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Research Article

Renewable Energy Based Smart Umbrella for Street Vendors

Vanitha Mahadevan [1*], Bindu Puthentharayil Vikraman [2], Hazem Yaqoob Al-Hatmi [3], Houd Salim Al-Shaqsi [4]
[1] *Senior Lecturer, Electrical Section, College of Engineering and Technology, University of Technology and Applied Sciences-Al Musanah, Muladdha, Sultanate of Oman*
[2] *Lecturer, Electrical Section, College of Engineering and Technology, University of Technology and Applied Sciences-Al Musanah, Muladdha, Sultanate of Oman*
[3] *Student, Electrical Section, College of Engineering and Technology, University of Technology and Applied Sciences-Al Musanah, Muladdha, Sultanate of Oman*
[4] *Student, Electrical Section, College of Engineering and Technology, University of Technology and Applied Sciences-Al Musanah, Muladdha, Sultanate of Oman*
Email: [1] vaniarun13@gmail.com, [2] bindup2005@gmail.com, [3] alhatmihazem@gmail.com, [4] Hoo1111d88@gmail.com
Orchid Id: [1] 0000-0003-4184-8174, [2] 0000-0003-3134-6824, [3] 0009-0001-7354-1196, [4] 0009-0003-5078-2522
Corresponding Author: Vanitha Mahadevan*

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ABSTRACT

Street vending is a common type of unofficial business that helps urban areas by providing necessary goods and services. However, poor weather and restricted access to electricity to power their enterprises are two issues that street vendors frequently deal with. This paper suggests a proposal for a smart umbrella based on renewable energy intended especially for street vendors to address these problems. Using integrated photovoltaic panels, the renewable energy-based smart umbrella captures solar energy to produce clean, sustainable power. To maximize energy consumption and improve operational efficiency, the umbrella's design integrates cutting-edge technologies, including smart sensors, power management units, and energy storage systems. The intelligent umbrella provides several benefits of solar energy. It offers a dependable supply of electricity for charging tiny electronic gadgets like tablets, smartphones, and portable payment terminals, which makes it possible for vendors to carry out commercial operations effectively. This smart umbrella uses DHT 11 to identify the temperature for the automatic ON of the Fan. It uses RTC to show the real-time and also uses the LDR to turn ON/OFF the lights. The smart umbrella can also run tiny equipment like food warmers and refrigerators, expanding the kinds of goods street sellers can offer.

Keywords: Smart Umbrella, Solar Energy, DHT, BMP180, RTC, Street Vendors.

INTRODUCTION

The research on the solar-powered smart umbrella for street vendors is rooted in the growing demand for creative and sustainable solutions across various industries, including street vending. Many metropolitan towns rely heavily on street vendors to supply visitors and locals with necessities. However, they frequently encounter difficulties, including inadequate infrastructure, a shortage of renewable energy sources, and restricted access to electricity [1], [2], [3], [4], [5]. There is a chance to solve these issues and enhance street sellers' sustainability and working conditions by incorporating solar energy into the umbrella design. Solar energy is a clean, renewable resource that can be used to create electricity, which makes it the perfect choice for supplying power to the smart umbrella's different capabilities. Incorporating solar energy solutions into commonplace products has become more practical due to developments in battery storage technology and solar panels' growing price and efficiency. This has created opportunities for cutting-edge applications in various fields, including street vending. The smart umbrella idea includes solar panel integration and other aspects that can improve street sellers' ease and functionality [6], [7], [8], [9], [10]. These features might be USB charging ports for mobile devices, LED illumination for longer operating hours, and a cooling fan for smooth business operations. Street vendors can cut operational expenses, lessen their dependency on non-renewable energy sources, and improve environmental sustainability by lowering carbon

emissions using solar energy. The smart umbrella can help street vendors operate more profitably and efficiently by improving their general working environment, productivity, and safety.

