

DESIGN AND FABRICATION OF POLLUTION MONITORING HEXACOPTER

A Project Report Phase – II

Submitted in partial fulfilment of requirements for the award of
Bachelor of Engineering degree in Aeronautical Engineering

by

JAYA SETHU PRAGATHISH J (39260009)

SHALU KUMARI S (39260034)

KRUPAL KODI K (39260014)



**DEPARTMENT OF AERONAUTICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC
JEPPIAR NAGAR, RAJIV GANDHI SALAI, CHENNAI**

600119

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Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai-600119
www.sathyabama.ac.in



DEPARTMENT OF AERONAUTICAL ENGINEERING
BONAFIDE CERTIFICATE

This is to certify that the Project Report is the Bonafide work of JAYA SETHU PRAGATHISH J (39260009), SHALU KUMARI S (39260034), KRUPAL KODI K (39260014) who carried out the project entitled "DESIGN AND FABRICATION OF POLLUTION MONITORING HEXACOPTER" under my supervision from November 2022 to April 2023.

Internal Guide

Dr. T. ANAND, M.E., Ph.D.

Head of the Department

Dr. P. BOOMA DEVI, M.E., Ph.D.

Submitted for Viva voce Examination held on ----

Internal Examiner

External Examiner

DECLARATION

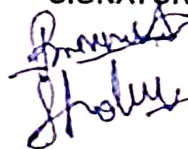
We, JAYA SETHU PRAGATHISH J (39260009), SHALU KUMARI S (39260034), KRUPAL KODI K (39260014) hereby declare that the Project Report entitled "DESIGN AND FABRICATION OF POLLUTION MONITORING HEXACOPTER" done by us under the guidance of Dr. T. ANAND, M.E., Ph.D., Department of Aeronautical Engineering, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Aeronautical Engineering.

DATE: 25.04.2023

PLACE: CHENNAI

SIGNATURE OF CANDIDATES

- 1.
- 2.

The image shows two handwritten signatures in blue ink. The first signature is for Jaya Sethu Pragathish J and the second is for Shalu Kumari S. They are written over the numbered list.

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ABSTRACT

This report presents a study on the effect of electron-beam physical vapor deposition of aluminum oxide on the reflectivity of carbon fiber. The purpose of this study was to investigate the potential of aluminum oxide coating to increase the reflectivity of carbon fiber. The methodology involved coating carbon fiber with aluminum oxide using the electron-beam physical vapor deposition method, followed by testing the coated fiber using Contact angle, Hardness and UV Spectroscopy tests. The results showed that the aluminum oxide coating significantly increased the reflectivity of the carbon fiber, and the three tests provided further insights into the wettability, hardness and optical properties of the coated fiber. These findings have important implications for the development of high-performance materials and can inform future research in the field of carbon fiber coatings.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	x
	ABBREVIATIONS	xi
1	1.1 INTRODUCTION	1
	1.1.1 DRONES HAVE A WIDE RANGE OF POTENTIAL USES IN DAY -TO-DAY LIFE	1
	1.2. MODELING AND DESIGNING OF HEXA-COPTER	3
	1.3. CONCEPTUAL DESIGN	4
	1.4. BASICS PLATFORM OF HEXACOPTER	5
2	LITERATURE SURVEY	6
3	AIM AND SCOPE	8
4	COMPONENTS AND ITS SPECIFICATION	9
	4.1. OVERVIEW	9
	4.1.1. FLIGHT CONTROLLER (APM)	9
	4.1.2. BRUSHLESS DC MOTOR 1100 KV	10
	4.1.3. MOTOR SPINNER	11
	4.1.4. MULTIROTOR PROPELLER	12
	4.1.5. ESC-ELECTRIC SPEED CONROLLERS	12
	4.1.6. MICRO CONTROLLER UNT-ESP 324	13
	4.1.7. AIR QUALITY SENSOR-MQ 135	14
	4.1.8. TEMPERATURE SENSOR -DHT 11	15
	4.1.9. PRESSURE SENSOR	16
	4.1.10. RC RECEIVER	17

