JEEMECS (Journal of Electrical Engineering, Mechatronic and Computer Science ISSN 2614-4859
Vol. 5, No. 1, February 2022, pp. 7-18

Distributed Panel-based Fire Alarm Design

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Keywords
Arduino Nano
Temperature Sensor
Light Sensor
LVMDP

ABSTRACT

The shopping center switchboard system consists of a 20 kV cabinet to a 20 kV to 380 V step-down transformer, then provided to the user to control the newly upgraded LVMDP (low voltage main switchboard). Before distributing to users, you need to pay attention to the fixed power factor of the capacitor bank. Lack of an exemplary power factor will cause an inductive load on the capacitor bank, so high temperatures due to high limitations will damage the capacitor bank. A switchboard safety automation technology with a microcontroller control system has been proposed to complete this research. Microcontroller control system for switch safety includes Microprocessor (Arduino Nano), light sensor (LDR), temperature sensor (LM35DZ), LCD 16x2 I2C, actuator (fan, buzzer, three-phase network disconnect switch relay), switch (5 VDC relay), ADC As data input. The working principle of the microcontroller is: if the LM35DZ sensor detects the specified temperature, an alarm will be triggered. While the LDR sensor detects a spark, the Alarm will be initiated as a danger warning signal and cut off the power grid. Equipment designed to prevent switchboard safety caused by high temperatures or sparks can prevent fires.

1. Introduction

Electricity is one of the energy requirements and plays a vital role in everyday life. More and more equipment uses electricity [1]. The community needs this because it is very effective and helps the smooth running of daily activities [2]. However, there are still many problems with the security system. Users must control/check the power panel components manually to avoid these problems: a fire caused by high component temperatures [3] distribution board. Still, using the manual inspection system on the electrical control panel will decrease power efficiency during operation [4]. You can also use hand tools to check the switchboard, namely using an infrared thermometer to check the temperature conditions on the switchboard, which of course, will take a long time [5]. The 2014 report stated that three components of the LVMDP 1 (low voltage main switch) were damaged in the form of a capacitor bank [6]. Excessive temperature will cause the capacitor bank to explode, thus damaging the capacitor bank on the distribution board [7]. From the perspective of the difficulty of inspection and the safety level of switchboard personnel [8], it is necessary to develop a microcontroller automation system on the switchboard to facilitate the inspection process and the safety system [9]. Using the Arduino Nano microcontroller as the primary sensor controller and actuator to run on the distribution board, the overheat detection sensor using the LM35DZ and the fire detector using the LDR are designed to simplify personnel inspection and prevent electrical fires safely [10].

Based on the background conclusions above, the problem that must be resolved is how to make a device that can prevent the switchboard from burning due to high temperatures and sparks and avoid fires to improve operation and safety [11].

The limitations of the problem in this study are as follows: This system is used on a switchboard to detect sparks with a temperature range of> 35 ° C,> 50 ° C,> 70 ° C and> 90 ° C [12], and displays

the results on an I2C 16x2 LCD [13]. The sensor used by the LDR (photosensitive resistor) is used as a light detection sensor, and the LM35DZ is used as a temperature measuring sensor [14].

This research aims to promote microcontroller automation to check conditions and improve the quality of the switchboard safety device, thereby stabilizing high temperatures and preventing ignition sources [15].

2. Method

2.1 The System Design

In this system, the installation is divided into two areas, and the installation method used is the "cross-area" method. When displayed, the fire alarm can be divided into two types of phases of fire alarm indication, viz:

a. Alarm phase 1 [single area].
   Suppose the detector unit in one of the areas detects smoke particles [16]. The function of this stage is that the multi-tone will produce a short intermittent sound, and the "immediate evacuation area" indicator will light up. The FM-200 purge gas barrier has not been removed [17].

b. Phase 2 alarm (cross-region).
   If detectors in other areas also detect the presence of smoke particles later, there are now two or more detectors in the two active regions, and this state is also called the ALARM-2 stage. Some sounds will produce intermittent sounds for a long time at this stage, and the "area to be evacuated" indicator will light up [18].

