



Air monitoring system using Arduino

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ABSTRACT

Air quality is one of the main factors that determine health. the human need for clean air is something that cannot be underestimated. because the number of sources of air pollutants everywhere is different. air pollution is a simple thing, but it is extremely dangerous if it is allowed to continue. so we need a monitoring tool to monitor air pollutants and the results can be monitored in real time. this is a device that measures the levels of carbon dioxide, nitrogen, benzene, methane and smoke by a gas sensor, indoor and outdoor temperatures, and humidity by a temperature sensor and controlled using an arduino processor. the light is red and it is a warning

Keywords:

Air quality , health , human

Introduction

Air pollution is the biggest problem of every nation, whether it is developed or developing. Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants [1]. Harmful effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. According to a survey, due to air pollution 50,000 to 100,000 premature deaths per year occur

in the U.S. alone whereas in EU number reaches to for in the 300,000 and over 3,000,000 worldwide [2][3]. Various kinds of anthropogenic emissions named as primary pollutants are pumped into the atmosphere that undergoes chemical reaction and further leads to the formation of new pollutants normally called as secondary pollutants. For instance, according to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), nearly all climate-altering pollutants either directly or indirectly (by contributing to secondary pollutants in the atmosphere) are responsible for health problems Almost every citizen spends 90% of their time in indoor air [4][5].

1.2 purpose of project

The project is an implementation of Based Air Pollution Monitoring System Using Arduino. Air pollution is a growing issue and it is necessary to monitor air quality for a better future and healthy living for all. Is getting popular day-by-day and standards are on its way. Therefore, collection of air quality information is easier. Analysis of monitoring data allows us to assess how bad air pollution from day to day. According to the recent survey, Dhaka, the capital of Bangladesh is the third in the list of most air-polluted city. Thus because of this expansion in the quantity of vehicles contamination is developing quickly and it influencing people groups wellbeing too. This air contamination makes disease and harm safe, neurological, regenerative and respiratory framework. In extraordinary cases, it can likewise cause passing. As indicated by overview 50000 to 100000 unexpected losses occurred to us only because of air contamination [6]. Along these lines, there is a requirement for checking air quality and to monitor it. Is the system of physical gadgets, vehicles, home apparatuses, and different things implanted with hardware, programming, sensors, and availability which empowers these articles to associate and trade information. Permits articles to be noticed or controlled. In this paper, I am proposing and going to piloting a model which to screen air contamination.

1.3 Related work

1.3.1

In this modern era, the issue of air pollution is becoming more prominent, especially when air pollution is mostly in urban areas, as almost all urban areas are affected by air pollution. This air pollution is mostly caused by human activities such as open burning, smoke emissions from vehicle exhaust, cigarette smoke emissions, and smoke emissions from industrial funnels. There are various types of harmful gases released through activity such as carbon dioxide, nitrogen oxide, carbon monoxide, ammonia, methane, some uncommon components, and many other types of gases that can harm a person while inhaling the gas .

Components:

1. LCD
2. Wi-Fi ESP8266
3. MQ-2 sensor
4. HC-05 Module
5. Arduino UNO



Fig. (1-1) air pollution monitor mini project

1.3.2

I have done this project to basically monitor natural gas and carbon monoxide levels in the kitchen air as it contains appliances using a combustible gas and they produce carbon monoxide, which is a toxic gas, as a product of incomplete combustion. I found this a good chance to make my first iot device to get the reading of this air monitor on my mobile anywhere in the world and to get notifications when gas levels exceed a certain limit and warn me about a potential gas leak or high CO level. The inspiration to make this device came from my wife as she works as a pediatrician in a hospital where she receives cases of gas poisoning and I was happy to make it for her.