	4.1.11. Li Po BATTERY	18
	4.1.12. GLOBAL POSITIONING SYSTEM (GPS)	19
	4.1.13. AVOINIC RCB 6i2.4 Ghz	20
	4.2. ADVANTAGES OF HEXACOPTER	21
	4.2.1 DISADVANTAGE OF HEXACOPTER	21
	4.3. DESIGN PROCESS	22
	4.4. COMPONENT SELECTION	23
	4.6. ASSEMBLY	24
	4.7. TESTING	25
	4.8. ALGORITHM	27
	4.9. BLYNK	28
	4.10. CODING	29
	4.11. WEIGHT ESTIMATION	32
	4.12. MODES OF HEXACOPTER	32
	4.12.1. MANNUAL MODE	32
	4.12.2. ALTITUDE HOLD MODE	32
	4.12.3. POSITION HOLD MODE	33
	4.12.4. WAYPOINT MODE	33
	4.12.5. FOLLOW ME MODE	33
	4.12.6. RETURN TO HOME MODE	33
	4.13. DESIGN OF HEXACOPTER	34
5	RESULT AND DISCUSSION	37
	5.1. RESULT AND DISCUSSION	37
	5.2. OBSERVATION	38
6	CONCLUSION AND FUTUREWORK	40
	6.1. CONCLUSION	40
	6.2. FUTURE WORK	40
	REFERENCES	41

LIST OF FIGURES

FIGURE NO	FIGURE NAME	PAGE NO
4.1	Flight Controller	9
4.2	Brushless Dc Motor 1100 Kv	10
4.3	Motor Spinner Set	11
4.4	Multi rotor Propeller (10x4.5)	12
4.5	Electric Speed Controllers	12
4.6	Micro Controller Unit	13
4.7	Air Quality Sensor	14
4.8	Temperature Sensor	15
4.9	Pressure Sensor	16
4.10	Rc Receiver	17
4.11	Li Po Battery	18
4.12	GPS	19
4.13	Avionic RCB6i	20
4.14	BLYNK Logo	28
4.15 - 4.20	Coding	29 - 31
4.21	Side View Of the Frame	34
4.22	Top View of the Frame	35
4.23	Bottom View Of the Frame	35
4.24	Building Process of The Hexacopter	36
4.25	Finished Product	36
5.1	Result Readings at Altitude of 50 m	38
5.2	Result Readings at Altitude of 100 m	39

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Drones, also known as unmanned aerial vehicles (UAVs), are aircraft that are remotely controlled or operate autonomously through pre-programmed flight plans. They come in a variety of sizes, shapes, and types, ranging from small consumer models to larger military drones. Drones have a wide range of applications, including aerial photography, surveillance and reconnaissance, agriculture, delivery services, search and rescue, and scientific research. They have become increasingly popular in recent years due to their versatility, cost-effectiveness, and ease of use. Drones also raise concerns regarding privacy, safety, and security. Regulations have been put in place by various governments to ensure responsible use of drones and to prevent accidents or unauthorized use.

Drones have the potential to revolutionize various industries and improve our lives in many ways, but their use must be carefully monitored and regulated to ensure their safe and responsible operation.

1.1.1 Drones have a wide range of potential uses in day-to-day life.

- **Aerial Photography and Videography:** Drones equipped with high-resolution cameras can capture stunning aerial footage and photographs, allowing for unique perspectives and creative opportunities.
- **Delivery Services:** Drones can be used for delivering packages and products to homes and businesses, providing faster and more efficient delivery options.
- **Agriculture:** Drones equipped with sensors and cameras can be used to monitor crops, track plant health, and identify areas that require attention, such as irrigation or fertilization.
- **Search and Rescue:** Drones equipped with thermal imaging and other sensors can be used to locate missing persons or stranded hikers in remote or dangerous locations.
- **Construction and Infrastructure Inspections:** Drones can be used to inspect buildings, bridges, and other structures, identifying potential issues or

damage without the need for scaffolding or other costly equipment.