Then, the control panel will send a signal to turn off the A / C, and the system will start calculating a 30-second delay. Then, FM-200 gas will be released outdoors together with the alarm bell, and the outdoor "exhaust" light will also light up [19].

However, if you press and hold the "Cancel" button, the delay count will stop at 10 to 0 seconds so that no fuel will be released. When you release the "Stop" button, the countdown timer will count down again from 10 seconds [20].

2.2 Diagram Block System

Before assembling the tool, it is necessary to design a power distribution board safety device based on the Arduino Nano. The image below shows a design tool design. Figure 1 above is a block diagram of the Arduino Nano-based power distribution board safety equipment block. The various parts of the block above can be explained as follows:

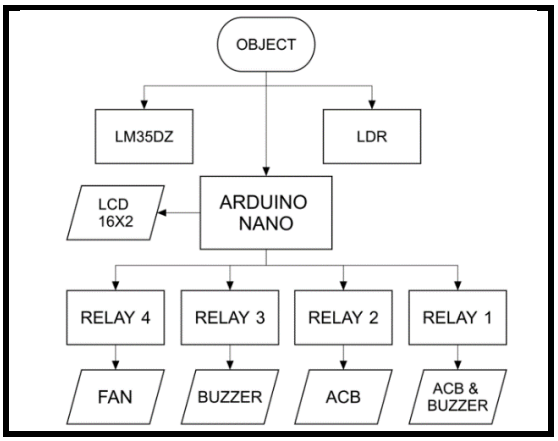

Fig. 1. Block Diagram System

a. Use an object as an object/target panel to measure temperature and light intensity;
b. LM35DZ is used as a temperature measuring sensor in the panel;
c. LDR is used as a light/fire sensor on the panel;
d. Arduino nano is used as an analog signal processing microcontroller for the LM35DZ and LDR, then digitized into measurement data via the ADC;

e. The relay is used as a connection access switch for operating actuators (fan, buzzer, three-phase network circuit breaker control);
f. When the temperature is higher than the normal level> 35° C, the fan is used as an exhaust fan to dissipate heat in the panel;
g. The alarm bell is used as a warning alarm;
h. LCD I2C 16x2 can display the LM35DZ temperature measurement results;
i. The microcontroller and fan power supply require a 5-12 VDC power supply;
j. Power 220 VAC, used for power input/com power, buzzer, ACB safety control network circuit breaker (R S T).

2.3 Flowchart System

When designing a program in software, a tool system flow chart must be developed first to facilitate programming. The tool system flow diagram of the program to be created is as follows:

Figure 2 The system flow diagram is designed for the Arduino nano microcontroller working tool. The various parts of the system flow chart are described as follows:

