Original Research Article

DESIGN OF AUTOMATIC DOOR LOCK BASED ON ATMEGA328P MICROCONTROLLER WITH MLX90614ESF DCI AND HC-SR04 SENSORS

Abstract- In conditions like now, it is very important to check a person's health level to be able to enter a room so as not to transmit the disease that exists in that person. Infectious diseases can be avoided by keeping yourself healthy, besides taking care of yourself you can also avoid them by keeping your distance from people who are infected with infectious diseases. The purpose of this study was to keep someone from entering the room due to high body temperature. With MLX90614ESF DCI sensor that can measure temperature without touching and solenoid door lock to lock the door of the person is sick. Temperature data from people who want to enter a room will be displayed by a 0.92 inch OLED and sent to a smartphone by SIM800L as SMS. The suitability of the temperature measurement carried out by this tool has been calibrated with a reference tool and the results of the coefficient of determination analysis are 99.80% of the temperature data obtained.

Keywords: MLX90614ESF DCI, Solenoid door lock, Avoiding infectious diseases, Keeping distance, Body temperature

I. INTRODUCTION

Health is a vital element in all activities carried out by humans. Measurement of these vital signs will provide valuable information, especially regarding the general health status of the patient. Vital signs of human health can be known from body temperature, respiration, blood pressure, and pulse [1]. Measurement of human body temperature is done using a body thermometer. There are two types of body thermometers currently available, namely non-digital body thermometers and digital body thermometers. Based on how it is used, thermometers are divided into two, namely contact thermometers and non-contact thermometers [2].

An Infrared Thermometer is a measurement tool that can detect temperature optically (as long as the object is observed), infrared radiation energy is measured, and described in terms of temperature. Infrared Thermometers measure temperature using the black box radiation (usually infrared) emitted by objects. It is sometimes called a laser thermometer to help with measurement work, or a touchless thermometer to describe the device's ability to measure temperature remotely. By knowing the amount of infrared energy emitted by the object and its emission, the temperature of the object can be distinguished.

Based on the description above, to reduce disease transmission between patients with sick visitors and patients with sick staff. The author sees the need to design an automatic door lock based on the ATmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors so that it can limit people who can enter the room due to high body temperature. This tool can be installed at the entrance to the patient's room so that before entering the patient's room, officers or visitors are required to check their body temperature first to be able to open the door to the patient's room. If the body temperature of the officer or visitor is high, the door will not open and lock. That way the spread of disease in the hospital can be handled properly. In addition to the hospital, this tool can be installed on the door of the house, the door of the workroom, and various doors that are frequently passed.

II. RESEARCH METHOD

2.1 Body temperature

Body temperature is a balance between heat generated and heat released [3]. This feedback mechanism occurs when the core body temperature has exceeded the body's tolerance limit to maintain temperature, which is called the set point. When the body temperature increases from a certain point, the hypothalamus will regulate to do what it wants to maintain temperature by decreasing production and increasing the temperature to keep it at a fixed point [4].

2.2 MLX90614 DCI

The MLX90614 DCI sensor is an infrared thermometer that is used to measure temperature without coming into contact with objects. This sensor consists of an infrared-based temperature-sensitive detector chip and ASSP signal conditioner (Affordable Small Sparkling Package) which is integrated with the TO-39 (Type 39 transistor). This sensor is supported by a low noise amplifier, 17 bit ADC (Analog Digital Converter), DSP (Digital Signal Processor) unit**,** and a thermometer that has high accuracy and resolution. As a standard PWM (Pulse Width Modulation) 10 bits will show temperature changes measured continuously with a temperature range of minus 40 to 120 degrees Celsius and object temperature range from -70 to 380 degrees Celsius with an output resolution of 0.14 degrees Celsius.

The PWM pins can be used as temperature change relays (To as input), which is easy and inexpensive to use in thermostats or temperature warning applications (freezing or boiling). The temperature threshold is easy to program. On the SM (System Management) Bus, this feature can function as an interrupt on the processor that can trigger a read of all slaves on the bus and determine the actual state. Normally, the MLX90614 DCI sensor can sense objects with an emissivity of 1. However, this sensor can be easily calibrated to sense objects with an emissivity of 0.1 to 1. The MLX90614 DCI can use 2 alternative voltage sources, namely 5V or 3V batteries. The position of the pin can be seen in Figure 4 and its description in Table 2.2 [5].

2.3 HC-SR04

The HC-SR04 sensor is an ultrasonic wave-based proximity sensor. The advantage of this sensor is the detection range of about 2 cm to a range of 400-500 cm with a resolution of 1 cm (Hanan, 2019). The HC-SR04 sensor is a low-cost version of the ultrasonic PING sensor made by Parallax. The difference lies in the pins used for the HC-SR04 using 4 pins while the PING made by Parallax uses 3 pins [6]. This device uses two digital pins to communicate the read distance. The working principle of this ultrasonic sensor works by sending an ultrasonic pulse of about 40 kHz, then it can reflect the echo pulse back (hapus saja kata back), and calculate the time taken in microseconds as depicted in Figure .3. The sensor can trigger pulses 20 times per second and it can know the distance of objects up to 3 meters [7].