COMPONENTS AND SUPPLIES

1. Arduino Nano R3
2. Gas Sensor (MQ5)
3. Gas Sensor (MQ7)
4. DHT11
5. Adafruit industries ada1536 image
6. Buzzer
7. Siren Transducer, 12VDC
8. Espressif ESP8266 ESP-01
9. LCD - 16x2
10. Relay (generic)
11. DC-DC Buck (Step Down) Regulator, Adjustable
12. Jumper wires (generic)



Fig. (1-2) Air Quality Monitoring System

1.3.3

Air quality monitoring is well known and established science which started back in the '80s. At that time, the technology was quite limited, and the solution used to quantify the air pollution complex, cumbersome and really expensive. Fortunately, nowadays, with the most recent and modern technologies, the solutions used for air quality monitoring are becoming not only more precise, but also faster at measuring. Devices are becoming smaller, and cost much more affordable than ever before. The presented device uses the Samyoung "DSM501A" dust sensor which is one of the cheapest on the market and can be purchased at aliexpress for a few dollars. This sensor is capable of detecting PM2.5 as well as PM10 particles. In the picture below, you can see the layout of the pins but don't pay attention to the color of the wires as they may be different.

COMPONENTS AND SUPPLIES

1. Arduino Nano R3
2. DSM501A Dust sensor module
3. LCD, 16 x 2
4. Fan kit 40mm
5. LED (generic)
6. Resistor 221 ohm
7. Single Turn Potentiometer- 10k ohms



1.4 Overview of project

This project provides a combination of process of sensing ambient temperature and humidity, thus sensing the temperature is displayed in a OLED display panel, and values of the gas sensors, temperature and humidity s

and also the
sensors and the
me output

1.5 Objective

1. To measure and display temperature and humidity
2. To combine advanced detection technologies to produce an air quality sensing system with advanced capabilities to provide low cost comprehensive monitoring.
3. To display the sensed data in user friendly format in OLED display panel.

1.6 Benefits

1. Achievement of proper facility to ensure pollution free environment
2. Reduction of health risk in day-to-day life

1.7 Beneficiaries

1. Society people
2. Special care units in the hospitals
3. Urban and rural planning sector and green building management system

2.2 Electronic Circuit Components:

The circuit will use a variety of components such as a arduino , and some sensors. The components will be listed below:

2.2.1 Arduino UNO R3

Arduino Uno R3 is one kind of atmega328p based microcontroller board. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started. The term Uno means “one” in the language of “Italian” and was selected for marking the release of Arduino’s IDE 1.0 software. The R3 Arduino Uno is the 3rd as well as most recent modification of the Arduino Uno. Arduino board and IDE software are the reference versions of Arduino and currently progressed to new releases. The Uno-board is the primary in a sequence of USB-Arduinoboard, & the reference model designed for the Arduino platform[16].

Arduino Uno R3 Specifications

- 1.** It is an atmega328p based Microcontroller.
- 2.** The Operating Voltage of the Arduino is 5V.
- 3.** The recommended input voltage ranges from 7V to 12V.
- 4.** The i/p voltage (limit) is 6V to 20V.
- 5.** Digital input and output pins-14.
- 6.** Digital input & output pins (PWM)-6.
- 7.** Analog i/p pins are 6.
- 8.** DC Current for each I/O Pin is 20 ma.
- 9.** DC Current used for 3.3V Pin is 50 ma.
- 10.** Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader.
- 11.** SRAM is 2 KB.
- 12.** EEPROM is 1 KB.
- 13.** The speed of the CLK is 16 mhz.

14. In Built LED.
15. Length and width of the Arduino are 68.6 mm X 53.4 mm.
16. The weight of the Arduino board is 25 g



Fig. (3-1) Arduino UNO R3

Fig. (2-1) Arduino Uno R3

2.3 Gas Sensor

Gas sensors (also known as gas detectors) are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosive gasses and measure gas concentration. Gas sensors are employed in factories and manufacturing facilities to identify gas leaks, and to detect smoke and carbon monoxide in homes. Gas sensors vary widely in size (portable and fixed), range, and sensing ability. They are often part of a larger embedded system, such as security systems, and they are normally connected to an audible alarm or interface. Because gas sensors are constantly interacting with air and other gasses, they have to be calibrated more often than many other types of sensors [7].

