NON-CONTACT THERMOMETER

Project report submitted in partial fulfilment of requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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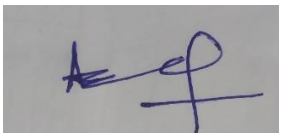
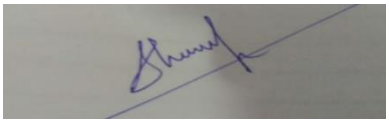
Declaration

We hereby declare that the work reported in the B.Tech Project Report entitled **"NON-CONTACT THERMOMETER"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Dr. Salman Raju Talluri.** We have not submitted this work elsewhere for any other degree or diploma.





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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Signature of the Supervisor

Dr. Salman Raju Talluri

DATE: 28 June 2021

Head of the Department/Project Coordinator

ACKNOWLEDGEMENT

It is a great expression of gratitude towards our project supervisor Dr. Salman Raju Talluri, as he guided and monitored us in our project of NON-CONTACT THERMOMETER. We empathize this as favourable opportunity and we got to unfurl different experiences.

We would also like to thank our HOD who provided us with a well experienced supervisor and was very much proactive with our providence.

Thereby, faculty of our department was also there to complete the project as a team, effectively. They all were helpful throughout and patiently handled every concern which we came across.

We are also thankful to our parents as they were there to support on finances, which helped us in fundamentals of project.

The whole compilation was a tremendous experience and we are highly obliged to each and everyone as their thoughts and work helped us to compile this project.

LIST OF ACRONYMS AND ABBREVIATIONS

Temp: Temperature

IR: Infrared Radiation

WHO: World Health Organization

I2C: Inter Integrated Circuit

SDA: Serial Data Address

SCL: Serial Clock Line.

ACK: Acknowledgement

R/W: Read/Write

OLED: Organic Light Emitting Diode

Tx: Transmit

Rx: Receive

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ABSTRACT

In the current scenario, social distancing is the primary factor to avoid transmission. However, the first symptom of the Coronavirus is a very high body temperature. It's impossible to maintain social distancing using our conventional thermometers, on the other hand, the non-contact thermometer can show the temperature on-screen operating Arduino Nano foremost control device with the proximity and temperature sensor. Therefore, comparing with conventional thermometer, it manifests powerful points like an easy reading, broad range of temperature computation, along with precision where temperature output is showed on the screen. Furthermore, it can be used anywhere as of its simple operating mechanism.

The purpose of this study is to implement a non-contact thermometer which is easy to operate, precise and cost effective. We have also talked about advantages and disadvantages of it and did error analysis of the non-contact thermometer.

CHAPTER-1

INTRODUCTION

1.1 Opening:

Current period of viral diseases such as Covid-19, Swine influenza, SARS, and Ebola has increased the need to diagnose potentially infected and contagious persons accurately and rapidly. These viruses are highly infectious and studies show that they can spread quickly from one person to another person via respiratory transmission. The change in body temperature is one of the known signs of COVID-19.As a result companies ,government facilities and even some busy areas (e.g., shopping centers, transport hubs and , fitness centers, churches, and health facilities), will have a body temp monitoring system in order to avoid those with bacteremia signs (e.g., a body temp greater than 97.8° F) from entering.

As a result, temperature testing is recommended as a requirement for entry to offices and commercial buildings. Temperature controls are now a regular custom in the most of the countries that are increasingly applying restrictions in response to the COVID-19 pandemic. WHO has proposed the use of thermal imaging cameras for body temperature monitoring in response to the global health emergency caused by corona virus.

Body temperature monitoring is a difficult challenge, particularly when the purpose is to efficiently and precisely classify infected people that could possibly spread and infect others with the COVID-19. For that reason body temp measuring must be fast, painless, easy, inexpensive and comfortable for the monitoring operators, and also be accurate, secure, and consistent.

There are different type thermometer available in market in order to check the body temperature, and every type of thermometer has its own specifications and procedure to use. Mercury thermometers are having the good accuracy but it take so much time to take readings from them and also much people find difficulties to read data from them. On the other hand, Digital thermometers are faster than conventional thermometers, as they have digital display for reading and detect temp quicker. But the cons with the digital thermometer is that they also need the contact of the probe, as a result they also can be a good medium to spread the virus. In order to avoid these problems Infrared thermometer can give you the relatively close non-contact temp readings.

The reliability of infrared temperature measuring devices is probably the most contentious problem. But research has shown that non-contact or infrared thermometers are also precise as conventional and digital thermometer. Thermometer assure the safety of operator as well as the other person and gives you the fast and accurate results. But user must follow the instruction as it doesn't work on the person who has taken the medicines to reduce the fever. In these days many organizations need to monitor the temperature of the people, non-contact thermometer is providing them the quick, precise results as well assisting in the reduction of COVID-19 spread.

1.2Working principle of non-contact thermometer:

Non-contact thermometer works according to the black body radiations which says that anything which have temp greater than the zero, they have molecules. As the temp goes higher, movement speed of the molecules increases. This Movement of the molecules emits infrared radiations and these radiations are detected by the thermometer.

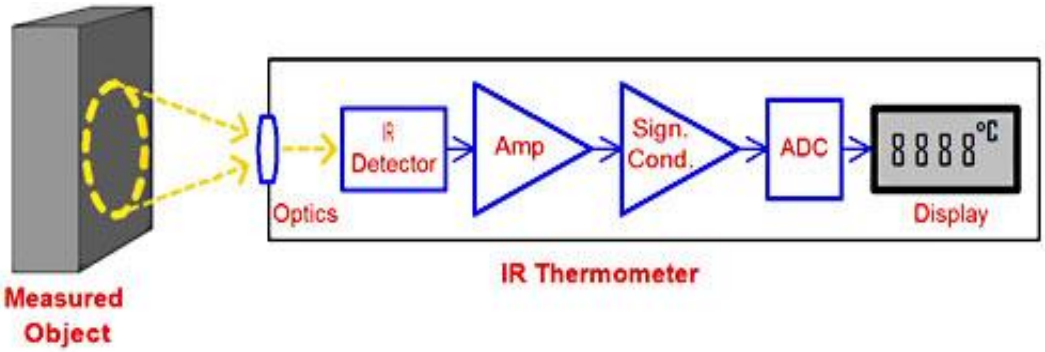

Figure 1.1: Working of IR thermometer

Source: sensortips.com

Like visible light, Infrared red rays are also absorbed, focused and reflecting. Thermopile is the lens that is used in temperature sensor, it focus on the infrared light in order to detect from the object. Thermopile absorbs the IR and convert it into the heat. As thermopile absorbs more IR, it goes hotter. After that the heat is converted into electricity, after amplification and temp stabilization, analog signal is converted into digital and displayed on the screen.