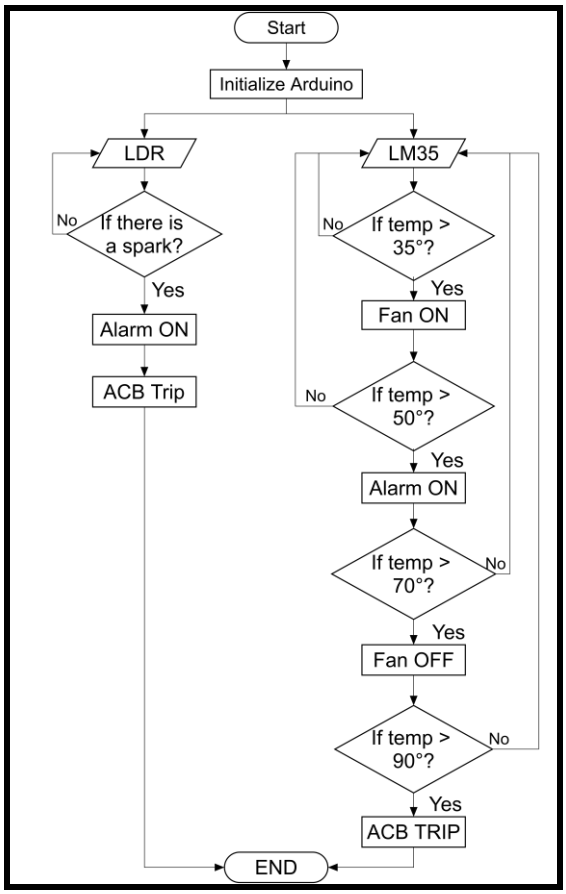

Fig. 2. Flowchart System

a. Start Arduino Nano and make it stand on the target (object);
b. When receiving input from the temperature sensor, Arduino Nano can provide input;
c. When the temperature range is> 35 °C on the temperature sensor when the temperature is <33 ° C, the fan will turn on and off;
d. If the temperature range is> 50 °C, the Alarm on the temperature sensor will be activated, and when the temperature is <40 °C, the Alarm will be off;
e. If the temperature range is> 70 °C, the fan on the temperature sensor will be turned off. If the temperature range is <70 ° C and the temperature range is> 90 ° C, the fan will be turned on. The opening temperature of ACB and ACB Travel is lower than 65 degrees Celsius;
f. When receiving input from the LDR light sensor, Arduino Nano can provide input.

When a spark is detected in the LDR light sensor, the Alarm will be activated. The three-phase power distribution network isolation switch relay will work on the distribution board. The system

design method is first to make a system block diagram and flow chart of the tools above, then do software design, including Arduino software design, LM35DZ temperature sensor circuit, light sensor (LDR), relay module, and 16x2 fluid. Display the Arduino Nano Board crystal, then run the experiment and test tools, then you can analyze the data obtained.

2.4 Software Design (Software)

Supporters use several supporting software (software) for research, including:

g. Software Arduino IDE
Please use the Arduino software to program the Arduino Nano microcontroller hardware through the C language program when designing the program. The program in the software is compiled into the hardware via a USB communication cable with the * hex file format. Figure 3 shows the appearance of the Arduino IDE 1.8.11 software.

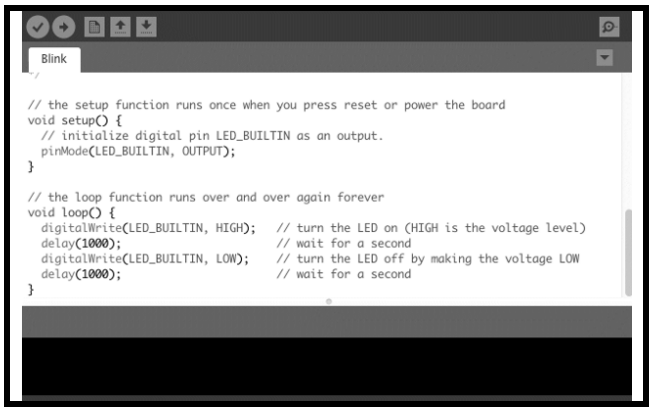

Fig. 3. Display Arduino IDE 1.8.11 Software

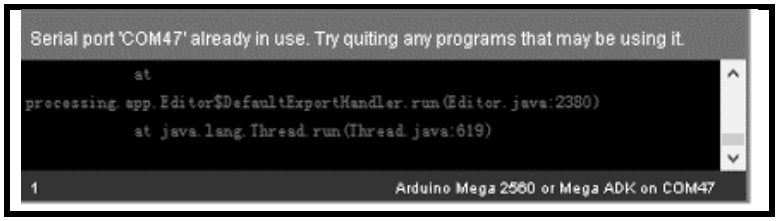

Fig. 4. Display errors in the Arduino IDE program

If there are errors in the compiled program, an error symbol will be displayed at the bottom of the list of programs being created. This can be seen in Figure 4.

2.5 Circuit of LM35DZ Temperature Sensor

Using the Arduino Nano module to convert analog signals to digital signals, the LM35DZ temperature sensor port design for an analog input is converted to ADC, and digital signals are connected to the output. Figure 5 is a series of LM35DZ temperature sensors with Proteus software.