LITERATURE REVIEW

There are many research articles discussing solar-powered umbrellas. The papers which are discussed here used different methods to implement the concept. Sathish Babu et al. [11] recommend using a smartphone app to remotely control a solar-powered smart umbrella that harnesses energy from the sun to produce shade. umbrella with remote control for customization, USB ports, and LED lights a lightweight, solar-powered smart umbrella designed for outdoor and beach use that has USB charging outlets.

Gopi Karelia [12] discussed that the unique umbrellas have built-in charging ports, a tiny fan, and solar panels that can provide up to 20 watts of power. They can even be utilized at night thanks to a battery backup.

Dad et al. [13] presented a project to enhance the smart cities. The smart cities are thought of as ultra-modern metropolitan regions that cater to the needs of people, businesses, and organisations. The concept of "smart cities" is not limited to automating daily tasks that help various people or traffic patterns. This smart umbrella uses a sensor to sense the rain for automatic opening and closing. It is also used to connect Wi-Fi, Music App and USB ports.

Youngtak Han et al. [14] present research on a smart navigation umbrella that can alleviate the problem, as mentioned earlier, by providing intuitive wayfinding through smartphone-umbrella interaction. Customers don't need to view the smartphone screen to locate and identify a path. The proposed technique attaches an LED light to the end of the umbrella ribs. It comprises three control modules that use a magnetic field to determine azimuth, Bluetooth to connect a smartphone to an umbrella, and eight LEDs to show each direction. The smartphone application transmits direction information to the umbrella and features a navigator to show the way from the present location to the destination. The smart umbrella uses the eight LEDs mounted to the umbrella ribs to display the direction when it gets that information from the smartphone.

Sumanth et al. [15] express an umbrella with solar panels and a cooling fan attached. Through solar photovoltaics, the photovoltaic panels produce electricity, which is then utilised to power the fan. Because they are made for outdoor use, solar umbrella fans are frequently seen in parks, public places, and other outdoor settings where shade and cooling are required. A framework within the canopy of solar umbrella fans usually supports the photovoltaic panels and the fan. A battery that saves the electricity the panels produce for later use is another option for connecting them. Usually found near the top of the umbrella, the fan's position can be changed to direct the airflow.

METHODS AND METHODOLOGY

A. Block Diagram

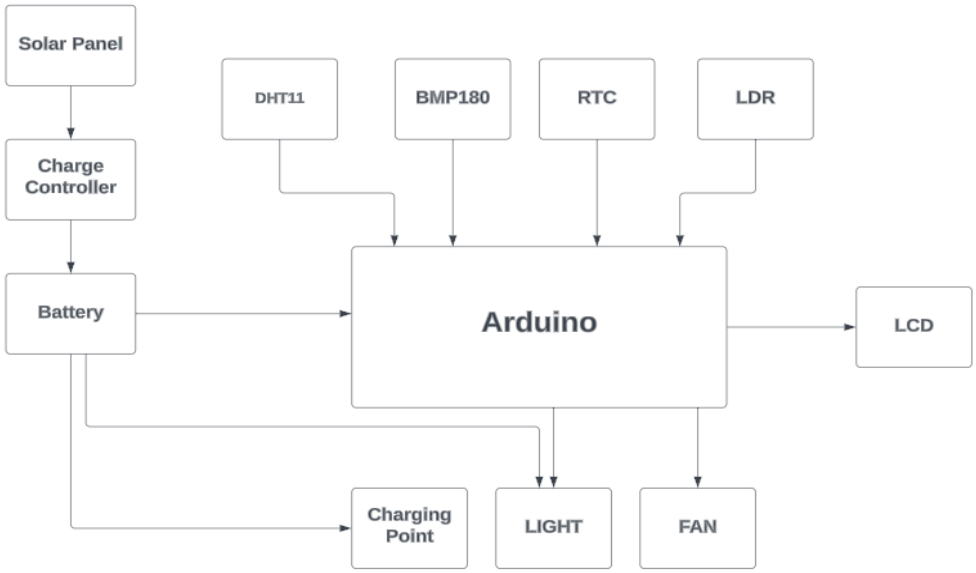

Figure 1 Block diagram

As the block diagram shown in figure 1, a solar panel is connected to the charge controller and the battery. The battery is supplying the Arduino and charging point. Moreover, there are four sensors connected to the Arduino (DHT11, BMP180, RTC and LDR). Also, there are two loads connected by the Arduino (Light and Fan). Finally, there is an LCD screen connected to the Arduino to show the Result and data.

