JURNAL TEKNOLOGI DAN OPEN SOURCE
Vol. 8, No. 2, December 2025, pp. 763~775
e-ISSN: 2622-1659, accredited Four Grade by Kemenristekdikti, Decree No: 152/E/KPT/2023
DOI: https://doi.org/10.36378/jtos.v8i2.5012

Design of Automatic Fan Base On Arduino Uno Microcontroler And DHT11 Sensor

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Article Info

Article history:

Received 10 30, 2025
Revised 11 20, 2025
Accepted 12 12, 2025

Keywords:

Arduino uno
DHTII sensor
Fan
Microcontroller
Temperatur and humadity

ABSTRACT

The temperature of the human body can fluctuate depending on environmental conditions, particularly the surrounding room temperature. To maintain comfort, a cooling device capable of providing adequate airflow is required, and one commonly used solution is an electric fan. This study focuses on designing and implementing an automatic fan system controlled by an Arduino Uno microcontroller and a DHT11 temperature sensor. The system is programmed to activate the fan automatically when the detected room temperature exceeds a predetermined threshold. In the design phase, the Arduino Uno functions as the core controller due to its ability to process sensor input and manage hardware operations efficiently. The DHT11 sensor measures both temperature and humidity, transmitting the data to the microcontroller, which then delivers a control signal to the relay module. Following the design stage, system implementation is carried out using the C++ programming language through the Arduino IDE. The program continuously reads temperature values from the DHT11 sensor, enabling real-time decision-making. When the temperature reaches the specified limit, the microcontroller triggers the relay, causing the fan to operate automatically. The results of this study show that the fan responds accurately to temperature changes, providing a practical automatic cooling solution.

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1. Introduction

In today's modern lifestyle, the use of fans has become an essential part of maintaining a comfortable indoor environment. Fans are not only utilized to circulate air and reduce room temperature but also serve an important role in preventing electronic devices such as computers and laptops from overheating [1]. Overheating can lead to reduced performance and a shorter lifespan of these devices, making effective cooling solutions highly necessary. Thus, the presence of an efficient and responsive fan system is crucial to ensure both comfort and protection of electronic equipment.

Despite their usefulness, traditional fans still present several limitations in daily use. Common issues include constant noise generation, lack of flexibility in adjusting rotation speed, and the need for manual control. These weaknesses often lead to energy inefficiency and user inconvenience[2]. Therefore, to overcome such drawbacks, there is a growing need for a more intelligent and adaptable fan system that can respond automatically to environmental changes without requiring frequent user intervention.

The integration of microcontroller-based systems offers a promising approach to improving fan performance. By incorporating a DHT11 temperature and humidity sensor and an Arduino Uno microcontroller, the fan can automatically regulate its speed according to the surrounding temperature and humidity levels. This automation allows the fan to operate more efficiently, ensuring optimal air circulation and energy savings. Additionally, it reduces human effort in manually adjusting the fan while maintaining a comfortable room condition.

Based on these considerations, this study aims to design and construct an automatic fan system that responds to changes in temperature and humidity using a DHT11 sensor, controlled through an Arduino Uno microcontroller. The goal of this project, titled **"**Design and Construction of an Automatic Fan Based on Arduino Uno Microcontroller and DHT11 Sensor**,"** is to develop a more advanced and energy-efficient cooling device. Through this innovation, the fan is expected to provide better environmental comfort, reduced noise levels, and improved energy management compared to conventional systems.

2. Research Method

2.1 Definition of System

There are several expert opinions defining the system, namely those that emphasize elements or components, there are also procedures based on the thinking of one of them, according to system is: a network of interconnected procedures, gathered together to perform an activity or complete a specific target. In general, the understanding of the system can be defined that the system is a group of elements that interact with the same intent and purpose to achieve the goal. The model of a system consists of input processing and output or often called input, process and output [3].