- **Wildlife Monitoring:** Drones can be used to monitor wildlife populations, track migration patterns, and detect illegal poaching or hunting activities.
- **Emergency Response:** Drones can be used to assess damage and locate survivors after natural disasters, such as earthquakes or hurricanes.

These are just a few examples of the many potential uses of drones in day-to-day life. As technology continues to improve and regulations become more established, we can expect to see even more innovative applications of drones in the future. Drones equipped with cameras or other sensors can potentially infringe on people's privacy by capturing images or video without their consent. Drones can potentially collide with other aircraft or objects, causing accidents or property damage. In addition, drones can be dangerous if they fall from the sky or crash into people or animals.

Drones can be used for nefarious purposes, such as spying or carrying out attacks. This has raised concerns about the potential for drones to be used in terrorist attacks or to smuggle contraband. The rapid growth of the drone industry has led to a need for increased regulation to ensure responsible use of drones and to prevent accidents or unauthorized use. Drones can produce a significant amount of noise, which can be disruptive and annoying to people living or working in the vicinity of drone operations. It is important for governments, industry leaders, and drone users to address these concerns and work together to promote safe and responsible use of drones while minimizing their potential negative impacts.

A hexacopter is a type of drone that is equipped with six rotors, which allow it to achieve greater stability and lift capacity than quadcopters or other smaller drones. Hexacopters can be used for a variety of purposes, including aerial photography and videography, surveying and mapping, search and rescue, and agricultural monitoring. Hexacopters are typically more expensive than smaller drones due to their larger size and additional components. They require a more experienced operator and can be more difficult to transport and operate in confined spaces. Hexacopters offer advantages in terms of stability and lift capacity, making them a popular choice for certain applications where larger payloads or longer flight times are needed.

Hexacopters are increasingly being used for pollution monitoring due to their ability to gather data from hard-to-reach areas and provide a comprehensive view of the environment. Hexacopters can be equipped with sensors that can detect various types of pollutants, including particulate matter, ozone, and carbon monoxide. They can also collect data on temperature, humidity, and wind speed, which can provide insights into how pollutants are dispersed in the environment. The data gathered by Hexacopters can be used to identify pollution sources, track changes in pollution levels over time, and inform policy decisions aimed at reducing pollution levels. Hexacopters can be especially useful in monitoring pollution in areas that are difficult to access or hazardous for human researchers, such as near industrial facilities or in disaster zones. the use of Hexacopters in pollution monitoring has the potential to improve our understanding of environmental issues and help us take action to reduce pollution levels and protect human health

1.2 MODELING AND DESIGNING OF HEXA-COPTER

The designing of a hexacopter involves several key steps. Firstly, the overall design and specifications of the hexacopter need to be determined, taking into account factors such as payload capacity, flight time, and range. Next, a 3D model of the hexacopter can be created using specialized software, which allows the design to be refined and optimized before any physical components are built. Once the design has been finalized, the components of the hexacopter can be assembled, which typically include the frame, motors, propellers, battery, flight controller, and sensors.

The hexacopter can then be programmed with software that allows it to fly autonomously or be controlled remotely by an operator. Finally, the hexacopter can be tested to ensure that it is functioning properly and meets the desired specifications. it involves careful planning and attention to detail to ensure that the final product is safe, reliable, and capable of performing its intended functions. Hexacopters use six separate arms, each with a rotating propeller in order to achieve stable flight. Recent technological developments in microprocessors have made possible the complex, dynamic control systems necessary for the stability of flight of a hexacopter