B. Hardware Description

Solar Panel

The fundamentals of photovoltaics state that when a solar panel, like the one in figure 2, is exposed to sunlight, its photovoltaic cells capture solar radiation. When this energy creates electrical charges, they move in reaction to the internal electrical field of the cell, which is what causes electricity to flow [16].

Figure 2 Solar panel

Charge controllers

Figure 3 illustrates charge controllers, which are crucial parts of BIPV systems because they manage the current that enters and exits batteries, shielding them from harm from excessive charging and discharging. They can also protect the appliances in BIPV systems that are connected to the batteries.

Figure 3 Charge controller

Battery 12V (DC)

A rechargeable battery system shown in figure 4 produces a direct current (DC) output of 12 volts is commonly called a 12V (DC) battery. These batteries are frequently utilised in many different applications, and these batteries are essential for offering a reliable power source for a range of applications.

Figure 4 Battery 12V (DC)

Arduino

Arduino shown in figure 5 is an open-source electronics platform that combines software and hardware to create interactive projects. It has an intuitive interface. With the help of a microcontroller board, users may program and control various devices, making it a popular tool for DIY electronics and prototyping.

Figure 5 Arduino

DHT11

The DHT11 shown in figure 6 is a digital temperature and humidity sensor is a simple, cost-effective device in electronics and Internet of Things projects. It is frequently integrated with microcontrollers such as Arduino for environmental monitoring and offers real-time readings.

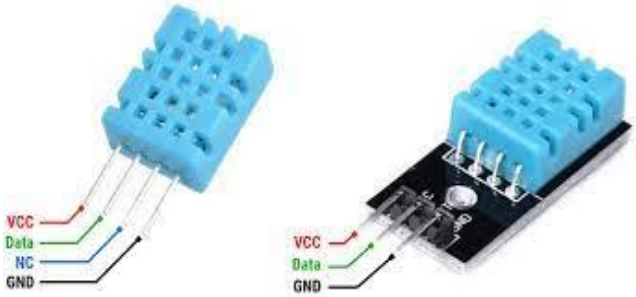

Figure 6 DHT11

RTC

Real-time clocks shown in figure 7, or RTCs for short, are timekeeping devices used in electronic systems to retain precise date and time records. It is essential in applications needing precise time monitoring, such as microcontrollers, computers, and numerous electronic devices. It runs independently and is frequently powered by a coin-cell battery.

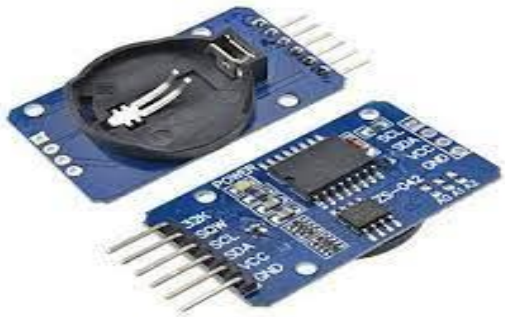

Figure 7 RTC

Pressure sensor BMP180

Bosch Sensor Tec developed the BMP180 barometric pressure sensor is shown in figure 8. It is frequently utilised in electronic projects and temperature and atmospheric pressure sensing equipment. Accurate measurements are provided by the BMP180, frequently included in systems for environmental monitoring, altimeters, and weather stations.