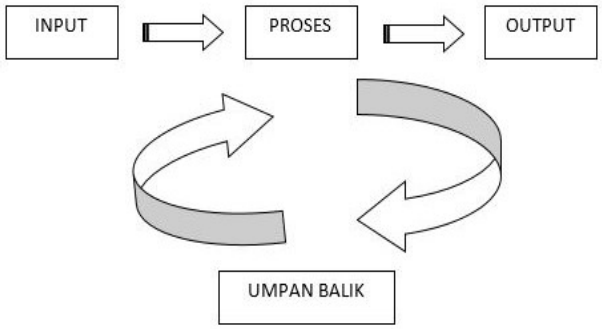

Figure 1 System Components

2.2 Fan

Fan convert electrical energy into mechanical energy and kinetic energy. Fans are generally used for air conditioning, air fresheners, ventilation (exhaust fans), dryers (generally using heat-producing components)[4]. Fans are also found in vacuum cleaners and various ornaments for room decoration. Fans are generally distinguished between traditional fans, including hand fans and electric fans that are driven using electricity. The current series of fans have various variations in terms of size, positioning, and use. The size of the fan starts from a mini fan (an electric fan that is held by hand using battery power). Fans are also used in computer CPUs to cool the processor, graphics card, power supply and casing. The fan functions to maintain the air temperature so that it does not exceed the set temperature limit. Fans are also installed on laptop bases or stands (cold pads) [5].

2.3 Temperature Sensor

The temperature sensor functions to detect the temperature in the room so that it can determine when the fan will turn on and when the fan will turn off [6]. A more precise definition states that temperature is a measure of the speed of motion of particles in an object or the average kinetic measure of particles in an object. To measure temperature in everyday life, people tend to use the sense of touch. However, in today's modern world, measuring temperature can be done easily, namely by using a sensor. One of the temperature sensors that is often used is DHT11. There are several temperature and humidity sensors that are generally used, namely*:*

2.3.1 DHT11

The DHT11 sensor is a sensor module that functions to read temperature and humidity objects that have analog voltage output and can be further processed using a microcontroller [7]. DHT 11 functions to measure indoor temperature, has the ability to read temperature levels and also humidity supported by a Negative Temperature Coefficient (NTC) thermistor measuring device that can be used at temperatures of −55°C to 200°C. The DHT11's ability to measure temperature and humidity is also equipped with a small production cost (low cost) but has a fast response rate to an 8-bit microcontroller. This sensor has 4 pin legs, and there is also a DHT11 sensor with a PCB breakout which only has 3 pins.

a. Input voltage: 5 Vdc
b. Temperature range:0-50°C error ±2°C
c. Humidity :20-90% RH ± 5% RH error

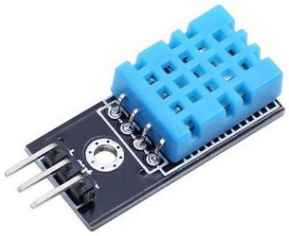

Figure 2 DHT11 Sensor

2.3.2 DHT22

DHT22 is a digital sensor of relative humidity and temperature. The DHT22 sensor uses a capacitor and a thermistor to measure the surrounding air and outputs a signal on the data pin.[8] DHT22DHT 22 or also known as AM2302 is a sensor equipped with an 8bit single chip that functions to calibrate data to achieve a level of accuracy according to the coefficient of the memory chip. The output of the DHT22 is a digital signal of temperature and humidity measurements with a wide range of coverage and is supported by a calibration coefficient in the memory chip making the DHT22 very suitable for use in open areas[9].