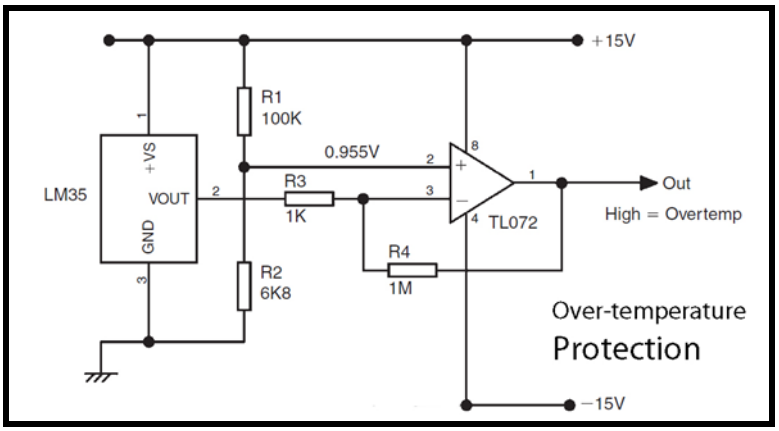

Fig. 5. LM35DZ Temperature Sensor Circuit

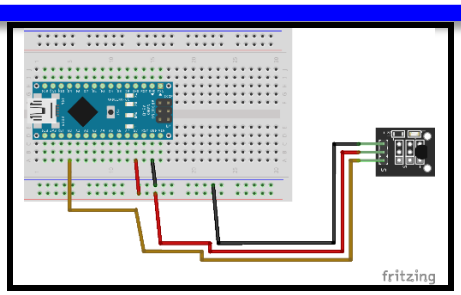

Fig. 6. The LM35DZ circuit on the Arduino Nano pin

When designing the LM35DZ temperature sensor circuit, this Arduino module circuit uses the following pins:

h. Pin A0 / ADC0 = connected to the output LM35DZ;
i. Pin D9 = connect to relay module 4 Turn on the fan;
j. (When the temperature is> 35 ° C, the fan is turned on; when the temperature is <33 ° C, the fan is turned off; when the temperature is> 70 ° C, the fan is turned off);
k. Pin D10 = connect to relay module 3 Set an alarm Pay attention to the temperature (when the temperature is> 50ºC) Alarm on and off <40ºC);
l. Pin D11 = connect to relay module 2 ACB circuit breaker (when temperature> 90ºC Alarm on and off <65ºC).

2.6 Light Sensor Circuit (LDR)

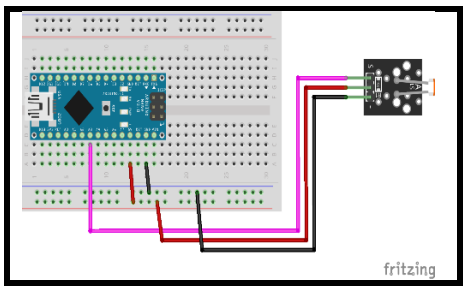

Fig. 7. The LDR circuit on the Arduino Nano pin

Equipment that uses an LDR sensor is used as a light/spark sensor on the switchboard to prevent ignition sources. The LDR operates the fire alarm by providing output to the digital port pin D12 and disconnecting the three-phase ACB network, and receives input and output of the light/spark intensity in the form of a resistor. That is, it is connected to the A3 connection. / ADC3 pin. Arduino Nano. 220 VAC is required to operate the buzzer or three-phase circuit breaker on the switchboard.