Figure 8 BMP180

C. Flowchart

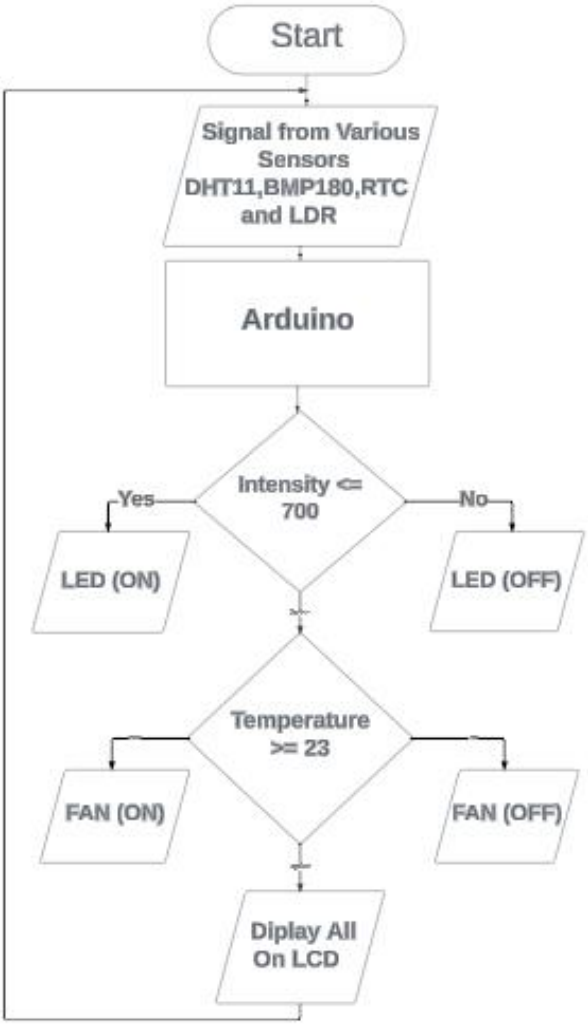

Figure 9 Flow Chart

Figure 9 shows the flow of the complete project with all the sensors connected to Arduino.

D. Hardware Setup

Temperature and Humidity Sensor Circuit Diagram (DHT11)

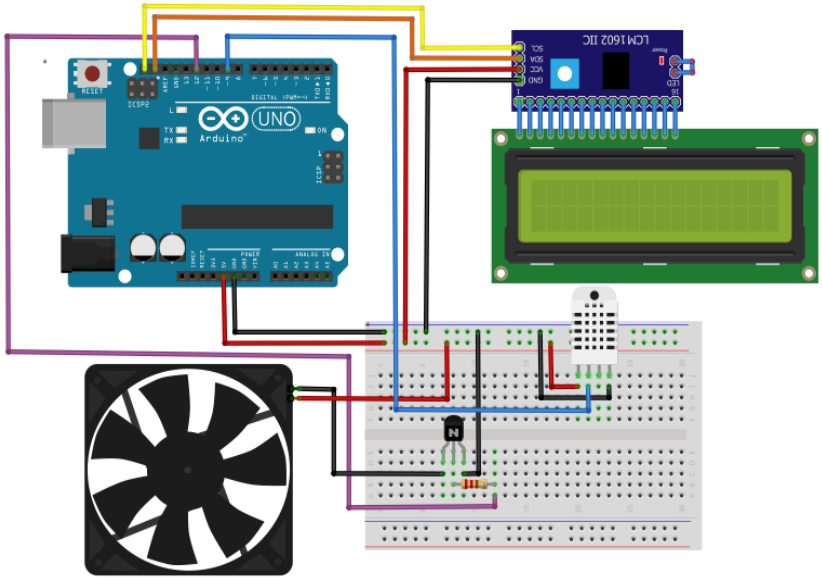

Figure 10 DHT11 Circuit Diagram with Fan

The first sensor shown in figure 10 is the temperature and humidity sensor (DHT11), which helps to measure the temperature and humidity around the stall or Umbrella and shows the values on the LCD. Also, there is a fan that relates to the circuit, and it operates if the temperature is equal to or more than 23 Degrees Celsius, and it is off if the temperature is less than 23 Degrees Celsius. Moreover, 5V and ground wires are connected from Arduino to the breadboard, and 5V and ground wires are connected from the LCD screen to the breadboard. SCL (yellow wire) and SDA (Orange wire) are connected from LCD to Arduino. In addition, we connected an NPN Transistor, so the emitter is connected to the negative terminal of the Fan, and Base is connected to a resistor, then to pin 12 on Arduino, and the Collector is connected to a negative source of Arduino. Finally, the positive terminal of the Fan is connected to 5v at Arduino [17], [18].