2.4 Microcontroller

A microcontroller is an integrated microprocessor chip that acts as the brain in making instrumentation [8]. Engineering logic and algorithms on microcontrollers for specific instrumentation purposes is done using programming languages such as assembler, C, or C++. The microcontroller can be programmed and can execute programmed steps [9]. The microcontroller was created to process or operate certain applications only. Where this is very different from a computer that can run many applications. The working principle and components of the microcontroller are the same as ordinary computers, but the specifications are lower than computers [10]. Microcontroller consists of many transistor arrangements with a very small size up to the size of a nanometer. The development of the microcontroller opens up opportunities to make instrumentation that is more precise, easy to use, and economical. One type of microcontroller that is widely used today is the Arduino.

2.5 SIM800L

It is one of the most popular types of GSM/GPRS Serial modules used by hobbyists, as well as electronics professionals for various remote control purposes. For now, there are several types of breakout boards, but the most widely sold in Indonesia is the mini version with a Micro SIM type GSM card [11].

2.6 OLED

OLED (Organic Light Emitting Diode) is one of the media that can be used as display output for Arduino modules or other controllers. It has the advantage that the pixel contrast is very sharp and does not require a backlight so that it is efficient in power consumption [12]. The disadvantage of OLED is that it uses a single color size which is relatively smaller than a Graphic LCD or from a TFT LCD.

2.7 Real Time Clock

Real-time clock (RTC) is a module that functions as a timer designed using electronic components in the form of chips that are able to perform work processes like clocks in general, such as calculating seconds, minutes, and hours. The calculation is calculated accurately and stored in real-time. This RTC chip will later be integrated with a controller to perform certain work functions. The RTC chip used in this study is the DS1307 [13].

2.8 Solenoid Door Lock

Solenoid Door Lock is an electronic door lock device using an electric voltage as a controller. This tool is widely applied to automatic doors. The door lock solenoid works when voltage is applied. Under normal circumstances**,** the lever on the door lock solenoid will extend, and if given a voltage the lever on this tool will shorten. The electric voltage given will create a magnetic field so that the lever on the door lock solenoid will be attracted by the magnetic field [14].

2.9 Relay

Relay is a switch that is controlled by current. Relays have a low-voltage coil wound around a core which is malleable iron. There is an iron armature that will be attracted to the core when current flows through the coil. This armature is attached to a spring-loaded lever. When the armature is pulled towards the core, the common line contact will change its position from normally-closed contact to normally-open contact. Relays are needed in electronic circuits as executors as well as interfaces between loads and electronic control systems with different power supply systems. Physically, the switch or contactor with the electromagnet relay is separate so that the load and control system are separate. The main parts of the electromechanical relay are as follows. Electromagnetic coil Switch or contactor Swing Armature Spring (Spring) [15].

III. RESULT AND ANALYSIS

3.1 Result

Research on designing automatic door locks based on the ATmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors displayed on a 0.96 inch OLED then sent via SMS in real-time with a solenoid door lock as a door lock and a servo motor to move the door open or closed, carried out in the Laboratory Electronics and Instrumentation Physics Study Program, Faculty of Mathematics and Natural Sciences, Udayana University. Research time is from October to December 2021.

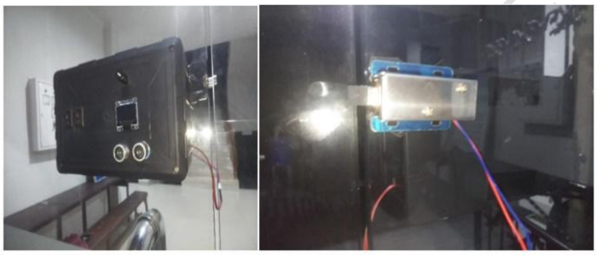

Figure 1. Automatic door lock based on ATmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors.

The design of automatic door lock based on ATmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors is shown in Figure 1.

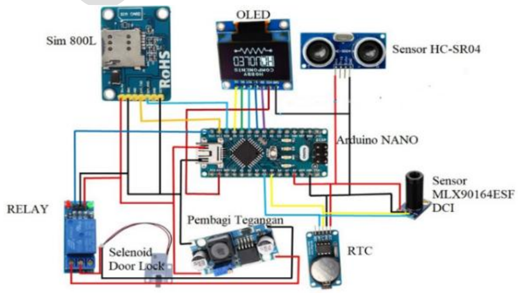

Figure 2. Design of a series of tools.

