasonic sensor, and stepper motor. Schematic of the whole tool system could be seen in Fig. 4.

According to the schematic and program made, the working principle of this tool was to use ultrasonic sensors to test the distance between the object and the top of it. Then the distance between them would move the stepper motor according to the distance detected on the ultrasonic sensor. After the stepper motor stop, the temperature sensor detect the object's temperature in front of it. Then the display would appear according to the results detected on the temperature sensor with a predetermined delay. Once completed, the display would clear, and the stepper motor would move counterclockwise to return to its original position. However, if the temperature sensor detected an object with a temperature that exceeded the predetermined limit, it would automatically sound the buzzer and activate the relay or (NC) to activate the camera, which would photograph the object with a temperature that exceeded the predetermined limit.

The temperature sensor can work optimally and produce accurate data when the sensor is placed in front of an object. The closer or farther the sensor is from the object, the temperature measurement does not get optimal results. Therefore, determining the optimal distance is very necessary at the time of measurement. In this study, several tests of the accuracy of the sensor were carried out with several distances.In the results of the experiment, the results of the sensor detections were less accurate with a large temperature that was high enough, which was 39.8°C—the closer the object to the sensor, the greater the result of the temperature sensor detection (Fig. 5.a). The results of the second experiment were obtained from less accurate sensor detections with a large low temperature of 30.3°C. The longer the distance between the object and the sensor, the smaller the result value of the temperature sensor detection. Then the third experiment was carried out with the object's distance to the temperature sensor set at 20 cm (Fig. 5.b).

In the third experiment, the results of the sensor detections were quite accurate with a large temperature of 36.3°C when compared to the Themogun detection commonly used by the general public to produce a temperature value of 36.5°C. Therefore, the optimal distance between the temperature sensor and the object was 15 cm (Fig. 5.c).

The stepper motor could move when the ultrasonic sensor detected the distance to the object. The stepper motor's sensor detections and movement would always be 3cm different, as seen in the table 1. In the Table I, it could be seen that each ultrasonic sensor detected a distance. The stepper motor would move with the distance that had been detected.

TABLE I. ULTRASONIC SENSOR DETECTIONS AND STEPPER MOTOR MOVEMENTS

No	Experiment	Sensor detection	Stepper motor movement
1	1	29cm	32cm
2	2	43cm	46cm
3	3	45cm	48cm
4	4	40cm	43cm
5	5	47cm	50cm
6	6	49cm	53cm
7	7	52cm	55cm
8	8	51cm	54cm
9	9	54cm	57cm
10	10	50cm	53cm

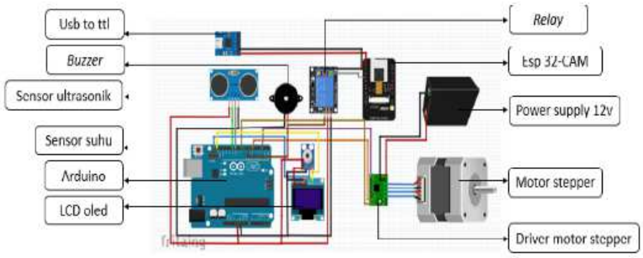

Fig. 4 Schematic of the whole tool system

(a) (b) (c)

Fig. 5 Distance sensor with object (a). less than 10cm; (b). more than 20cm; (c). 15cm

Ultrasonic sensors detected the distance between the top or part of the human head, so the movement of the stepper motor would always move more than 3cm from the sensor detection. That was because the program added number 3 so that the stepper motor moved the screw placed by the temperature sensor could stop right on the human face. The results of sensor detection could be seen in the serial display of the monitor contained in the Arduino IDE, and the results of the movement of the stepper motor were calculated manually using a ruler. The movement of the stepper motor could be adjusted by setting up in programming, as in Fig. 6. In the Fig. 6, it could be seen that variable x was the result of ultrasonic sensor detection. Then the speed of the stepper motor could be determined through the program.

```
void loop() {
  x=distanceSensor.measureDistanceCm();
  if (x<=50){
    // Set the spinning direction clockwise:
    digitalWrite(dirPin, HIGH);
    Serial.print(x);
    Serial.println(F("cm"));
  for (int i = 0; i < ((250*x)+ (250*3)); i++) {
```

Fig. 6. Program for stepper motor movement

The command $((250 \cdot x) + 250 \cdot 3)$ in the preceding program was the command to determine the movement of the stepper motor to match the ultrasonic sensor detection, followed by the speed of the stepper motor multiplied by variable x (the result of detection from ultrasonic sensors).

Then, the stepper motor speed was added at times with the number 3, the object's distance (above the human head with the forehead). Therefore, the movement of the stepper motor was always following the predetermined distance. The number 250 was the pulse given to the stepper motor in 1 second. The total pulse per second (pps) given is 500.

C. Discussion

Based on the results of tests that have been done on the parts of the device used, both as input, processing, and until the action output was obtained, data results following the system creation plan. The results obtained from testing followed the function of the human body temperature measurement system. The suitability of the test results was based on several things, namely:

- Ultrasonic sensors could function well to detect distance at the beginning of the system's work.
- The dynamics of the stepper motor: the stepper motor could work if the ultrasonic sensor detected the distance to the object, then the motor would move a distance of 50 cm at a time of 10 seconds, then the stepper motor would move at a speed of 0.05m/s.

V. Conclusions

The results show that there has been an optimal distance between the object and the temperature sensor so that the temperature measurement can run and get optimal results. Photos have been obtained from temperature measurement objects with temperatures exceeding normal limits. The stepper motor has performed optimally with the lap speed specified in the program.

Acknowledgment

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