Real-Time Clock Sensor Circuit Diagram (RTC)

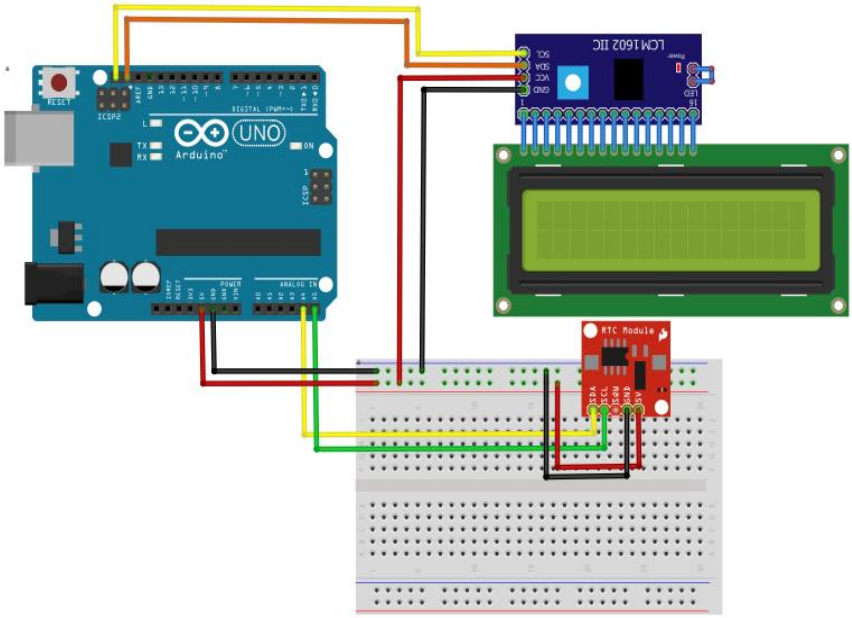

Figure 11 RTC Sensor Circuit Diagram

The second sensor shown in figure 11 is Real Time Clock (RTC), which can show the time and date. The result will be shown on the LCD. The 5V and Ground wires are connected from Arduino to the Breadboard, and the RTC sensor has four terminals, so the 5v and GND from the RTC sensor are connected to 5v. GND at the breadboard SDA (Yellow wire) is connected to A4 at the Arduino, and SCL (Green wire) to A5 at the Arduino. Also, LCD has four terminals, which the positive (RED wire) and negative (Black wire) are connected breadboard, and SCL from LCD (Yellow) is connected to SCL at Arduino. SDA from LCD (Orange) is connected to SDA at Arduino.

Pressure Sensor Circuit Diagram (BMP180)