Here are some MQ series of gas sensors

- 1) MQ-2 - Methane, Butane, LPG, smoke
- 2) MQ-3 - Alcohol, Ethanol, smoke
- 3) MQ-4 - Methane, CNG Gas
- 4) MQ-5 - Natural gas, LPG
- 5) MQ-6 - LPG, butane gas
- 6) MQ-7 - Carbon Monoxide
- 7) MQ-8 - Hydrogen Gas
- 8) MQ-9 - Carbon Monoxide, flammable gasses
- 9) MQ131 - Ozone
- 10) MQ135 - Air Quality (CO, Ammonia, Benzene, Alcohol, smoke)
- 11) MQ136 - Hydrogen Sulfide gas

2.4 Air Quality Parameters

The important parameters that are considered in the proposed framework include:

1. Carbon Dioxide (CO₂) – CO₂ is colorless, odorless gas and non-combustible gas. Also, it is measured under the category of smother gases that have ability of interfering the availability of oxygen for tissues. Carbon Dioxide is a gas vital to life in the world, because it is one of the most vital elements evolving photosynthesis process, which converts solar into chemical energy. [8] [9].

2. Sulphur Dioxide (SO₂) - Sulphur Dioxide is a colorless gas, detectable by the distinct odor and taste. Like CO₂, it is mainly due to fossil fuels boiling and to manufacturing processes. In high attentions may cause breathing problems, especially in sensitive groups, like asthmatics [10] [11].
3. Nitrogen Dioxide (NO₂) – Nitrogen Dioxide is a brownish gas, easily detectable for its odor, very corrosive and highly oxidant. It is produced as the result of fossil fuels burning. Frequently NO₂ terrified to the atmosphere is converted in NO₂ by chemical processes [12].
4. Smoke - About 1 million people are in custom of tobacco smoking globally of which majority population is from rising countries. Every year nearly 4.9 million people expired due to smoking allow to 2007 report. In addition, second hand smoke is serious threat to the health of people of all age's causes 41000 deaths each year[13].
5. LPG - Liquefied petroleum gas (LPG) is an odorless and colorless liquid which evaporates readily into a gas. Leakage is generally noticed by adding an odorant into it. It is considered 4 under the category of highly flammable gases and it can be classified as a carcinogen and mutagen if Butadiene content is more than 0.1%. LPG may escape in the form of a gas or a fluid [14].
6. Temperature and humidity- Quantity of temperature is an important for safety of people and affects our life skills. Greenhouse outcome can be observed by measuring temperature and comparing temperature changes from historical to present time especially since the industrial revolution using climate data. Humidity is a type of gas that guards us from UV rays from the sun and helps trick heat on Earth, thereby making the climate on Earth, a pleasant one for living. [15].

2.2.2 MQ-135 Gas sensor

MQ135 sensor (Gas sensor): It is a air quality detecting sensor which detects the toxic gases like NH₃, smoke, CO₂, alcohol and benzene steam.

Character Configuration:

1. Good sensitivity some kind of gases.
2. High sensitivity to NH₃, Sulphide and Benzenesteam.
3. Long life and low cost.
4. Simple drive circuit.

Features:

1. Operating Voltage is +5V.
2. Analog output voltage: 0V to +5V.
3. Digital Output Voltage: 0V or 5V.
4. Preheat duration 20 seconds.
5. The Digital pin Sensitivity varied using the potentiometer.[17]



MQ-135 Gas sensor

2.2.3 Temperature / Humidity Sensor dht11

It is a digital sensor that provides temperature and humidity readings. The capacitive humidity sensor and the thermistor measure the air and give the values. Three main components constitute dht11. The first is a resistive type humidity sensor which gives the humidity reading. The second is a negative temperature coefficient (NTC) thermistor whose function is to measure the temperature of the desired area. The third is an 8-bit microcontroller that converts and sends the obtained analogue readings of temperature and humidity into a single digital signal. Humidity is the amount of moisture in the air. There may be situations where the temperature may be low, but people feel the heat and it due to the high humidity. So, humidity readings make sense at times when those situations arise. dht 11 is low cost, small and high-performance sensor

Features :

1. dht series numeric humidity sensor.
2. Humidity measuring range : 20 % ~ 90 % RH (0-50 C temperature compensation)
3. Temperature measuring range : 0 ~ +50 ° C
4. Humidity measurement accuracy : + 5.0 %RH
5. Temperature measurement accuracy : ± 2.0 ° C
6. Response time : < 5s
7. Low power consumption
8. Size : 2.3cm x 1.2cm x0.5cm [18]