1.3 Objective/Aim:

As we're dealing with a pandemic situation right now, Objective of this project to ensure the safety, efficiency and accurate reading with this thermometer. In addition, we will try to make it cost efficient.

1.4 Block Diagram

The block diagram shows all the instruments that are related to each other. Firstly, APDS-9960 detect the gesture and data from the body or object is read by the MLX90614 temperature sensor.

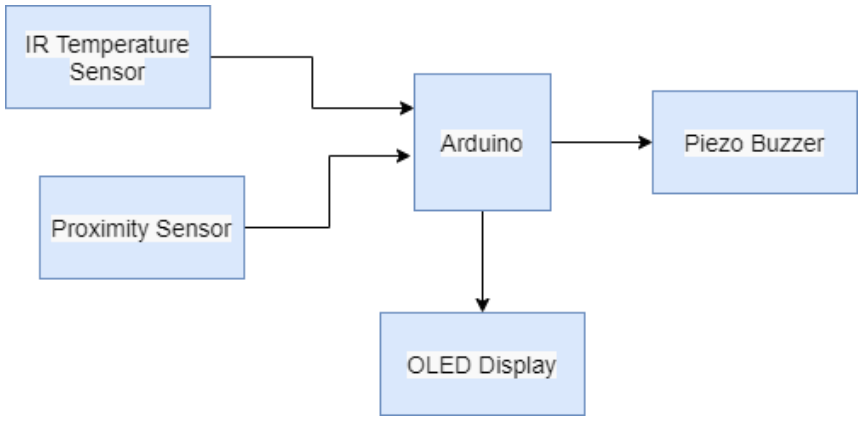

Figure 1.2: Block diagram

Secondly, the data collected is sent to Arduino for further analysis and the device shows the results after running the operations.

1.5 Flow Chart

In flowchart, when Arduino is on, the gesture sensor and temperature sensor is still on to begin with the pressing control switch**.** APDS9960 sense body and temperature sensor also reads the object or body temperature and outputs the response on display. First, as well as initializing OLED control, the device initializes analogue pins A4 and A5. The machine consistently reads and supplies the temperature if the

control switch is held on. If the temperature will be very high buzzer will be triggered. Otherwise any time will be delayed and the loop will stop. Furthermore the loop repeats the same procedure whenever the control button is pressed.

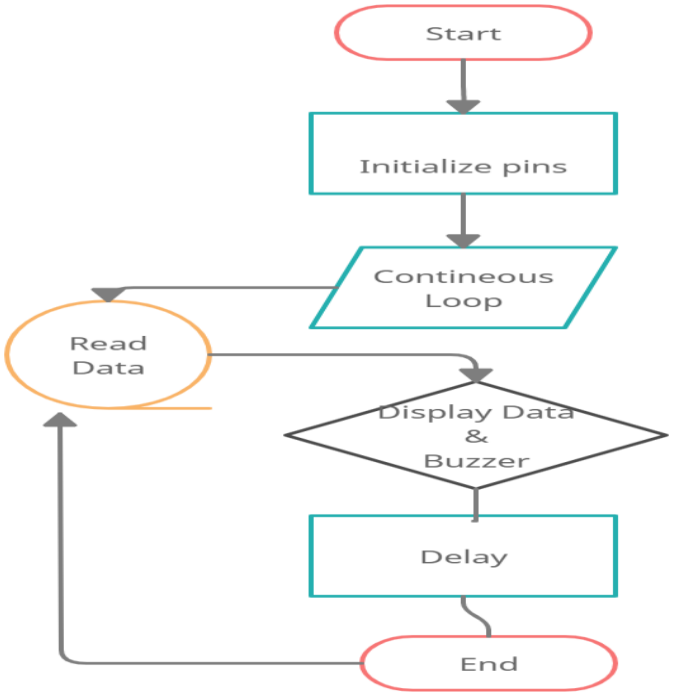

Fig 1.3: Flow Chart

1.6 Applications:

Non-contact thermometers are now being used in a number of lab and factories temperature monitoring applications.

Non-contact Thermometer is used where quick response is required and if the contact thermometer is not accessible or damaged the object. Non-contact thermometer could be used in a number of different temp sensing applications like monitoring the temp and hot spots of electrical or mechanical machines.

In current scenario, Non-contact thermometers have been used in hospitals to read temp of patients by avoiding contact with them and also used in workplaces, institutes and other places to do the screening visitors.

It is also used monitoring products in processes requiring cooling and heating, detecting danger zones in fire prevention and calibration

CHAPTER - 2

LITRATURE SURVEY

Literature survey 1

Teran, C., Torrez-Llanos, J., Teran-Miranda, T., Balderrama, C., Shah, N. and Villarroel, P., 2011. Clinical accuracy of a non-contact infrared skin thermometer in paediatric practice. *Child: Care, Health and Development*, 38(4), pp.471-476.

In this paper, In order to compare the efficacy of the infrared non-contact thermometer to two other recognized methods for measuring body temperature, a prospective, observational, cross-sectional study was planned. Children from the emergency department and inpatient unit included in the study, ranging in age from one to forty-eight months.

Three separate thermometers were used to measure all of the patients: (1) mercury thermometer, (2) Non-contact thermometer (3) temporal artery thermometer.

A total of 434 patients were entitled to participate in the study. 167 people were found to have fever. Study show that non-contact thermometer has a sensitivity and accuracy of 97 percent. The negative predictive value is 99 percent, which is critical for excluding fever and avoiding needless laboratory tests. Conclusion of study was that non-contact thermometer is a safe, convenient, and precise way to measure temperature, and it's particularly useful for fever monitoring in children.

Literature survey 2

Dell'Isola, Giovanni Battista, Elena Cosentini, Laura Canale, Giorgio Ficco, and Marco Dell'Isola. 2021. "Noncontact Body Temperature Measurement: Uncertainty Evaluation And Screening Decision Rule To Prevent The Spread Of COVID-19". *Sensors* 21 (2): 346.