In the design of this tool, the Arduino Nano ATmega328p microcontroller is used as the input and output processing center. For input from this tool, there are 3 systems, namely the MLX90164ESF DCI sensor as a remote temperature measuring sensor that will send data to the microcontroller, the HC-SR04 sensor as a distance sensor that will control data retrieval from the MLX9016ESF DCI sensor to be active at a certain distance so that the sensor does not pick up data. temperature data from distant objects, and the RTC module as a timer that will control the tool for data retrieval at a certain time. While the output of this tool is four systems, namely 0.92 inch OLED as a medium for displaying object temperature and room temperature, GSM SIM800L module as a sender of temperature data from sensors that will be received by mobile phones in the form of SMS, and relay module as a solenoid door lock activation device that has been set in the microcontroller with the object temperature limiter as a lock to open the door.

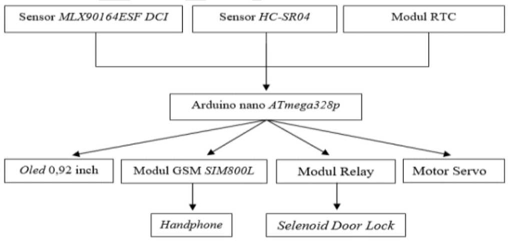

Figure 3. Block diagram of measuring instrument design.

3.2 Analysis

Temperature calibration aims to test the design of measuring instruments with standard tools that have been commercialized, namely XK-W2001. This calibration was carried out at the Electronics and Instrumentation Laboratory of the Physics Study Program, Faculty of Mathematics and Natural Sciences, Udayana University. The temperature setpoint range used in the calibration process is between 34-42. Based on the data, the overall calibration of the temperature parameters is plotted in the graph in Figure 4.

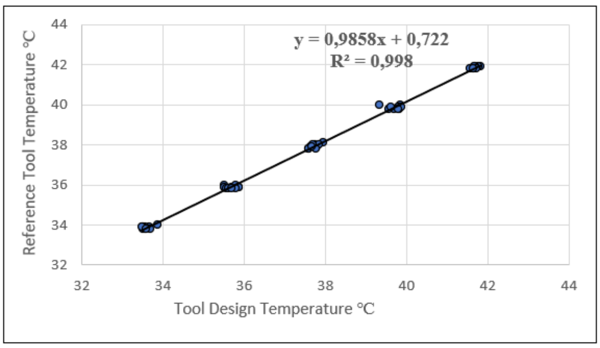

Figure 4. Graph of temperature parameter calibration.

Then the regression equation obtained is as follows:

$$y = 0{,}9858x + 0{,}7220 \quad (1)$$

The regression equation (1) shows a gradient of 0.9858 and a regression constant of 0.7220.
Next, this calibration is to test the results of the tool design that has been adjusted to the standard. Based on the calibration data of the entire temperature parameter adjusted to the standard, the average value of the correction between the standard tool and the tool design is -0.0050. This value indicates the average correction is getting better. From the calibration data**,** it is plotted in the graph in Figure 5.

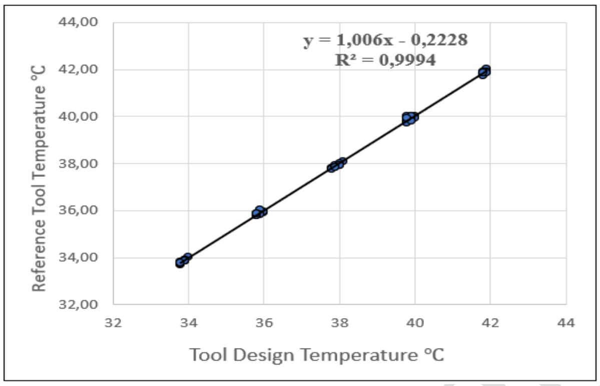

Figure 5. Graph of calibration of air pressure parameters adjusted to the standard.

Based on the calibration graph in Figure 5 shows there is a linear regression line. The regression equation obtained is as follows:

$$y = 1{,}006x - 0{,}2228 \quad (2)$$

The R2 value obtained is 0.9994. The regression equation (2) shows a gradient of 1.006 approaching one. While the regression constant is -0.2228.
Distance calibration aims to test the design of measuring instruments with standard tools that have been commercialized, namely the meter. This calibration was carried out at the Electronics and Instrumentation Laboratory of the Physics Study Program, Faculty of Mathematics and Natural Sciences, Udayana University. The distance setpoint range used in the calibration process is between 20-100 cm. Based on the data, the overall calibration of the distance parameters is plotted in the graph in Figure 6.