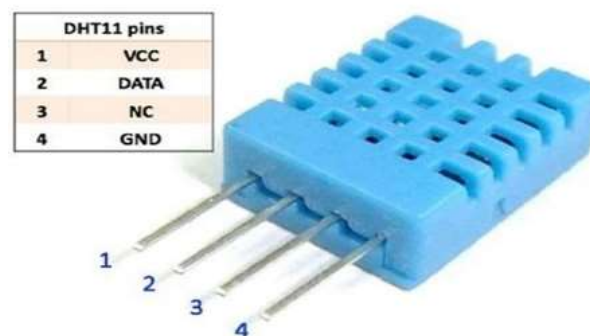


Fig. (2-3) Temperature and Humidity Sensor dht11

2.2.4 OLED display

In contrast to LCD technology, Organic Light-Emitting Diode (OLED) displays do not require a backlight and are regarded as the ultimate technology for the next generation of flatpanel displays. This 0.96" 128*64 Blue OLED Module offers 128*64-pixel resolution. They are featuring much less thickness than LCD Displays with good brightness and produce better and true colors. This OLED Display Module is very compact and will add a great ever user interface experience to your Arduino project. The connection of this display with Arduino is made through the I2C serial interface. The 0.96" 4 pin 128*64 Blue OLED Display Module produces blue text on black background with very good contrast when supplied with 3.3V-5V Supply. The OLED Display Modules also offers a very wide viewing angle.

Features:

1. Resolution: 128 X 64
2. Visual Angle: >160°
3. Input Voltage: 3.3V ~ 6V
4. Compatible I/O Level: 3.3V, 5V
5. Mini Size: 2.7 X 2.8cm
6. Only Need 2 I/O Port To Control
7. Pixel Color: Blue
8. Full Compatible With Arduino
9. Working Temperature: -30°C ~ 70°C
10. Module Volume (Generous): 27.0 X 27.0 X 4.1mm
11. Pins: 4 Pins
12. Pin Definition: GND, VCC, SCL, SDA

PIN DESCRIPTION:

1. Supply Voltage(Vcc, 5V) Can Be Powered By Either 3.3V Or 5V
2. Ground (GND) Pin Ground
3. Serial Clock(SCL) Pin SCL Of I2C Interface
4. Serial Data(SDA) Pin SDA Of I2C Interface [19]

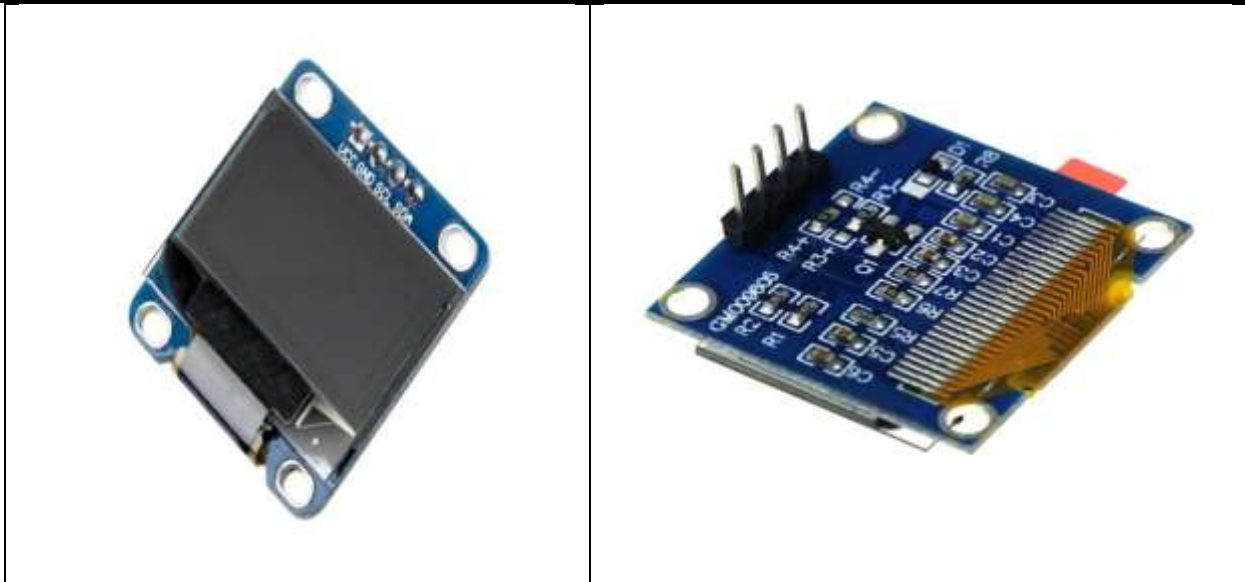


Fig. (2-4) OLED

display

2.2.5 Buzzer

Buzzer is also known as Piezo Speakers (buzzers). You want to generate sound in our project you can use this simple magnetic buzzer. This one generates a continuous beep usually when supplied with power but you can generate any tone as you wish by interfacing it with a microcontroller with proper coding.