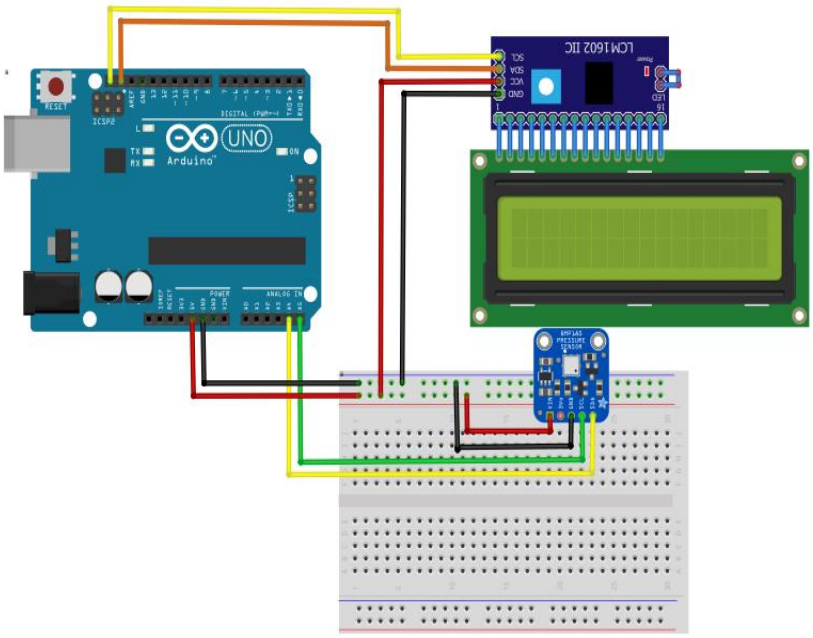

Figure 12 BMP180 Circuit Diagram

The third sensor shown in figure 12 is a pressure sensor (BMP180), which can measure the pressure around the stall or umbrella and show it on the LCD. It has four pins. The 5v and GND from the sensor are connected to 5v and GND at the breadboard, SDA (Yellow wire) is connected to A4 at the Arduino, and SCL (Green wire) is connected to A5 at the Arduino. Also, LCD has four terminals, which the positive (RED wire) and negative (Black wire) are connected to the breadboard, and SCL from LCD (Yellow) is connected to SCL at Arduino, and SDA from LCD (Orange) is connected to SDA at Arduino.

A photo Resistor Circuit Diagram (LDR)

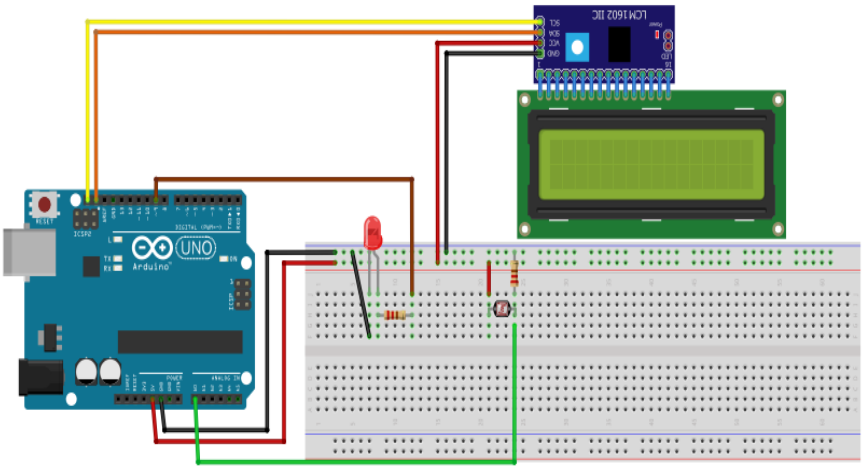

Figure 13 LDR Sensor Circuit Diagram with LED

The last and fourth sensor shown in Figure 13 is a photoresistor (LDR) sensor connected to LED lights. this sensor depends on the lighting, so if it darkens, it will sense that, and it will give a signal for the LED lights to work. LDR has two terminals: the left terminal is connected to the positive at the breadboard, and the right terminal is connected to the resistor (10Kohm), then to the negative, and A0 at the Arduino. Moreover, the LED has two terminals, Cathode (-) is connected to the negative at the Breadboard and Anode (+) is connected to the resistor (220 Ohm) to pin number 9 at Arduino. Also, LCD has four terminals which the positive (RED wire) and negative (Black wire) are connected breadboard, and SCL from LCD (Yellow) is connected to SCL at Arduino. SDA from LCD (Orange) is connected to SDA at Arduino.