2.7 Relay Module

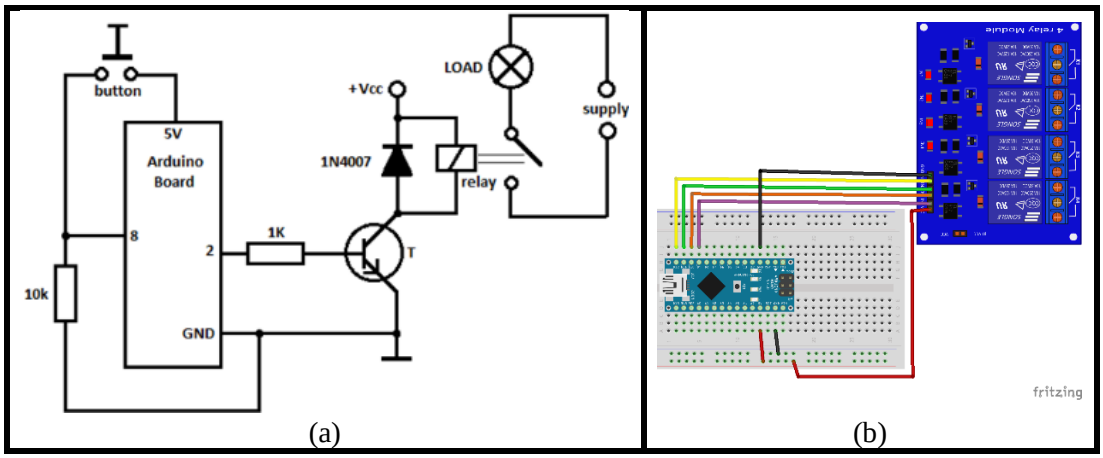

Fig. 8. (a) Relay Schematic, (b) The 4 module relay circuit on the Arduino Nano pin

The relay module used is a 5VDC relay with a power of 10 amperes. Figure 7 This is a schematic diagram of the relay circuit in Proteus. When making this tool, the actuator cannot be

directly connected to the Arduino nano via pins D9, D10, D11, and D12. Therefore, the actuator switch must be operated in a relay module 4, a fan switch, a high-temperature alarm switch on relay module 3, an ACB circuit breaker when relay module 2 overheats, and an alarm one on a three-phase ACB network. Send—modular equipment, circuits, and switchboards that can trigger fire alarms.

2.8 Temperature Sensor Indicator (LCD 16 x 2)

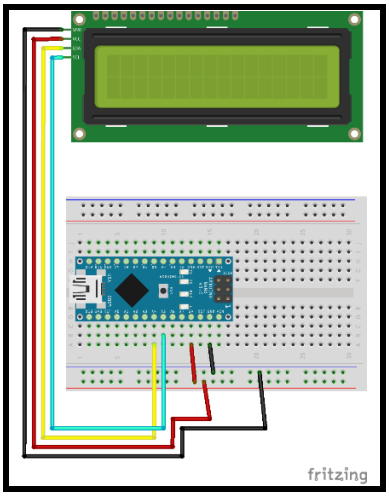

Fig. 9. The Lcd 16x2 I2C circuit on the Arduino Nano pin

There must be an indicator in an I2C 16x2 LCD to find out the LM35DZ temperature sensor process results. This indicator displays the measurement results to understand the current temperature conditions. SDA and SCL pins on the 16x2 I2C LCD receive signal data from A4 / ADC4 A5 / ADC5 pins on the Arduino Nano. SDA pins are connected to A4 / ADC4 pins, and SCL pins are connected to A5 / ADC5 pins. The 16x2 I2C LCD circuit is as follows.

2.9 Board Arduino Nano

When designing this series of Arduino modules, the pins used are as follows:

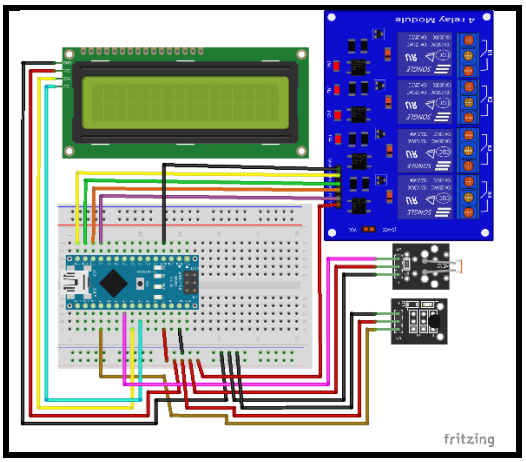

Fig. 10. The Fire Alarm circuit on the Arduino Nano pin

a. Pin A0 / ADC0 = connect to the LM35DZ sensor Used for input;
b. Pin A3 / ADC3 = connect to the LDR sensor Used for input;
c. Pin A4 / ADC4 = connect to the LCD 16 x 2 I2C for Serial Data Line;
d. Pin A5 / ADC5 = connect to the LCD 16 x2 I2C for Serial Clock Line;
e. Pin D12 = connect to relay module 1 warning Fire alarms and switches ACB network circuit breaker Three-phase power;
f. Pin D11 = connected to relay module 2 for ACB isolation switch Three-phase grid When the temperature rises;
g. Pin D10 = connect to relay module 3 for buzzer (Alarm);
h. Pin D9 = connect to relay module 4 for the fan.