1.3 CONCEPTUAL DESIGN

Before considering the abstract design, the functionality conditions of the drone must be honored. The first step in the design process is to define the mission requirements for the hexacopter. This includes factors such as payload capacity, flight time, and range. And to determine the configuration of the hexacopter. This includes the number and placement of rotors, the size and shape of the frame, and the type and placement of sensors and other equipment. Once the configuration has been determined, a 3D model of the hexacopter can be created using specialized software. This allows the design to be refined and optimized before any physical components are built. Based on the 3D model, the components for the hexacopter can be selected, including motors, propellers, battery, flight controller, and sensors. Once the components have been selected, the hexacopter can be assembled, which involves mounting the components onto the frame and wiring them together. Once the hexacopter has been assembled, it can be tested to ensure that it is functioning properly and meets the mission requirements. This involves both ground testing and flight testing. Based on the test results, the design of the hexacopter may need to be refined and optimized. This involves making changes to the configuration or components to improve performance and ensure that the mission requirements are met.

UAV Configurations UAVs are advanced aircraft in technologies used, flexible for operations and cost effective which can perform a massive quantum of innately dangerous operations. In general, UAVs are divided into three groups grounded on their configurations which are fixed sect UAV, rotary sect UAV and multirotor UAV. In this paper, hex rotor has been named as the introductory platform, which has come under multirotor UAV. A multirotor UAV is lifted and propelled by further than one rotor similar as Tri copter (three propellers), quadcopter (four propellers), Penta copter (five propellers), hexacopter (six propellers), octocopter (eight propellers), etc. Then, the design methodologies, the real time manufacturing criticalities and the generation of object discovery/ crack discovery algorithms have been concentrated for advanced multirotor UAV in order to employ for critical operations.

1.4 BASIC PLATFORM OF HEXACOPTER:

Introductory platform of this paper is hexacopter, which is the coming step over from a quadcopter. It has six rotors, which are attached with individual arms all connected symmetrically to the central mecca. In which, further rotors are added to the high stability of an aircraft that can suit further image processing operations by a stable camera detector platform. Probability of charge failures due to rotor working nature is low because one motor can die while the rest pick up the slack. Each rotor is driven by an individual electric motor, in which four rotors have fixed pitch blades and other two rotor blades are suitable to do cock. The electronics used for communication and control are located on the main mecca associated with the battery. With the help of the rotor's thrust, the manoeuvrings have been executed efficiently in the Hexacopter. In which, discrimination thrust can be used to execute the manoeuvring of the Hexacopter because the source of the thrust is located outside the centre of graveness. The gyration of rotors also produces a response necklace contrary to the direction of the gyration. Since half of the propellers are spinning in one direction.

The basic platform of a hexacopter consists of a frame, six motors, six propellers, an electronic speed controller (ESC) for each motor, a flight controller, a battery, and a remote-control system. The frame is usually made of lightweight materials such as carbon fibre or aluminium and is designed to hold all of the components securely in place.

The motors are responsible for powering the propellers and lifting the hexacopter off the ground. The ESCs regulate the speed of each motor based on the input from the flight controller, which receives commands from the remote-control system. The flight controller is the brain of the hexacopter and uses sensors such as accelerometers and gyroscopes to stabilize the platform in flight.

CHAPTER 2

LITERATURE REVIEW

Considering that the term 'drones' refers to any aerial device that is unmanned, the earliest unmanned aerial vehicle in history was first reported in 1839 an Austrian soldier attacked the city of Venice with unmanned balloons that was filled with explosives. It is important to point out that the use of these vehicles even in its earliest forms was for military purposes. The Ruston Proctor Aerial Target developed in 1916 was the first pilotless winged aircraft that was controlled with radio control in a similar manner as the majority of the drones that are in existence today (Hurwitz et al., 2002). The Aerial Target was built with the hope that it will counter the German Zeppelins that were used to carry explosives during World War I. In 1917, the Americans developed the Hewitt-Sperry Automatic Airplane also known as the Kettering Bug, which even though had impressive results and could be mass produced, its timing was a little bit late to be used in World War I and therefore was never deployed in combat.