Combined Circuit Diagram

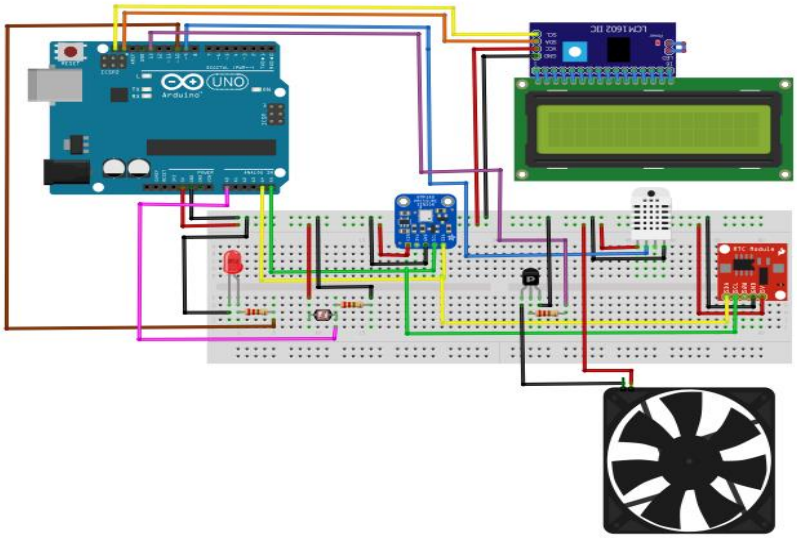

Figure 14 Final Circuit Diagram

As the circuit shown in figure 14, all four previous sensors are combined in one circuit with one Arduino and LCD. Finally, this circuit has one Arduino, and it is able to control the operation of sensors. Moreover, all the sensors are working with a 5V supply. Also, the breadboard is a common connecting board that helps connect all the sensors with one circuit.