A "piezo buzzer" is basically a tiny speaker that you can connect directly to an Arduino. From the Arduino, you can make sounds with a buzzer by using tone. You have to tell it which pin the buzzer is on, what frequency (in Hertz, Hz) you want, and how long (in milliseconds) you want it to keep making the tone. [20]

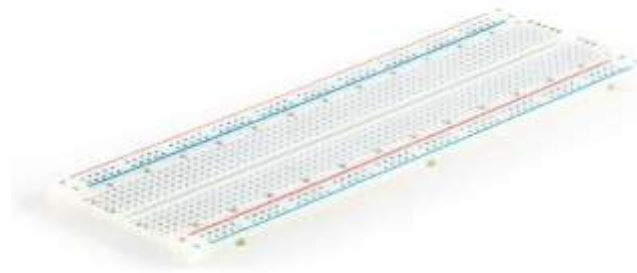
Table Description Buzzer

Voltage	4-8VDC
Maximum current	≤30MA/5VDC
Minimum sound pressure	≥ 85db / 10cm
Resonant frequency	2500+---300HZ



Fig. (2-5) Buzzer**2.2.6 Breadboard**

The breadboard or solderless breadboard is the most popular tool used for prototyping (building temporary electronic circuits and testing them before the final version is permanently designed) without any need for soldering. You can use it as an independent circuit to create your project, or it can be used as an auxiliary part of a main circuit such as Arduino or Raspberry pi. The breadboard has a user-friendly construction and quite a safe layout, which make it an important step for newcomers to electronics who wish to test their ideas in quick experiments. However, you can use the breadboard to build all types of electronics projects, starting from very basic circuits to the most complicated robotics. [21]

**Fig. (2-6) Breadboard****2.2.7 Jumper wire**

A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Fig. (2-7) Jumper wire**2.2.8 Arduino A-B Cable (0.5m)**

Standard USB 2.0 cable. Use it to connect arduino uno, Genuino Uno, Genuino Mega 2560, Genuino 101 or any board with the USB female A port of our computer. Cable length is approximately 50cm.



Fig. (2-8) Arduino A-B Cable

3.1 Conclusion

In conclusion, a simple and effective device has been successfully built using an Arduino circuit to measure Gas sensor, temperature and humidity in order to provide a safe and stable environment. The cost of this project was calculated based on materials and components spent and The total cost was around 99\$ and the cost for each part is given in the below table :

Item Name	Quantity	Total Price
Arduino UNO R3	1	10\$
MQ-135 Gas sensor	1	8\$
dht11	1	6\$
OLED display	1	15\$
Buzzer	1	3\$
Breadboard	1	2\$
Jumper wire	1	2\$
Led	2	1\$
Box	1	52\$

Table Item Prices

3.2 Suggestions For Future

- 1.** Interface more number of sensors to know detail content of all gases present in air.

2. This project can also be implemented using a wifi module that displays the AQI on a web server continuously. The server can be accessed by everyone, anytime and it can keep them informed about the air quality of a particular location.

4.3 Advantages

1. Sensors are easily available.
2. Simple, compact, easy to handle.
3. Sensors have long life and less cost.
4. Quality of air can be checked indoor as well as outdoor.
5. Detecting a wide range of physical parameters including temperature, humidity and carbon dioxide.