This paper examine non-contact body temp measurement problems from both a clinical and a metrological standpoint in order to (i) increase body temp measurement accuracy; (ii) evaluate the instability of body temp monitoring and (iii) recommend a monitoring judgement guideline for COVID-19 prevention. Method used during the paper provides for both conventional instrumental and clinical–medical causes of complexity due to the subjectivity of the measurand. During a COVID-19 pandemic emergency, it is important to understand the importance of instability in selecting the right thre temperature value and measurement system to gain access to critical locations.

Literature survey 3:

Matsukawa, Takashi, Makoto Ozaki, Tomoki Nishiyama, Makoto Imamura, and Teruo Kumazawa. 2000. "Comparison Of Infrared Thermometer With Thermocouple For Monitoring Skin Temperature". *Critical Care Medicine* 28 (2): 532-536.

Aim of this study was to find out whether to see how an IR thermometer can be used in the same way as thermocouples can. For the 70 minutes, in interval of 10, Skin temperature was monitored by Mon-a-Therm thermocouple and IR thermometer before and after warmed by forced air warmer.

Skin temp on the forearm and fingertip, as well as skin surface temp gradients (from arm to finger and calf to toe) was measured. Both were compared with linear regression and Bland and Altman statistics. Temperatures in the fingertip and forearm varied about 87.8-97.7°F and 72.5-96.8°F.Gradients's temp varies from 26.6-50.0°F to 26.6-51.8 ° F. The temperatures calculated by the IR thermometer and the Mon-a-Therm thermocouple had close and accurate correlations. Conclusion of this study was IR thermometer can be used for monitoring the skin's surface temp and to determine the severity of shock in patients.

CHAPTER-3

I2C PROTOCOL

We are using I2C protocol to establish communication between Arduino and sensors. In I2C, a single master can handle the multiple slaves (like SPI), and also single or multiple slave can be connected to multiple masters. Data is transmitted between systems using just two wires. Data is sent bit by bit in I2C and master controls the clock signal.

SDA (Serial Data): Sending and receiving of data between master and slave is done by SDA line.

SCL (Serial Clock): clock signal is carried by the SCL line.

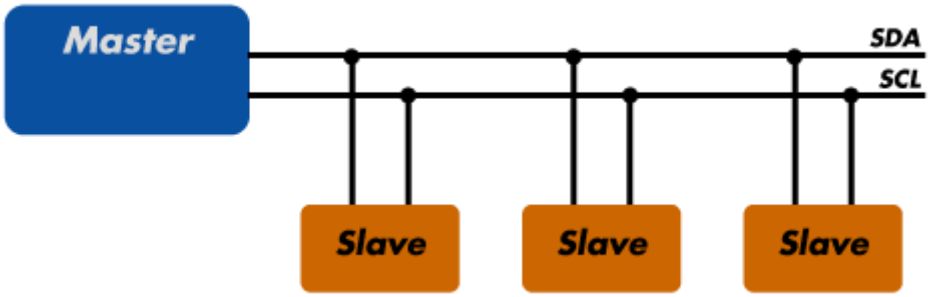

Figure3.1: Connection of SDA and SCL with master and slaves

Source: mikore.com

3.1 Working of I2C:

I2C receive and send data in the form of messages. Messages get split into data frames.

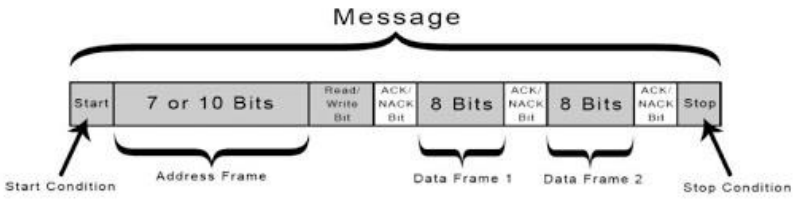

Figure 3.2: Message classification

Further classification of message, it consists of an address frame containing the slave's binary address and one or even more data frames containing data to be sent. Message additionally contains start and stop bits, r/w bits and acknowledgment bits between them.

In start condition, before the serial clock line changes from high to low voltage, serial data line changes from high to low voltage.

In stop condition, serial clock line switches to low voltage and serial data line changes to high voltage.

Address frame is a unique series of seven or ten to each slave that defines each slave when master wants to communicate with a specific slave.

R/W bit take care of that master wants to send the data or receive the data from the slave. If master wants to send, voltage level goes low and in case of receiving it gets high.

Each frame of message have ACK bit. In transmitting data, receiving system returns an ACK bit to the sender if an address frame or data frame was successfully received.

3.1.1 Addressing:

There are no slave select lines in I2C, so how do the slaves know that data is send to which slave. This is done by addressing. When a new message is send to slave, after the start bit, address frame is send to specify message is sent to this slave. Every slave linked to the master receives the address of the slave with whom it wants to communicate. After that, slave compares the own address with the address sent from the master. ACK bit is sent back to master if the address matches otherwise slave does nothing and serial data line stays high.

3.1.2 Read/Write bit:

A single bit at the end of the address frame tells the slave whether the master needs to write data to it or receive data from it. R/W bit get low voltage level if master sends data to slave. In case of requesting, bit has high voltage level.

3.1.3 Data frame:

First data frame is sent when the master gets acknowledgment bit from the slave. Each data frame is of eight bit long and most important bit is sent always first. ACK bit confirms that each data frame is

obtained. Before sending the data frame, Acknowledgement bit should be obtained by the sender (master or slave). From the master, stop condition is send to slave when all data frames are transmitted.