RESULT AND DISCUSSION

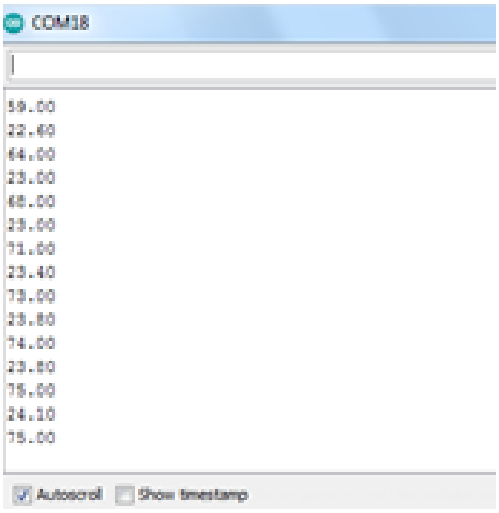

Figure 15 DHT11 Serial Monitor Output

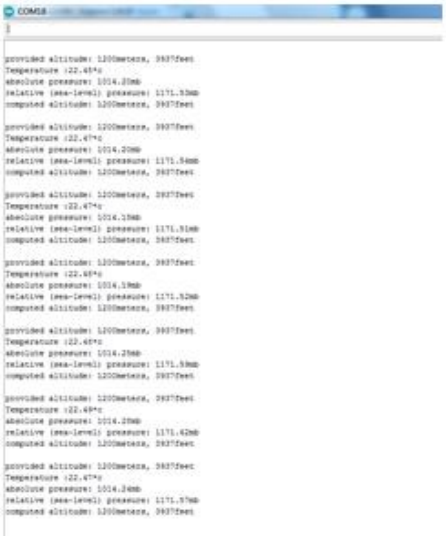

Figure 16 BMP180 Serial Monitor Output

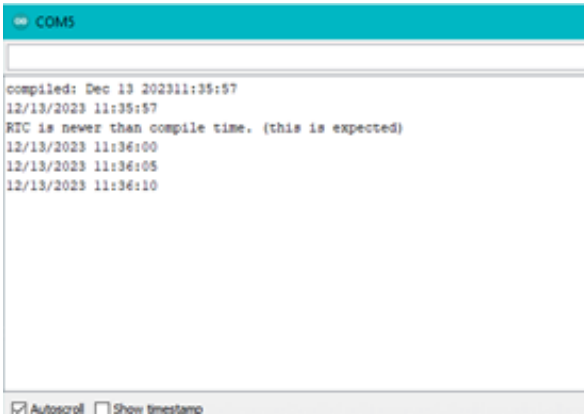

Figure 17 RTC Serial Monitor Output

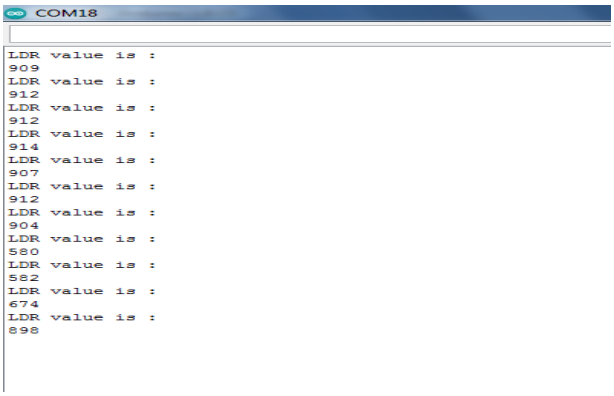

Figure 18 LDR Serial Monitor Output

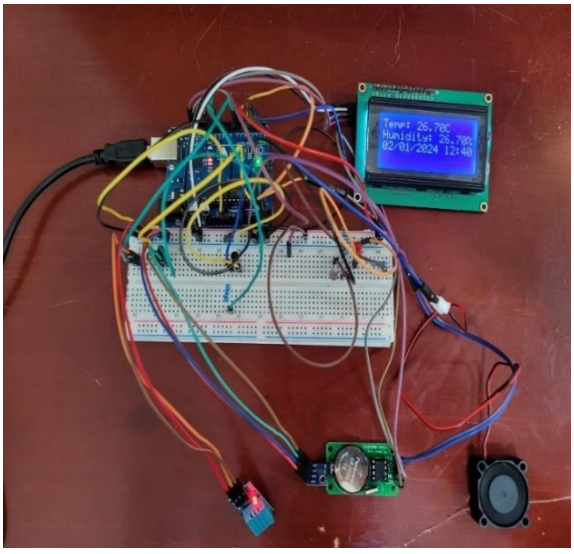

Figure 19 Combined Circuit

Figure 20 Final Model

Figure 15 shows the serial monitor output of DHT 11. Figure 16 shows the serial monitor output of BMP180. Figure 17 shows the RTC serial monitor output. Figure 18 shows the Serial monitor output of LDR. The combined model Shown in figure 19 connects all four sensors. The result of the sensors is displayed in LCD as shown in figure 20. Based on the temperature the fan is operated. If the temperature exceeds or exceeds 23 Degrees Celsius, the fan will be ON. The LDR decides the operation of the light connected to the umbrella during the night.

CONCLUSION

A smart umbrella for street vendors incorporating solar energy, a fan, a light, a charging point, and an LCD screen can be a highly beneficial and practical solution. The umbrella's design incorporates solar panels to harness this renewable energy source efficiently. The solar panels can produce electricity throughout the day, which powers the umbrella's numerous features. Street vendors can remain cool and comfortable during hot weather by including a fan in their umbrella design. The vendor's working conditions are improved and may draw in additional business because it offers a cool breeze. The light improves visibility, enabling customers to see the products more easily and fostering a safer atmosphere for the vendor and the clients. Street sellers can use the charging station to charge their electronic devices, like tablets and cellphones, right from their umbrellas. This functionality is especially helpful for vendors who depend on mobile devices for communication, commercial transactions, and financial management. Vital information like prices, menus, and promotional offers can be shown on the LCD screen. A smart street vendor umbrella with solar power, a fan, a light, a charging port, and an LCD screen has several benefits. It offers sustainable energy, better working conditions for vendors, more safety and visibility, and a multipurpose platform for marketing and communication. Putting such an umbrella in place can help street vending enterprises succeed and remain sustainable.

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