References

- [1] Tudose, D. Ş., Pătraşcu, N., Voinescu, A., Tataroiu, R., and Țăpuş, N. , “Mobile Sensors in Air Pollution Measurement.”, in Positioning Navigation and Communication (WPNC), IEEE , pp. 166-170, 7 Apr 2020.
- [2] TERI. 2021. Air Pollution and Health. Discussion Paper by The Energy and Resources Institute: New Delhi by Rinki Jain (Associate Fellow, TERI), KarnikaPalwa (Research Associate, TERI)
- [3] João Ramos Maria, João Dias, “Analyses of Indoor Environmental Quality and Ventilation in a Building of a School of Higher Education in Portugal”, in the 4th Advanced Research in Scientific Areas conference, pp. 273-278, 1 Nov 2018.
- [4] Dias, M. J. et al., (2017). “Indoor Air Quality Evaluation in School Buildings Ventilated by Natural and Mechanical Systems”. Clima pp. R6- TS62-OP02, Turkey: REHVA. ISBN Code of the CD 978-975-6907-14-6, 2017.
- [5] Olesen, B. W., &Brager, G. S., “A Better Way to Predict Comfort: The New ASHRAE Standard 55-2019”, ASHRAE Journal, pp. 20-26, 8 Aug 2020.
- [6] Riteeka Nayak, Malaya Ranjan Panigrahy , Vivek Kumar Rai and T Appa Rao “IOT based air pollution monitoring system”, International Journal on Information Theory (IJIT) Vol-3, Issue-4, 2018;
- [7] Ch.V.Saikumar, M.Reji, P.C.Kishoreraja, “ Based Air Quality Monitoring System”, International Journal on Information Theory (IJIT), Vol-117, No.-9, 2017;
- [8] Buckley, N. A., Isbister, G. K., Stokes, B., &Juurlink, D. N, "Hyperbaric Oxygen for Carbon Monoxide Poisoning: a Systematic Review and Critical Analysis of the Evidence", Toxicological Reviews,Vol. 24, Issue 2, pp. 75-92, 1 Jun 2017
- [9] Weaver LK, "Clinical practice. Carbon Monoxide Poisoning". The New England Journal of Medicine, Vol. 3601, Issue 12,pp. 1217-1225, Mar 2017.

- [10] Asmi, A., Putra, J. C. P., & Rahman, I. B. A., "A Study of Indoor Air Quality of Public Toilet in University's Building", in Humanities, Science and Engineering (CHUSER), IEEE Colloquium ,pp. 403-408, 3 Dec 2019.
- [11] Raza A. Khan¹ et al, "Impact of HVAC Systems on IAQ in Building Environment" International Journal of Advance Research, in Science And Engineering, IJARSE, Vol. 3, Special Issue1, Sep 2017
- [12] Asmi, A., Putra, J. C. P., & Rahman, I. B. A., "A Study of Indoor Air Quality of Public Toilet in University's Building", in Humanities, Science and Engineering (CHUSER), IEEE Colloquium ,pp. 403-408, 3 Dec 2018.
- [13] West, Robert and Shiffman, Saul, "Fast Facts: Smoking Cessation. Health Press Ltd." pp. 28. ISBN 978-1-903734-98-8, 2019.
- [14] Raza A. Khan¹ et al, "Impact of HVAC Systems on IAQ in Building Environment" International Journal of Advance Research, in Science And Engineering, IJARSE, Vol. 3, Special Issue1, Sep 2019
- [15] "Tobacco Fact Sheet N°339". May 2019. Retrieved on 13 Mar 2019.
- [16] Diakopoulos, D., & Kapur, A., "HIDUINO: A Firmware for Building Driverless USB-MIDI Devices Using the Arduino Microcontroller", in NIME, pp. 405-408, May 2018.
- [17] Vandana, K., Chaitanya Baweja, Simmarpreet, and S. Chopra, "Influence of Temperature and Humidity on the Output Resistance Ratio of the MQ-135 Sensor", *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 6, no. 4, April 2019, pp. 423-429.
- [18] Krishnamurthi, Karthik, Suraj Thapa, Lokesh Kothari, and Arun Prakash. "Arduino Based Weather Monitoring System", *International Journal of Engineering Research and General Science*, vol. 3, no. 2, 2018, pp. 452-458.
- [19] ^ Shim, Richard. "Kodak, Sanyo demo OLED display". CNET. Retrieved 6 October 2019.
- [20] Definition of Buzzer by "The Free Dictionary". 22,May-2020
- [21] U.S. Patent D228136.: "Breadboard for electronic components or the like", filed 1 Dec 2020, retrieved 14 July 2021.