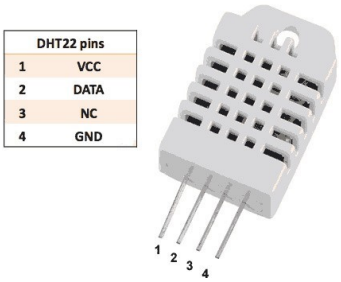

Figure 3 Physical Appearance and Configuration of DHT22

2.3.3 IC LM35

IC LM35 is a sensor in the form of an IC that has high accuracy[10]. LM 35 is used as a basic temperature sensor as shown in Figure 5

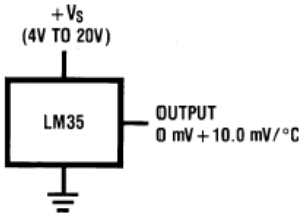

Figure 4 LM 35 Basic Temperature Sensor

2.3.4 PIR Sensor

The PIR (Passive Infra Red) sensor module is a sensor that functions as a motion detector that works by detecting differences or changes in current and previous temperatures [11]. Motion sensors using the PIR module are very simple and easy to apply because the PIR module only requires a DC 5V input voltage which is effective enough to detect movement up to a distance of 5 meters [12]. When not detecting movement, the module output is LOW. And when it detects movement, the output will change to HIGH. This sensor has three pins including.

VCC : Voltage source
GND : Ground
OUT : Output (high and low logic)

Figure 5 PIR Sensor

2.4 LCD (Liquid Crystal Display)

LCD (Liquid Crystal Display) is an electronic component that functions to display numbers, letters or other symbols . In addition, LCD can also be used to display characters or images. In Figure 6 is the form of LCD[13].

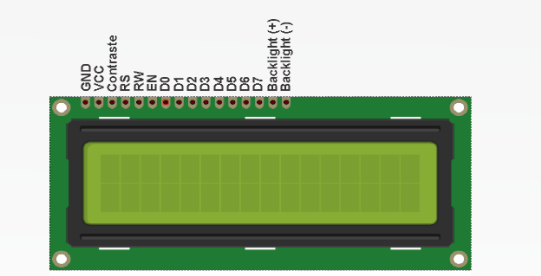

Figure 6 LCD

The following is a table that explains the pin configuration of a 16x2 LCD:

Table 1. 16 x 2 LCD Pin Configuration

Pin	Symbol	Level	Objective	Function
1	Vss	-	*Power Supply*	*Ground*
2	Vdd	-	*Power Supply*	Supply Voltage
4	RS	H/L	uC	H: Data; L: Instruction Code

5	R/W	H/L	uC	H : Read; L : Write
6	E	H/L	uC	*Enable*
7	DB0	H/L	uC	Bus Line Data
8	DB1	H/L	uC	Bus Line Data
9	DB2	H/L	uC	Bus Line Data
10	DB3	H/L	uC	Bus Line Data
11	DB4	H/L	uC	Bus Line Data
12	DB5	H/L	uC	Bus Line Data
13	DB6	H/L	uC	Bus Line Data
14	DB7	H/L	uC	Bus Line Data
15	V+BL	-	uC	Supply voltage
16	V+BL	-	uC	*Ground*

2.5 Arduino

Arduino is the name of a family of microcontroller boards originally created by the company smart projects. One of its creators is Massimo Banzi. This board is an "open source" hardware so that anyone can make it. Arduino was created with the aim of facilitating experiments or the realization of various microcontroller-based equipment[14].

2.6 Arduino UNO

Arduino Uno is a microcontroller board based on ATmega328 (datasheet). It has 14 input pins from digital output where 6 input pins can be used as PWM output and 6 analog input pins, 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. To support the microcontroller to be used, simply connect the Arduino Uno Board to the computer using a USB cable or electricity with an AC-to-DC adapter or battery to run it [15].

Figure 7 Arduino Uno

2.7 Arduino Due

The Arduino Due is a microcontroller board based on the Atmel SAM3X8E ARM Cortex-M3 CPU. The Arduino Due is the first Arduino board based on a 32-bit ARM core microcontroller [16]. It has 54 digital input/output pins (12 of which can be used as PWM outputs), 12 analog inputs, 4 UARTs (hardware serial ports), an 84 MHz clock, a USB OTG connection, 2 DACs (digital to analog), 2 TWIs, a power jack, SPI header, JTAG header, reset button and erase button [17].