3.2 Data transmission in I2C:

STEPS:

1. By changing low SDA line's high voltage level to low, master passes the start condition to all slaves.

2. After that seven or ten bit address of the slave is sent to all the slaves along with r/w bit.

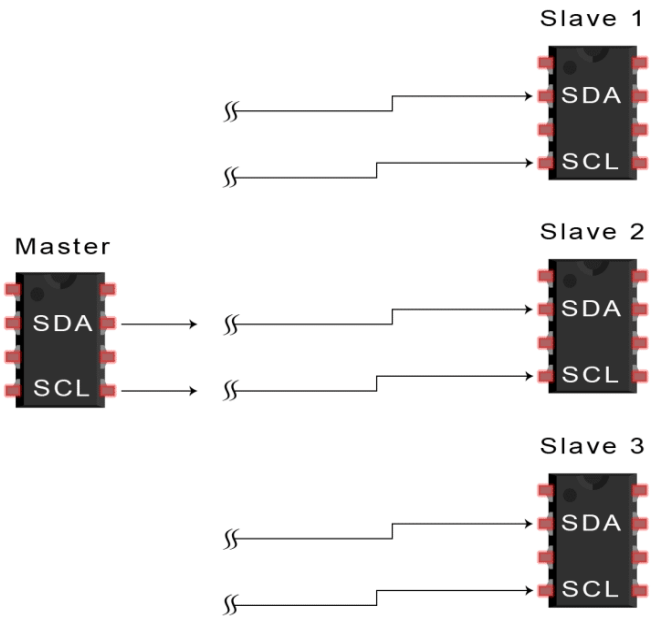

Figure3.3: data transmission in I2C

Source: circuitbasics.com

3. Master's address is compared to each slave's address. ACK bit is returned to master by slave if the address matches with its address; by changing serial data line low for one bit.

4. Data frame is sent or received by the master.

5. After transmitting every data frame, Another ACK bit is sent for sender by receiver to confirm successful transmission.

6. For stopping the data transfer master passes the stop condition to slave.

3.3Advantages of I2C:

- Works on only two lines; SDA AND SCL.
- Works for multiple masters and slaves.
- Hardware can be implemented easily.

3.4 Disadvantages of I2C:

- The data frame can only be 8 bits long.
- Comparing with SPI, it has slightly slower data transmission rate.

CHAPTER-4

METHODOLOGY AND COMONENTS

4.1 Design:

In this figure, Arduino Nano attaches to the temperature sensor, proximity sensor, Piezo Buzzer and OLED display. Arduino analogue pin-4 and pin-5 are attached to the MLX90614 temperature sensor, proximity sensor and also to the OLED display as it is connected in I2c. Proximity sensor detect the body and MLX90614 reads the temperature when the desired body or object is within the range of the thermometer and displays it on screen.

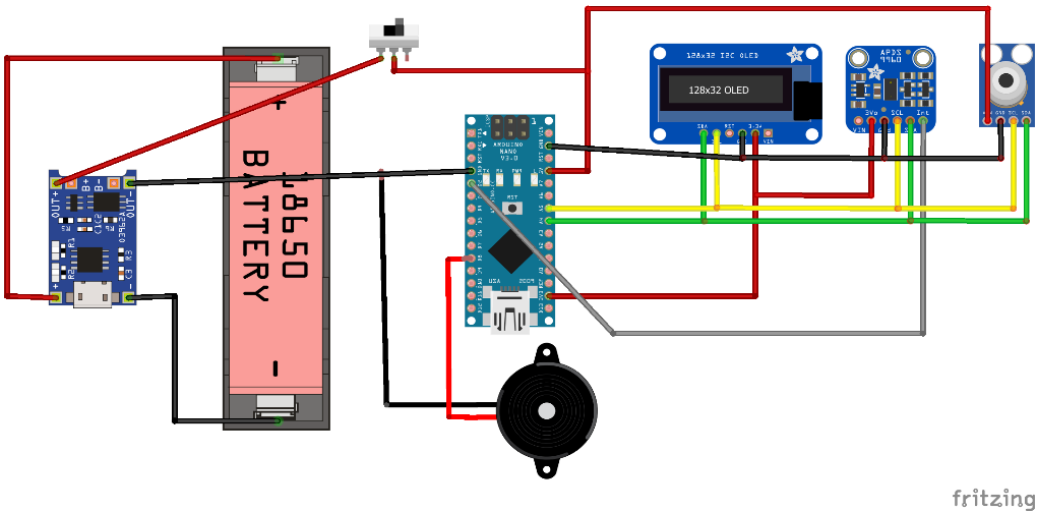

Figure 4.1 Design of non-contact thermometer

Piezo buzzer is connected to the Digital pin-8 and it will be triggered if the body temperature goes critical above 100 Fahrenheit. 18650 battery gives the power supply to the circuit, connected to the 5V pin of the Arduino through the charging module. Charging module is used to recharge the battery. Switch act as a power button to on/off the power supply.

4.2Processing unit:

Arduino Nano is a microcontroller board created by Arduino.cc in Italy that is lightweight, compatible, modular, and breadboard friendly. The Arduino Nano is certainly smaller variant of the Arduino Board, for almost equivalent functionality. It has a 5V operating voltage, but the input voltage can be anything between and 12V. There are 8 analogue pins, 14 digital pins, 6 power pins and 2 reset pins on the board. All of them (analog and digital pins) has many features, but the most important one is to be programmed as an input or output. When they're used to communicate with devices, they're used as input pins, though if you're operating a load, they're used as output pins. Digital pins are operated by functions like pinMode() and digitalWrite(), and analogue pins are operated by analogRead().The analogue pins have a complete resolution of 10 bits and can determine values ranging from 0 to 5V.

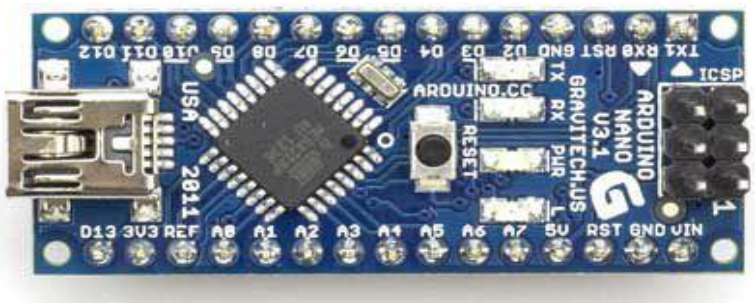

Figure 4.2: Arduino nano board

Nano has some drawback: it lacks a DC power port, this indicates you can't use a battery to provide external power. Arduino Nano will not interface to a system via standard USB; rather it supports Mini USB type. This device's small size and breadboard-friendly design make it an excellent alternative for most projects where the size of electrical parts is vital. The boar comes with 16KB or 32KB flash memory size, based on the Atmega board. For example, the Atmega168 has 16KB of flash memory while the Atmega328 has 32KB. The code is stored in flash memory. A bootloader occupies two kilobytes of the overall flash memory. For the Atmega168 and Atmega328, the SRAM can be 1KB or 2KB, and the EEPROM can be 512 bytes or 1KB. Arduino IDE is used for Programming the board, which is a cross-platform i.e used as offline as well as online. The board should be used without any advannce

arrangements. The only things you'll need are Arduino IDE and a micro USB cable connected to your system. The code is transferred from the system to the board using a USB cord.Since this board has a builtin bootloader, there is no need for a dedicated burner to COMPILE and burn the code.