3. Results and Discussion

3.1 Testing the Power Supply 5-12VDC

The purpose of testing a power supply is to ensure that the power supply can also operate normally. This is a schematic diagram of the power supply, as shown in Table 1.

Table 1. Testing the Power Supply 5-12VDC

No.	Experiment	Output Voltage		Testing				All Voltage	
		5 VDC	*12 VDC*	*Without Load*		*With Load*		*5 VDC*	*12 VDC*
1	1	5	12	5	12	4	9	1	3
2	2	5	12	5	12	4	9	1	3
3	3	5	12	5	12	4	9	1	3

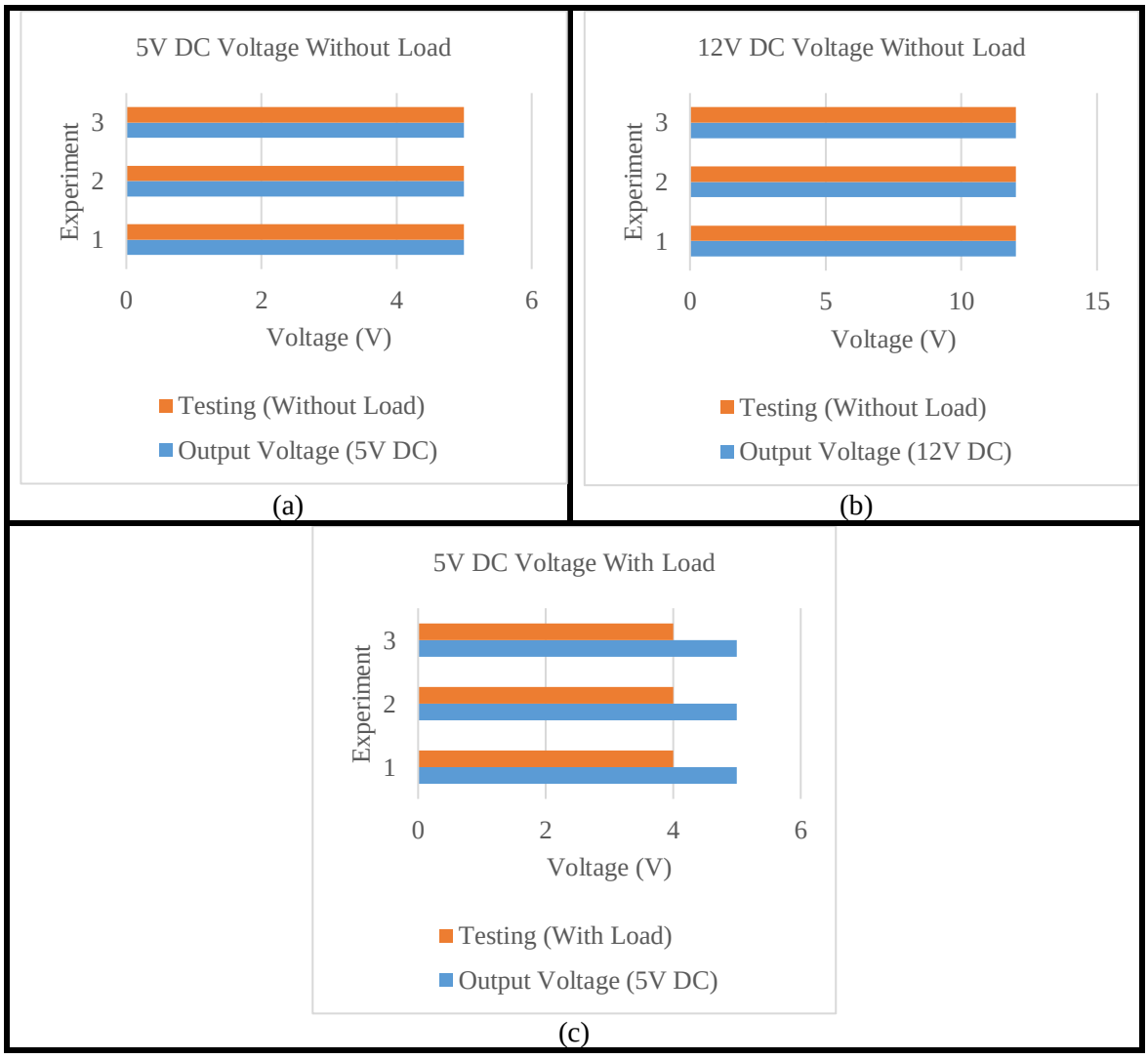

Fig. 11. (a) Comparison graph between the 5V DC output voltage to the experimental voltage at no load, (b) Comparison graph between the 12V DC output voltage to the no-load experimental voltage, (c) Comparison graph between the 5V DC output voltage to the experimental voltage with the load.

Figure 11 (a) and Figure 11 (b) above show that the voltage remains stable at 5V and 12V when the power supply is not burdened or without load, which was carried out three times.

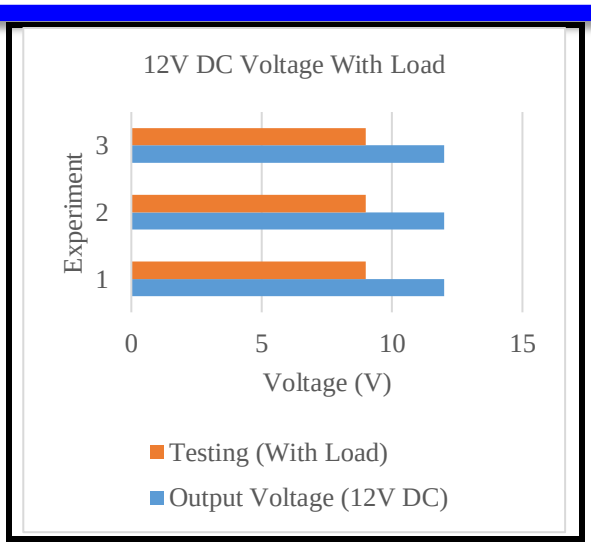

Fig. 12. Comparison graph between the 5V DC output voltage to the test voltage with the load