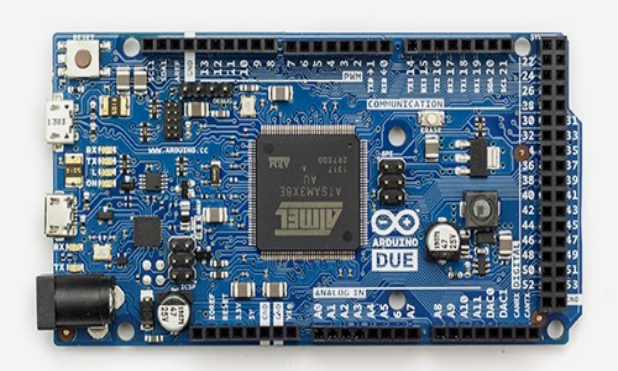

Figure 8 Arduino Uno

2.8. Arduino Mega

The Arduino Mega is a microcontroller board based on the Atmega2560 [18]. It has 54 digital input/output pins (15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button[19][20]. It contains everything needed to support the microcontroller, simply connect to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started [21]. The Mega 2560 board is compatible with shields designed for the Uno and former Duemilanove or Diecimila boards. The Mega 2560 is an update to the Arduino Mega, which it replaces.

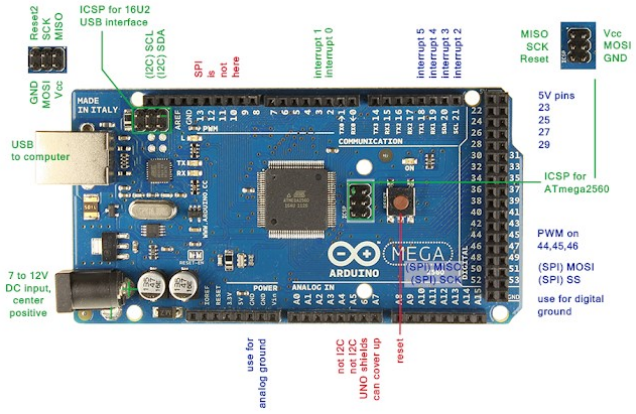

Figure 9 Arduino Mega

2.9. Arduino Nano

Arduino Nano is one of the microcontroller development boards that is small, complete and supports the use of breadboards. Arduino Nano is created with the basis of the Atmega328 microcontroller (for Arduino Nano version 3.x) or Atmega 168 (for Arduino version 2.x) [22]. Arduino Nano has more or less the same function as Arduino Duemilanove, but in a different package. Arduino Nano does not include a DC plug of the Barrel Jack type, and is connected to a computer using a USB Mini-B port. Arduino Nano is designed and manufactured by the company Gravitech [23].

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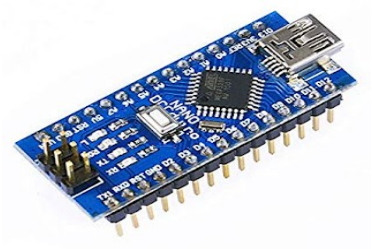

Figure 10 Arduino Nano

2.10. Arduino IDE

IDE stands for Integrated Development Environment, or in simple terms, an integrated environment used to do development [24] [25]. It is called an environment because through this software Arduino is programmed to perform functions embedded through programming syntax [26]. Arduino uses its own programming language that resembles the C language[27].

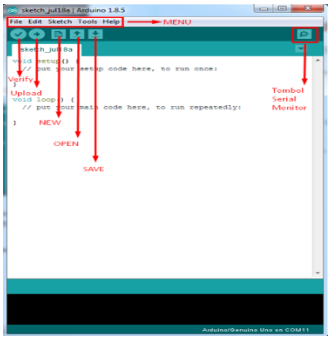

Figure 21 Arduino IDE

2.18. Relay

Relay is a device that works based on electromagnetism to move a number of arranged contactors or an electronic switch that can be controlled from other electronic circuits by utilizing electrical power as its energy source. The contactor will be closed (on) or open (off) due to the magnetic induction effect produced by the coil (inductor) when it is supplied with electric current [28]. Unlike a switch, the movement of the contactor (on or off) is done manually without the need for electric current. The system utilizes a microcontroller capable of receiving input from the remote and the process then sends that data to activate the relay so that electronic devices can be controlled.