The UAV technology greatly improved during World War II and even the Cold War where it is alleged that it was used for surveillance purposes in particular taking aerial photographs of military bases by the US and former USSR intelligence. However, genuine reports of whether this is true are classified. UAVs were extensively used in modern day warfare in 1982 when Israel used a combination of manned aircraft and UAVs to conduct attacks against the Syrian fleet with minimal losses. In particular, the UAVs were used to identify the Syrian army's position, jam their communication lines, and act as decoys and ensure manned aircraft executed attacks with little or no retaliations. The success by the Israeli's military generated international interest in the drone technology and led to countries investing millions of dollars in this sector (Huang & Thomson, 2010).

The first non-military drones were deployed or began to be used in earnest in 2006 by government agencies that were responsible for disaster relief, border surveillance, and wildfire fighting for surveillance purposes. Also, corporations began to use drones to inspect pipelines and spray pesticides on their farms. It is also important to point out that the FAA issued its first commercial drone

permits in 2006, and for the next eight years, it issued an average of two permits per year. Things changed in 2013 when the Amazon CEO Jeff Bezos announced that the company was considering using drones to deliver parcels to its customers and this generated a public interest into the use of drones. In 2015, the FAA issued 1,000 drone permits and one year later provided 3,100 permits. Simulation also its selection is depending upon the motor's capability, the quantum of weight and the specification of propellers. For this work the suitable battery is 3 Cell LiPo battery because of its specification fully satisfies the introductory conditions of Hexacopter. Each motor collectively attached by the Electronic Speed Control (ESC) and it's used to control the speed of the motor and also contemporaneously to produce the pitch, roll, yaw stir of the hexacopter. Generally, all the aircraft equipped with an IMU (inertial dimension unit) which is nothing but a device that provides accelerometers, gyros and an implanted regulator to incorporate information to present accurate data on the aircraft maneuvering details as well as accelerations in all directions. GPS is most ideal for out-of-door operations and presents a positional fix. GPSs suffer from GPS drift, which is answered either by combining data with that from an IMU or by using a discrimination GPS system. Vision grounded navigation systems regularly take up either a single or stereo camera. Stereo vision lends itself to estimating the distance of the features from the cameras using observation, while other distance detectors similar as ultrasound are demanded for single camera systems. In this paper cargo used for hexacopter is infrared detector, camera, rainfall detector, and ray scanners.

CHAPTER 3

AIM AND OBJECTIVE

The Aim of the project is to Withstand the assistance of an efficient air quality monitoring system based on Internet of Things (IoT) technology it provides suitable environmental and health protection. This device is easy to use, dependable, responsive, and reasonably priced. Due of its compatibility, efficacy, and simplicity of use, the MQ 135 sensor, Temperature Humidity sensor and Pressure sensors which detects the ambient air quality, Temperature and Pressure was utilized. The IoT Blynk application has been utilized to make it easier for the user to continually regulate the air quality using a simple interface. The area nearest to the source, which is generally quite high, is the greatest location for monitoring the air quality. The monitoring system must simultaneously read the actual air quality levels in order to ascertain the desired level of air quality to be monitored. Real-time monitoring data that was connected to a smartphone that was placed on the ground at the time revealed that a wireless communication system had been set up using the Blynk app. In order to predict future air quality expectations and give users access to the air quality level at a certain location and time in the future, this project has also merged forecasting methods.