Figure 11 (c) and Figure 12 above show that the voltage drops when it is loaded, or there is a load. The 5V power supply delivers the voltage drops to 4V when under load. The 12V voltage also decreases to 9V when underloading.

3.2 Testing Relays

Table 2. Relay testing 1, 2, 3 and 4

No.	Port Arduino Nano	Arduino Program Logic				Relay Status				Error (%)
		RL1	*RL2*	*RL3*	*RL4*	*1*	*2*	*3*	*4*	
1	12	HIGH	LOW	LOW	LOW	1	0	0	0	0
2	11	LOW	HIGH	LOW	LOW	0	1	0	0	0
3	10	LOW	LOW	HIGH	LOW	0	0	1	0	0
4	9	LOW	LOW	LOW	HIGH	0	0	0	1	0

Perform the relay test to check whether the relay works as planned. The following are the relay test results, as shown in Table 2.

3.3 Testing the LM35DZ Sensor on the Arduino Nano

Test the LM35DZ sensor on the Arduino Nano to determine which sensor is working correctly. AS SHOWN IN THE IMAGE BELOW, the LM35DZ calculation formula can also be proven and tested. , as in

$$Vout=Vin*°C \quad (1)$$

$$Vout=10mV* °C$$

So 32 ° C The calculation result of Vout (320mV) divided by Vin (10mV).

3.4 Testing the LDR Sensor on the Arduino Nano

Test the LDR sensor on the Arduino Nano to find out if the sensor works. The test results can be seen in Table 3 below.