4.2.1 Pinout of Arduino nano:

VIN: When using an external power source of 7 to 12 V, VIN is the input power supply voltage to the board.

5V: The board's controlled power supply voltage, 5V, is being used to operate the controller and other components on the board.

3.3V: The voltage regulator on the board generates this minimum voltage.

GND: On the NANO board, it indicates ground. Where more than one ground pin is needed, the board has several ground pins that can be interfaced in the appropriate way.

RESET: The board has a reset pin that is need to reset the system. It comes in useful if a running code becomes too complicated and lags the arduino. The controller will be reset if the reset pin is set to LOW.

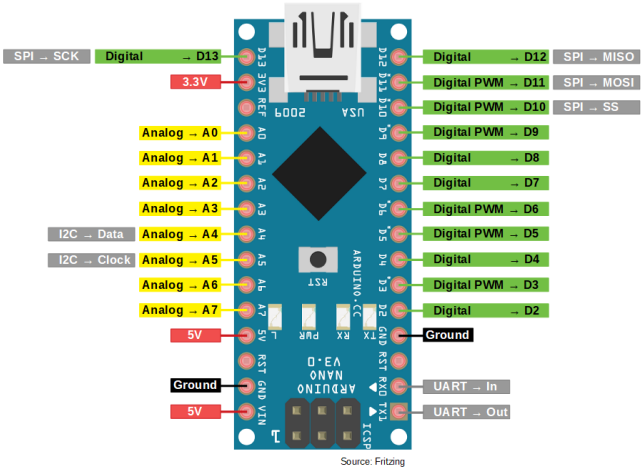

Figure 4.3: Arduino nano pinout

ANALOG PINS: On the board, there are eight analogue pins labelled A0 to A7. All tests the analogue voltages fluctuating from 0 to 5V.

Rx, Tx: Tx represents data transfer and Rx represents data receive in serial communication.

13: The built-in LED is turned on using this pin.

PWM: Eight-pit PWM (Pulse Width Modulation) output can be given using the six pins 3,5,6,9,10, and 11. Analog result is extracted from digital information using this method.

SPI (Serial Peripheral Interface): SPI uses four pins: 13 (SCK), 12 (MISO), 11 (MOSI) and 10 (SS), 12 (MISO) . SPI is a data transfer bus that connects microcontrollers to other devices such as Storage devices, sensors and registers.

EXTERNAL INTERRUPTS: In case of emergency, external interrupts pins 2 and 3 are used when we need to pause the main code and call vital instructions. When the interrupt instruction is triggered and executed, the program code continues.

I2C: The A4 and A5 pins are used in I2C communication, with A4 indicating the serial data line (SDA) that carries data and A5 representing the serial clock line (SCL), that is a clock signal provided by the master system and used for file transfers between systems on an inter integrated circuit bus.

4.2.2 Communication and programming:

Board interface has the option to communicate to other sensors and pcs. Digital pins such as pin 0 (Rx) and pin 1 (Tx) are used for data transfer, with Tx being used to send data and Rx being used to get data. Serial monitoring is a feature of the Arduino IDE that allows textual data to be sent to and from the Nano. The program also offers FTDI drivers, which act as a virtual serial port for the software. An LED blinks on the Tx and Rx pins as data is shared in between USB and FTDI connections to the system. For serial communication between the board and the system, the Arduino Software Serial Library is used. Board also supports I2C and SPI communication in addition to serial communication. To use the I2C bus, the Wire Library in the Arduino IDE is used. Arduino IDE software is needed to programm nano, same software is used in different type of Arduino. After installing the software, choose the Arduino you are working with. Programming in arduino can be done by two methods: by using the bootloader included with the software, which eliminates the need for an additional burner to compile and burn the programm into the controller, or using ICSP (In-circuit serial programming header). Although the Arduino IDE works with Windows, Linux, and MAC, but Windows is the recommended operating system.

4.2.3 Comparing arduino NANO and arduino UNO:

Design of the both boards are almost alike, with only small changes in PCB format, form factor and scale. Uno microcontroller with 14 digital I/O pins, 6 of which are PWM. It is based on the Atmega328 microcontroller. Board is configured with six analogue pins. Requirements like USB connections, power jack, 16MHz Oscillator, reset button and ICSP header to support microcontroller are already in Arduino Uno. To use the board for automation, you don't need any additional consoles.

In comparison to the Arduino Uno, the Arduino Nano is mini and portable. Arduino nano comes with mini USB support rather than standard USB, also doesn't have DC power jack. In addition board has two additional analogue pins, totaling eight, in contrast to six on the Uno. Where UNO lacks to be fit on breadboard, Nano is breadboard friendly.

Apart from that, both works on 5V operating voltage, 16 MHz of clock frequency and 40mA current rating.

4.3 MLX90614 Temperature sensor:

It is a non-contact temperature sensor focused on infrared technology that can determine the temperature between -70°C and 382.2°C and also an atmospheric temperature of -40°C to 125°C by don't making direct contact with anything within analysis.

Figure 4.4: MLX90614 Temperature Sensor

Source: elementzonline.com

MLX90614 has an I2C interface that allows it to transmit temperature readings to microcontrollers via the I2C bus. Moreover, it has ESD safety to prevent the sensor from break down. Because of its efficient ADC, this small sensor is incredibly accurate and reliable. Interface provides a 17-bit ADC that outputs values with a resolution of 0.14 C. Sensor comes with multiple variants depending on input voltage specifications, such as 3 or 5 volts, and resolving power for various project needs. However, it is a flexible temperature sensor with a wide range of applications, notably in wireless networking.