- **Monitoring:** The hexacopter can be used to cover a specific area, similar as a construction point, a ranch, or a border region, and prisoner images or vids of any exertion in that area.
- **Surveillance:** The hexacopter can be used for surveillance purposes, similar as tracking a person or a vehicle or covering a crowd. Hunt and Deliverance The hexacopter can be equipped with thermal imaging cameras and other detectors to search for missing people or to prop in deliverance.
- **Inspection:** The hexacopter can be used to check structure, similar as islands or power lines, or to check hard- to- reach areas, similar as rooftops or high- rise structures

CHAPTER 4

COMPONENTS AND ITS SPECIFICATION

4.1 OVERVIEW

A hexacopter is a type of drone or UAV that has six rotors or propellers. Its components include a frame made of lightweight materials, six brushless DC motors, propellers, electronic speed controllers (ESCs), a flight controller, a battery, a radio transmitter and receiver, a camera and gimbal, and landing gear. The flight controller is the brain of the hexacopter and controls all the other components using sensors such as accelerometers, gyroscopes, and GPS. The camera and gimbal allow for aerial photography, videography, or surveillance, while the landing gear provides support when the hexacopter is on the ground.

4.1.1 FLIGHT CONTROLLER (APM)



Fig.4.1 Flight Controller

APM is an open-source flight control system, it's a multifunction system that can support quadcopter, as well as aircrafts of fixed- sect, three- axis, 6- axis, 8 - axis etc. APM flight control is a rather mature fashion with redoubtable capabilities

- it supports GPS designated voyage and automatic return;
- supports data transmission to realize the remote receiving of real- time data from the aircraft;

- supports pan-tilt control fashion of professional cameras to insure anti-vibration upstanding snap.

Specifications:

- Software: Mission Planner
- Autogiro -level: Yes
- Input Voltage: 4.8-6.0V
- Max Motor/ESC Channels: 8
- GPS Option: Yes
- AVR interface: standard 6 pin.
- Signal from Receiver: 5 channels

4.1.2 BRUSHLESS DC MOTOR 1100 KV



Fig.4.2 Brushless Dc Motor

This DYS D2826- 15 1100KV brushless outrunner motor specifically made to power Quadcopters and Multirotor. It's a 1100 kV motor. It provides high performance, superpower, and brilliant effectiveness. These motors are perfect for medium size quadcopters with 7 propellers. This is a low price and excellent quality Brushless Motor. It comes with pellet Connectors formerly soldered

- The sword design is able of opposing competitive conditions.
- Featherlight design makes them suitable for a wide range of Quadcopter and Hexacopter Frames.

- Compact size.
- Offers great performance and value for plutocrat.
- Smooth throttle response for stylish RC experience.

Specifications:

- No. of Cells: 2 - 3 Li-Poly
- Kv: 1300 RPM/V
- Max Efficiency: 85%
- Max Current: 40A
- Max Watts: 150W
- Weight: 52.7 g
- Size: 28 mm dia x 28 mm bell length
- Shaft Diameter : 3.2 mm
- Model Weight: 300 - 800g / 10.5 - 28.2 oz

4.1.3 MOTOR SPINNER



Fig.4.3 Motor Spinner Set

The flight regulator expects each motor to rotate clockwise or counter clockwise, depending on where they are. Check your flight regulator primer or datasheet for motor gyration direction symbols and make sure your motors match the configuration of your flight regulator.

4.1.4 MULTIROTOR PROPELLER (10*4.5)



Fig.4.4 Multirotor Propeller

A multirotor propeller is a type of propeller used on multirotor drones or aircraft, which are also known as quadcopters, Hexacopters, or octocopters depending on the number of propellers they have. Multirotor propellers are generally made of featherlight accoutrements similar as carbon fibre or plastic, and they come in a variety of sizes and shapes. The size and shape of a multirotor propeller can have a significant impact on the performance of the aircraft. Generally, larger propellers give further lift and are more suited for carrying heavier loads, while lower propellers are more nimble and more suited for acrobatic pushes. The pitch of the propeller also affects the performance, with advanced pitch furnishing further speed and lower pitch furnishing further thrust.