Table 3. Relationship of Light Intensity and Voltage (Input 5 VDC)

No.	Light Intensity	Voltage (V)	Resistance (kΩ)
1	Dark	4.8	1
2	Dim	3.4	0.4
3	Light	1.9	0.2

Graph The following is a graph of the results of the relationship between light intensity and voltage:

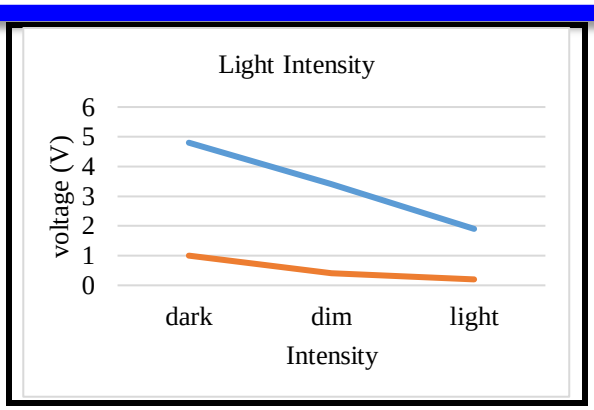

Fig. 13. Graph of the Relationship of Light Intensity and Voltage

3.5 Discussion

Based on the conclusions drawn, there are several suggestions when designing and testing this tool, including some recommendations: Design of power distribution panel safety device to select more sensitive and accurate sensor.

Fire alarm manipulates panels carry out a considerable variety of life-saving and property-shielding tasks. Some prompt hearthplace suppression or hearthplace sprinkler structures, while others don't. Some transmit a sign used to alert first responders, while others sound alarms in or across the construction. Every hearthplace panel is an intermediary among gadgets that look ahead to dangers and devices that alert human beings to hazards or issues with hearthplace safety structures.

Here's how that works: while a hearthplace starts, a smoke detector, warmness detector, hand-activated pull transfer, or guide name factor sends a sign to a hearthplace panel. Fire sprinkler structures geared up with a floating transfer or alarm strain transfer – gadgets designed to stumble on sprinkler activation – also can transmit a sign to the panel. At the same time, water starts off evolving to float thru an activated sprinkler machine.

The hearthplace alarm manipulates panel responses to any of those indicators with the aid of lighting fixtures up or making noise, activating nearby bells or different hands, and sending a sign to hearthplace officers or a non-public tracking agency tasked with notifying the authorities.

Many of those panels aren't geared up to prompt or ship water to hearthplace sprinkler heads, which commonly prompt separately in reaction to growing ambient temperatures. However, panels set up with a few deluge sprinkler structures, for example, can open or near a deluge valve, which lets in hearthplace suppressant to be dispensed to many sprinkler heads simultaneously. In a few centers, panels for hearthplace alarm structures move even further, locking or unlocking doorways, disabling elevators, turning off the electricity, or shutting off or turning on ventilation.

Fire panels also can be incorporated with constructing control structures and protection structures. In those cases, the capabilities of a hearthplace panel take precedence over the alternative formats, and "the alternative structures can not intrude with the operation of the hearthplace alarm." For example, suppose a get admission to manipulating machine locks down positive outer doorways in construction because of an outside protection threat. In that case, that command could want to be overridden withinside the occasion of a hearthplace evacuation.

Except for carbon fire extinguishers (fire extinguishers) which use rotary tools/actuators. A new system has been added to assist Android and other operations better. An odor sensor has been added to feel sound when the connectors/components on the power distribution panel contact prioritizing the results of tools, making tools easier to use and more sensitive to safety to avoid fire.

4. Conclusion

a. Based on the analysis, design, and testing of this tool, it can be concluded that, among others, the following: Based on the LM35DZ sensor test results, the measurement results obtained are based on the LM35DZ sensor output voltage, if the output voltage increases, the temperature reading is

also high, and if the temperature drops, the voltage drops. The temperature ratio at 1 ° C is equal to 10 mV;

b. The results of LDR sensor testing can be concluded that the brighter the sensor, the lower the resistance value and the darker the resistance value;
c. The Arduino Nano microcontroller processing system can process data from the LM35DZ sensor and then issue commands to run the fan and buzzer in high-temperature conditions;
d. The processing system on the Arduino Nano microcontroller can process data from the LDR sensor and then issue commands to the relay so that the buzzer continues to operate in the event of a fire.

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