4.3.1Working principle of MLX90614:

The Stefan Boltzmann principle is used in the non-contact infrared temperature sensor. According to this principle, all emits Infrared radiations proportional to their temperature. Sensor transmit the radiation, processed to a digital signal, and sent to the microcontroller via the I2C bus. An Infrared thermopile reader and a signal ASSP processing unit make up the Infrared sensors assembly. The role of the thermopile is to absorb radiation with its peripheral vision, which differs from design to design. Analogue signals are converted to filtered amplified signals by the processing units.

4.3.2 Interface with Arduino

The interfacing of the Arduino Nano and the MLX90614 contactless IR Temperature sensor is described in this section. Connections between the MLX90614 temperature sensor and the Arduino Nano is seen in the diagram below.

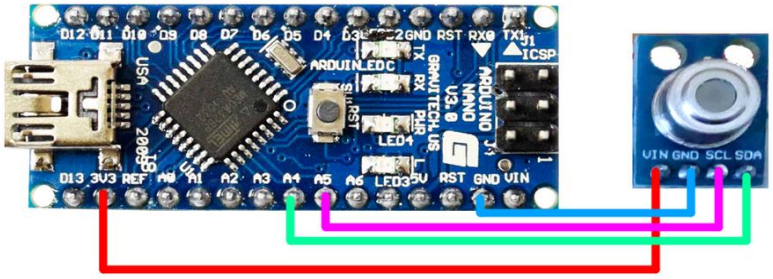

Fig4.5: Interfacing of MLX90614 with Arduino Nano.

VIN (Power supply pin) of MLX90614 is connected to 5V pin of the Arduino Nano and GND pin of the sensor is connected to GND pin of board.

To pass data serially, SDA and SCL pins of the temperature sensor is connected to the Arduino NANO's A4 and A5 pins.

4.3.3 Specifications of MLX90614:

Table4.1: Specifications of MLX90614

Operating Voltage	3.6 Volts – 5.5 Volts
Ambient Temperature Range	-40°C – 125°C
Object Temperature Range	-70°C – 380°C
Measurement resolution	0.02°C
ESD Sensitivity	2Kv
Sink/Source Current	25mA
ADC Resolution	17 bits

For fine output digital signals, an Infrared sensor is combined with an optical filter, a DSP, and a low noise amplifier.

4.3.4 Pinout of MLX90614:

Table 4.2: Pinout of MLX90614

PIN NAME	FUNCTION
VCC	Power Supply
GND	Ground
SCL	Serial Clock pin for I2c
SDA	Serial Data Address pin for I2c

4.4 APDS-9960:

Apds-9960 is used for gesture detection, proximity sensing, RGB light and ambient light. In our circuit we are using it as gesture detection. It detects gestures very precisely with very quick response because of its very advanced gesture system. APDS-960 can be used in gesture robotics, because of its advanced features.

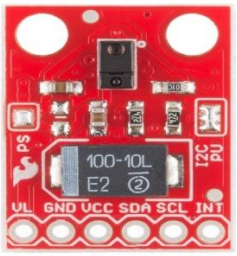

Figure 4.6: APDS: 9960

Source: learn.sparkfun.com

4.4.1 Pinout of APDS-9960:

Table 4.3: Pinout of APDS9960

Pin	Function
SDA	Serial Data Address Pin of I2C
SLA	Serial Clock Address PIN OF I2C
INT	External Interrupt pin
VL	IR LED'S Optional supply
VCC	Power supply

4.4.2 Features of APDS-9960:

- Advance gesture system
- Four photodiodes for gesture sensing so complex gesture can be detect easily

Table 4.4 Features of APDS-9960

Operating Current	0.2mA
Operating Voltage	2.4 to 3.6A
Communication Protocol	400KHz

4.4.3Working and use:

APDDS-9960 can be used in various operations, we are using is it here to detect body or object. It works with I2c Communication which makes it very easy to connect with arduino. This sensor is power efficient, work with very low operating voltage of 2.4 to 3.6A (generally 3.3V) and current 0.2mA.. For the gesture detection, LED transmits the IR signals and when it got reflected

from the obstacle, photodiode detects it and sends the information. It is the process to detect the gesture. Detect function is controlled by interrupt. In order to detect gesture, Interrupt pin activate sensor to release IR.

4.5 OLED Display:

OLED Display generates it's on light so it doesn't require the backlight. It has a wide angle view, high contrast and deep black levels. This display uses less power as compared to display with backlight. It generally uses about 20mA.Display's operating voltage ranges from 1.65 to 3.3V, allowing it to be connected to the microcontroller. The displaying bit pattern is stored by the inbuilt 1kb GDDRAM (Graphic Display Data RAM)

Fig 4.7. OLED Display 128x32

Source: startingelectronics.org

4.5.1 Specifications of OLED Display:

Table 4.5 Specifications of OLED

Display	OLED (Organic LED)
Operating Voltage	3.3V
Operating Current	Maximum 20mA
Interface	I2C
Character per row	21
Resolution	128x32

4.5.2 Pinout of OLED Display:

Table 4.6: Pinout of OLED Display

PIN	Function
VCC	Power supply
GND	Ground
SDA	Serial data address for I2C
SCL	Serial clockline for I2C

4.5.3 Connection with arduino nano:

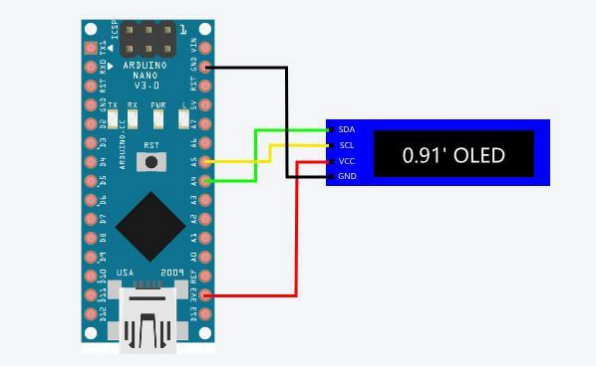

Figure 4.8: OLED with arduino nano

Source: .programmersought.com

As we are using I2c communication, SDA pin of the OLED will be connected to the arduino's analog pin-4 and SCL to the analog pin-5. VCC will be connected to 3.3V and GND to the ground.

4.6 Piezo buzzer:

Piezo buzzer is a small and effective element of the project which is used to add the sound.