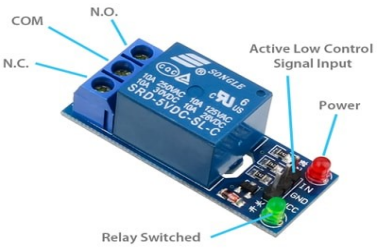

Figure 12 Relay

Arduino and Relay Structure consists of 3 main parts, namely:

a. *Common,*is the part that is connected to Normally Close (in normal conditions).
b. The coil is the main component of the relay which is used to create a magnetic field.
c. Contacts, consisting of Normally Close and Normally Open.

˙ d. There are two types of relays that can be obtained, namely the input works on direct current and the one that works on alternating current. In general, the relay used in the circuit is the one that works on DC voltage.

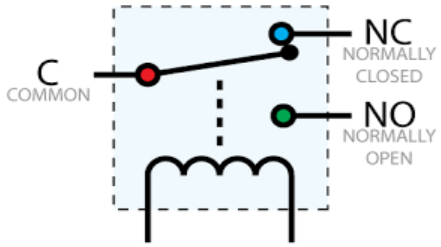

Figure 33 Relay Construction

3. Result and Discussion

3.1 System Analysis

This system aims to automatically control the fan in a room or bedroom. How this system works is that the sensor will detect the temperature and humidity of the room after that the information from the sensor is processed by the Arduino then the information that has been obtained is sent to the relay to turn the fan automatically if it has passed the specified temperature. Then the information will be displayed on the 16x2 LCD. This system can provide a display of room temperature, room humidity and the state of the fan on or not.

3.2 System Requirements Analysis

This system requirements analysis discusses the needs*software*and hardware needed to build a system that fits the designed function. The following are the system requirements needed:

1. Software
   *Software*what is needed to make an automatic fan based on an Arduino Uno microcontroller and DHT 11 sensor as follows:
   a. Arduino IDE: Processing software used to write programs into Arduino.
   b. *Library*Arduino IDE: a collection of basic Arduino program codes packaged to give commands to a component so that it works according to its function.
2. Hardware
   *Hardware*what is needed in making an automatic fan based on a microcontroller and DHT 11 sensor as follows:
   a. Arduino Uno
   b. DHT11 temperature sensor
   c. LCD 16x2
   d. I2C
   e. Relay 1 channel
   f. Adapter
   g. Jumper pins
   h. Laptop
   i. Fan

3.3 System Design

3.3.1 Hardware Design

In this hardware design, the assembly of hardware that will be used in making this system will be discussed. The devices or tools used in making an automatic fan based on a microcontroller and DHT 11 sensor consist of Arduino Uno, DHT11 sensor, Relay, LCD, Adapter and fan. The stages of assembling the tool will be explained in the block diagram as follows:

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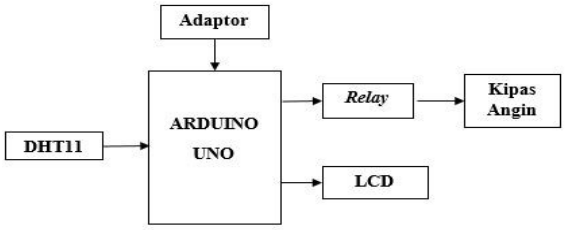

Figure 14 Microcontroller Circuit Block Diagram

3.3.2 Relay Circuit Design

*Relay*5V with 1 output channel. Can be used as an electronic switch to control large voltages and currents. On the Relay there are 3 Connection pins, the Black Cable is connected to the ground pin on the Arduino, the Red Cable is connected to the 5V pin on the Arduino as a power supply, the Orange Cable is connected to the digital pin 8 as a data transmission.