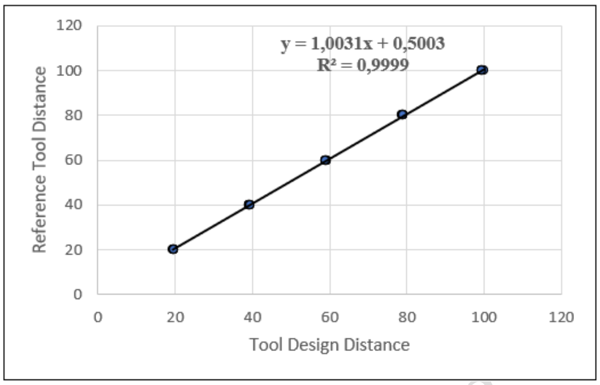

Figure 6. Graph of distance parameter calibration.

The calibration equation obtained for the distance parameter is as follows:

$$y = 1{,}0031x + 0{,}5003 \quad (3)$$

The value of R2 obtained is 0.9999. The regression equation (3) shows a gradient of 1.0031 and a regression constant of 0.5003. The correction value obtained is 0.6848.
Based on the calibration data of the entire distance parameter adjusted to the standard, the average correction between the standard tool and the tool design is 0.1034. This value indicates the average correction is getting better. From the calibration data**,** it is plotted in the graph in Figure 7.

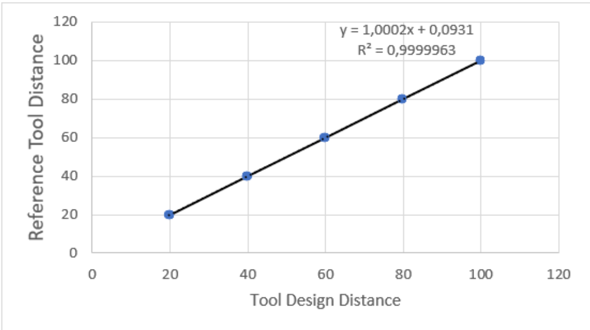

Figure 7. The calibration graph of the distance parameter adjusted to the standard.

Based on the calibration graph in Figure 7 shows there is a linear regression line. The regression equation obtained is as follows:

$$y = 1{,}0002x + 0{,}0931 \quad (4)$$

The value of R2 obtained is 0.9999963. The regression equation (4) shows a gradient of 1,0002 close to one. While the regression constant of 0.0931 is close to zero.
Testing of OLED and SMS output data aims to check data communication between the microcontroller and smartphone through the provider network connection. The test is carried out by observing the OLED output data on design

tools and applications on smartphones. The output test data is shown in Table 1.

Table 1. OLED and SMS output data on smartphones.

No	Temperature in OLED (℃)	Temperature SMS (℃)	Description
1	34,55	34,55	Matching
2	34,41	34,41	Matching
3	34,51	34,51	Matching
4	34,49	34,49	Matching
5	34,41	34,41	Matching
6	34,93	34,93	Matching
7	35,05	35,05	Matching
8	35,13	35,13	Matching
9	34,77	34,77	Matching
10	34,81	34,81	Matching

The application of the automatic door lock design based on the Atmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors was carried out at the Electronics and Instrumentation Laboratory of the Physics Study Program, Faculty of Mathematics and Natural Sciences, Udayana University. Measurements used 6 people as samples to measure their body temperature. For each person, ten data were collected. The application data are shown in Tables 2 and 3. With the condition to open the door less than 37℃, if someone has a temperature of more than 37 then the door will be locked.

Table 2. Data on the application of the measuring instrument design to the 1st person.

No	Temperature Data (℃)	Selenoid door lock	Description
1	36,41	Open	Matching
2	36,55	Open	Matching
3	36,61	Open	Matching
4	36,43	Open	Matching
5	36,45	Open	Matching
6	36,57	Open	Matching
7	36,37	Open	Matching
8	36,25	Open	Matching
9	36,35	Open	Matching
10	36,42	Open	Matching

Table 3. Data on the application of the measuring instrument design to the 2nd person.

No	Temperature Data (℃)	Selenoid door lock	Description
1	36,63	Open	Matching
2	36,83	Open	Matching
3	37,08	Locked	Matching
4	37,03	Locked	Matching
5	36,69	Open	Matching
6	36,71	Open	Matching
7	36,55	Open	Matching
8	36,55	Open	Matching
9	36,63	Open	Matching
10	36,67	Open	Matching

IV. CONSLUSION

The design of an automatic door lock based on the ATmega328P microcontroller with MLX90614ESF DCI and HC-SR04 sensors has been successfully made. The results of the measurement test compared with the reference tool show that the value in accordance with the compatibility obtained from linear regression analysis of the device test data is 99%. The measured temperature can be viewed on the OLED and sent via SMS for data collection. Control the solenoid door lock to open and lock the door lock with a temperature that has been set by setting if it is above 37℃ the door lock solenoid will be locked so that the door cannot be opened is appropriate.

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