Figure 4.9: Piezo Buzzer

It is 2pin small and compact component. Where, positive terminal of the piezo is connected to the digital pin-8 and negative to the ground. The operating voltage of buzzer is 4 to 9V. The buzzer is usually connected to a drive system that turns it on and off at predetermined times and intervals. It is usually used in alarming circuits, automobiles, communication devices and portable devices due to its compact size.

CHAPTER-5

RESULT AND OUTPUT

We are seeing the desired non-contact thermometer here, which is used without any contact to determine temperature. In this project, we create a temperature measurement device that will be useful to measure the body temperature. In addition, in the OLED display, the temperature will appear. For a particular targeted object or body, we can see the APDS-9960 sensor and temperature sensor will act and read the temp. The system also calls a switch where the Arduino gets power if the switch is pressed down and OLED display will be initialized with “NOT DETECTED”, after that when an object/body comes in appropriate distance proximity and temperature sensor will work.

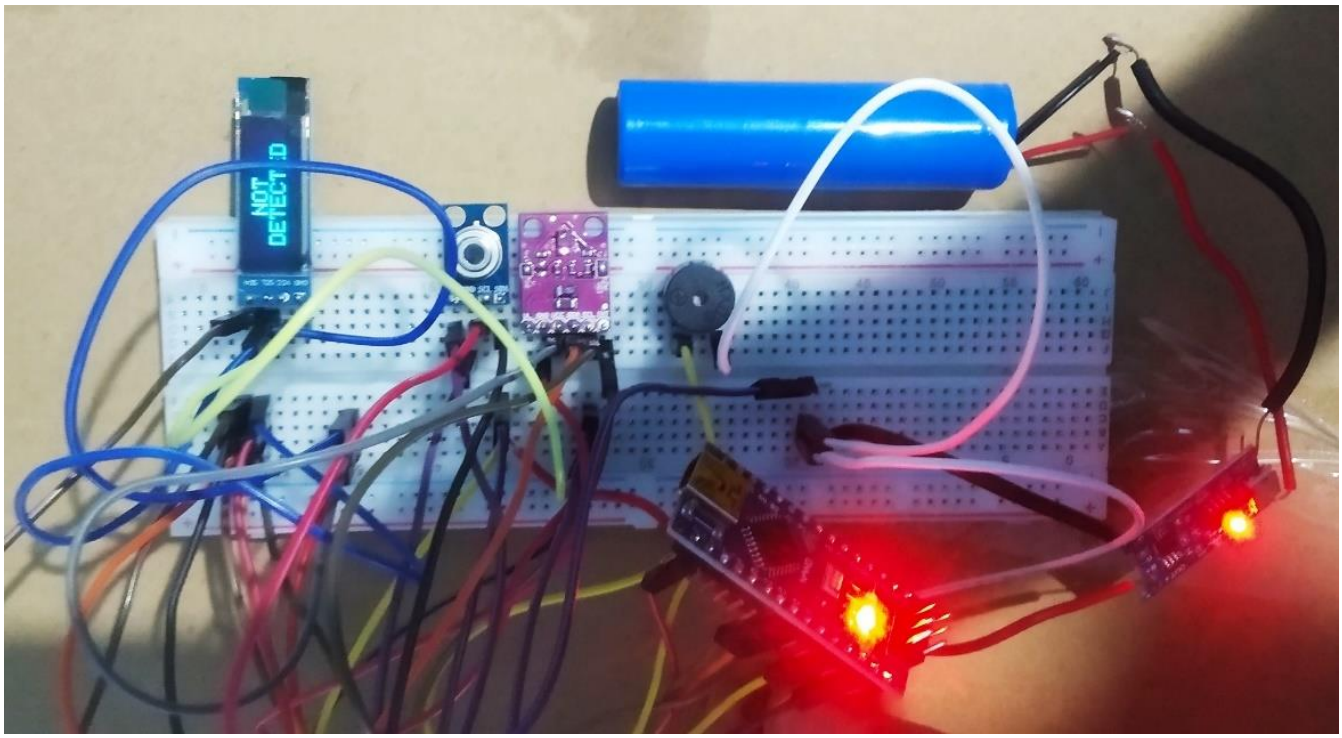

Figure 5.1: Implementation of hardware

5.1 Temperature comparison of conventional and non-contact thermometer readings:

Table5.1: comparison of conventional and non-contact thermometer readings

	Conventional thermometer	Non-contact thermometer
Person 1	98.2	98.37
Person 2	97.5	97.65
Person 3	97.2	97.35

In the table, reading from conventional is close to non-contact thermometer. So non-contact thermometer can be a reliable method to monitor the temperature of person.

Fig 5.2: Temperature monitoring

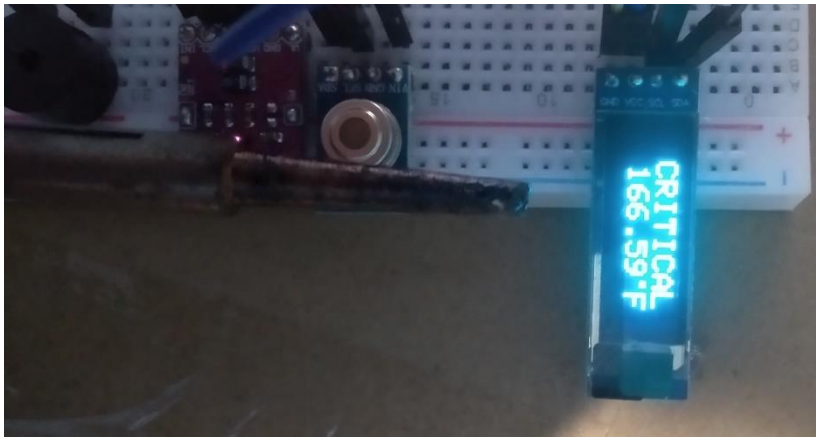

Figure 5.3: Temp above 100F

5.2 System Error Analysis and Processing:

Due to the following interruptions, the designed non-contact thermometer may create some measurement error.

Interference light. Since the device monitors body temp primarily via IR emitted from the object and any light outside the process can affect interference.

Ambient temp. The effect on the device increases as the atmospheric temperature rises.

Device is specifically focused on human body with a wavelength range of 2-4cm. It cannot work out with interference from additional object and light.

Precautions need to be taken to reduce major errors:

Many readings to be collected to determine precise result.

Go for measurement distance between 2cm and 4cm.

While monitoring the temperature make sure there is no interference of any other object.