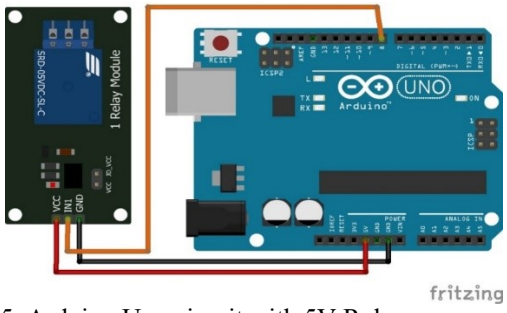

Figure 15 Arduino Uno circuit with 5V Relay

3.3.3 Overall Network Design

The system device starts from the installation of DHT11 connected to Arduino Uno which is used for reading room temperature and humidity. Next, the installation of the relay as a switch to turn the fan on and off automatically, then the installation of the LCD as a provider of information on what has been read by DHT11.

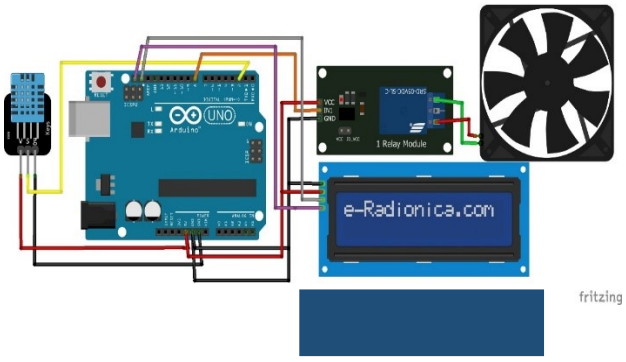

Figure 16 Whole System Circuit

3.3.4. Temperature Sensor Testing

Sensor testing aims to ensure that the sensor that has been made is as expected, by observing the output produced by the DHT11 sensor which can be observed by utilizing the tools available on the Arduino IDE, the observations that will be made are as in Figure 23.

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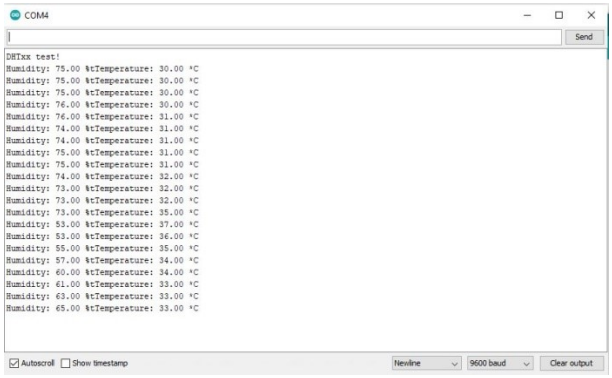

Figure 17 Whole System Circuit

Table 1 Temperature Sensor Test Results

No	Rules		It is expected	Fact	Information
	Temperature	Humidity			
1	15 ˚C	35% RH	Dead	Dead	In accordance
2	22 ˚C	34% RH	Dead	Dead	In accordance
3	27 ˚C	34% RH	Dead	Dead	In accordance
4	34 ˚C	23% RH	Light up	Light up	In accordance
5	41 ˚C	22% RH	Light up	Light up	In accordance
6	17 ˚C	41% RH	Dead	Dead	In accordance
7	27 ˚C	32% RH	Light up	Light up	In accordance
8	30 ˚C	51% RH	Dead	Dead	In accordance
9	32 ˚C	57% RH	Light up	Light up	In accordance
10	41 ˚C	52% RH	Light up	Light up	In ccordance
11	16 ˚C	75% RH	Dead	Dead	In ccordance
12	29 ˚C	72% RH	Dead	Dead	In accordance
13	26 ˚C	67% RH	Dead	Dead	In accordance
14	32 ˚C	65% RH	Light up	Light up	In accordance
15	39 ˚C	76% RH	Light up	Light up	In accordance

From the results of the tests that have been carried out, the aim is to test the temperature sensor that has been made on the Arduino Uno Microcontroller Based Automatic Fan and DHT11 Sensor, and data analysis has been carried out, the results obtained are that the temperature sensor that was made is able to work with an accuracy of 97%, after being calibrated with a room temperature thermometer which can be seen in the image below.