Chapter: 6

ADVANTAGES AND DISADVANTAGES OF NON-CONTACT THERMOMETER

Advantages:

- Non-contact thermometer is good with surface measurements and could be measured from a distance for hot surfaces and materials or for food processing purposes where the products need not be effected or polluted.
- Due to memory and enhanced analysis capabilities of this thermometer, it is available for a wide range of applications. It is quick and simple to use. For example, moving parts can be monitored.
- Non-contact thermometer is a simple and easy process to monitoring the temp for a number of personal or work things. Their power light beam features enable customers to aim at any surface and easily identify their temp.
- Using this thermometer seems to be a reliable method to find cooking progress in food samples such as pork, sausage, and seafood, not touching the food and enabling heat and moisture to disperse.
- In cases where it would not be easy to monitor temp via conduction methods, such as in industrial applications with extreme temps and in complex mechanical without any direct easy accessibility, this thermometer is useful.
- This thermometer may be used for a number of purposes in the home including tracking room temp, soil temperatures, and maintenance work.
- The non-contact thermometer could also be used to test mechanical and electrical equipment for defects by monitoring their temp at heating points.
- Because of its non-contact functioning, this thermometer have a great advantage over contact measuring as they can reliably measure the temp of the targeted object with no direct contact. Many industrial processes benefit from this tech

- It is a thermometer that presumes the temp through a segment of the thermal radiation known the blackbody radiation produced by the subject getting measured. It is used in a wide variety of process industries, like minerals, metal and plastic
- It is capable of measuring temperature in conditions where the object is unstable or rotating, where the object may be tainted or affected by the contact and also where contact is impossible because of very high temp.

Disadvantages:

- Sudden increases in ambient temp and close to a radio frequency with an electric field power about 3 volts per meter or more can hinder non-contact thermometer.
- Non-contact thermometers are incapable of monitoring gases and liquid. Setting must be clear, free of dust, high humidity and other related factors.
- Surface probe readings of the same surface are assumed to be quite precise than non-contact thermometers as moisture, frost, rain, smoke, and other airborne contaminants may all have an influence on them.
- Results can be affected by the reflection of radiation from a hotter object, particularly near ambient tem, including that person who operates device.

CHAPTER-7

CONCLUSION

This project shows development of non-contact thermometer. We're competing against unknown viruses that increase transmission from one person to another day by day. So we need to preserve social space, even without touch, we need to determine body temperature. This project aims to build non-contact thermometer and to test temp with no contact. It is easy convenient, trustable and precise way to monitor temp and useful for screening fever in different workplaces. It can be also used in various home and industries application. In addition, especially in the medical field, the contactless thermometer is more beneficial in its use.

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APPENDIX

Code for interfacing arduino with sensors :

```
#include <Wire.h>
#include <SparkFun_APDS9960.h>
#include <Adafruit_MLX90614.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define OLED_RESET 4 // Reset pin
Adafruit_SSD1306 display(OLED_RESET);

SparkFun_APDS9960 apds = SparkFun_APDS9960();
uint8_t proximity_data = 0;
Adafruit_MLX90614 mlx = Adafruit_MLX90614();

void setup() {
  mlx.begin();
  apds.init();
  apds.enableProximitySensor(false); // Initialize APDS-9960
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  Serial.begin(9600);
```

```
}

void loop() {
  String temperature = "";
apds.readProximity(proximity_data);

  if (proximity_data == 255 && mlx.readObjectTempF() < 100) {
    display.clearDisplay();
    display.invertDisplay(false);
    display.setTextSize(2);
    display.setTextColor(WHITE);
    display.setCursor(8, 0);
    display.clearDisplay();
    display.println("Body Temp:");
    display.setCursor(25, 18);
    display.print(mlx.readObjectTempF());

    display.setCursor(85, 8);
    display.print(".");

    display.setTextColor(WHITE);
    display.setCursor(85, 18);
    display.print(" F");
```

```
  display.display();


  delay(1000);


}
if (proximity_data == 255) {
  if (mlx.readObjectTempF() > 102) {
    noTone(5); //
    tone(8, 523, 500);


    display.clearDisplay();
    display.invertDisplay(false);
    display.setTextSize(2);
    display.setTextColor(WHITE);
    display.setCursor(20, 0);
    display.clearDisplay();
    display.println("CRITICAL");


    display.invertDisplay(true);
    display.setTextSize(2);
    display.setTextColor(WHITE);
    display.setCursor(20, 0);
    display.clearDisplay();
```

```
display.println("CRITICAL");



display.invertDisplay(true);
display.setTextColor(WHITE);
display.setCursor(20, 0);
display.clearDisplay();
display.println("CRITICAL");



display.invertDisplay(false);
display.setTextSize(2);
display.setTextColor(WHITE);
display.setCursor(20, 0);
display.clearDisplay();
display.println("CRITICAL");

display.invertDisplay(true);
display.setTextSize(2);
display.setTextColor(WHITE);
display.setCursor(20, 0);
display.clearDisplay();
display.println("CRITICAL");
```

```
display.invertDisplay(true);
display.setTextColor(WHITE);
display.setCursor(20, 0);
display.clearDisplay();
display.println("CRITICAL");


display.invertDisplay(false);
display.setTextSize(2);
display.setTextColor(WHITE);
display.setCursor(20, 0);
display.clearDisplay();
display.println("CRITICAL");

display.setCursor(23, 18);
display.print(mlx.readObjectTempF());
display.setCursor(93, 8);
display.print(".");
display.setTextColor(WHITE);
display.setCursor(93, 18);
display.print(" F");
display.display();
```

```
    delay(1000);
   }

  }

  if (proximity_data == 255) {
   if (mlx.readObjectTempF() > 100) {

    display.setCursor(93, 8);
    display.print(".");

display.setTextColor(WHITE);
    display.setCursor(93, 18);
    display.print(" F");
    display.display();

   }
  }

  else if (proximity_data <= 255) {
   delay(1000);
```

```
    display.clearDisplay();
    display.invertDisplay(true);
    display.setTextSize(2.8);
    display.setTextColor(WHITE);
    display.setCursor(45, 1);
    display.clearDisplay();
    display.println("NOT");
    display.setCursor(17, 17);
    display.print("DETECTED");
    display.display();
    digitalWrite(5, LOW);

  }
}
```

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