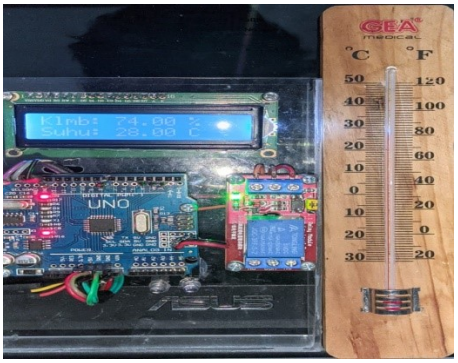

Figure 18 Calibration of Room Temperature Thermometer with DHT11

3.3.5 System Testing

This automatic fan system testing is carried out to ensure that the hardware components that have been assembled can run and work properly on the prototype automatic fan based on the Arduino microcontroller and DHT11 sensor and to ensure that the temperature sensor that has been made can work as expected. The testing method is to observe the temperature and humidity readings from the DHT11 sensor so that it can be processed by the Arduino and provide a signal to the relay to turn on the fan according to the specified temperature and humidity. Where the test was carried out in a 3x2 room for three days.

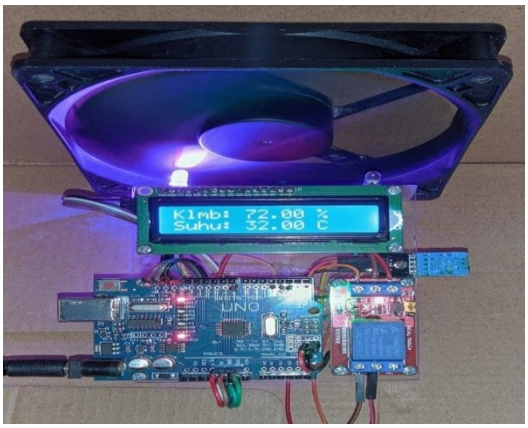

Figure 19 Testing Tools With Complete Circuits

Table 3 Test Results

Day	O'clock	Temperature	Humidity	It is expected	Fact	Information
	11:00	29 ˚C	73%RH	Dead	Dead	In accordance
	12:00	30 ˚C	72%RH	Dead	Dead	In accordance
07/07/2023	13:25	32 ˚C	69%RH	Light up	Light up	In accordance
	11:00	29 ˚C	81%RH	Dead	Dead	In accordance
	13:00	30 ˚C	73%RH	Dead	Dead	In accordance
07/08/2023	16:30	29 ˚C	70%RH	Dead	Dead	In accordance
	11:00	33 ˚C	76%RH	Light up	Light up	In accordance
	16:30	29 ˚C	68%RH	Dead	Dead	In accordance
07/09/2023	20:40	27 ˚C	79%RH	Dead	Dead	In accordance

4. Conclusion

Based on the descriptions that have been explained in the previous chapters, the following conclusions can be drawn, The program will activate the temperature sensor continuously until the temperature and humidity are detected > 30˚C the fan will turn on and if < 30˚C the fan will turn off. The sensor will repeat continuously until it detects the temperature and humidity again. Temperature and humidity data are displayed on a 16x2 LCD according to temperature detection via a sensor.Arduino IDE programming makes it easy to create.This design uses an Arduino Uno R3 microcontroller circuit, DHT11 sensor, Relay, 16x2 LCD and fan. This tool can be turned on using AC or DC voltage and also a power supply such as a battery.

Acknowledgement

The author would like to thank those who helped in completing this research. Especially to my student Mhd. Kholil Bisri, A.Md., who actively participated in preparing the supporting tools for this research. May your knowledge, time and energy be your charity. Aamiin Ya Mujibasailin

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