4.1.5 ESC - ELECTRIC SPEED CONTROLLERS



Fig.4.5 ESC - ELECTRIC SPEED CONTROLLERS

An electronic speed control (ESC) is an electronic circuit that controls and regulates the speed of an electric motor. It may also give reversing of the motor and dynamic retardation. Atomic electronic speed controls are used in electrically powered radio-controlled models. An ESC or an Electronic Speed Controller controls the brushless motor movement or speed by cranking the applicable MOSFETs to produce the rotating glamorous field so that the motor rotates. The advanced the frequency or the hastily the ESC goes through the 6 intervals, the advanced the speed of the motor will be.

Specifications :

- Constant Current: 30A (Max 40A<10s).
- BEC: 5V 3A.
- Input Voltage: 11.1 ~ 11.7V.
- Li-Po battery: 2S ~ 3S.
- Ni-MH 4-10 CELLS Auto Detect.

4.1.6 MICRO CONTROLLER UNIT – ESP 324

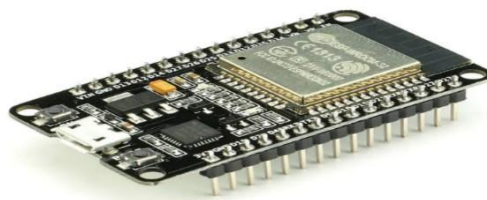


Fig.4.6 Micro Controller Unit

ESP32 is a low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and Bluetooth capabilities. It is designed and developed by Express Systems. One of the most notable features of ESP32 is its built-in Wi-Fi and Bluetooth capabilities, which make it easy to connect to the internet and other devices. It supports a wide range of Wi-Fi standards, including 802.11b/g/n and 802.11ac, and Bluetooth standards, including Bluetooth Low Energy and Bluetooth Classic.

Specifications:

- Microcontroller: Ten silica Xtensa LX6 dual-core processor with a clock frequency of up to 240 MHz
- Memory: 520 KB SRAM and up to 16 MB of external flash memory
- Connectivity: Wi-Fi (802.11 b/g/n/e/i) and Bluetooth (v4.2 BR/EDR and BLE)
- Interfaces: SPI, I2C, UART, ADC, DAC, PWM, SDIO, CAN, and Ethernet MAC
- Operating voltage: 2.2V to 3.6V
- Power consumption: varies depending on usage, but can range from a few milliwatts to several hundred milliwatts
- Temperature range: -40°C to +125°C

4.1.7. AIR QUALITY SENSOR -MQ 135



Fig.4.7 Air Quality Sensor

MQ-135 sensor is a gas sensor that is commonly used to detect and measure the concentration of gases in the air. It is a small and affordable sensor that can detect a wide range of gases, including ammonia, sulphur dioxide, nitrogen oxides, benzene, smoke, and many others. The MQ-135 sensor works based on the principle of gas absorption. The sensor consists of a sensing element that is made up of a tin dioxide (SnO_2) layer on an alumina substrate. When the gas molecules come in contact with the sensing element, they are absorbed into the SnO_2 layer, which changes the resistance of the sensor.

The change in resistance is then measured and converted into a voltage signal, which can be read by microcontroller or other electronics. The output voltage of the sensor is proportional to the concentration of the gas in the air.

Specifications:

- Operating voltage: 5V DC
- Heater voltage: 5V DC
- Heater power consumption: about 350mW
- Benzene (C₆H₆) - 1 to 50 ppm
- Carbon Monoxide (CO) - 1 to 1000 ppm
- Nitrogen Dioxide (NO₂) - 0.05 to 10 ppm
- Alcohol (C₂H₅OH) - 10 to 500 pp
- Operating temperature range: -10 to 50°C
- Humidity range: 95% RH (non-condensing)
- Dimensions: 36mm x 22mm x 25mm
- Weight: about 5 grams

4.1.8 TEMPERATURE SENSOR – DHT 11



Fig.4.8 Temperature Sensor

DTH11 is a digital temperature and humidity sensor that is commonly used in various electronic projects and applications. It is a low-cost, easy-to-use sensor that provides accurate and reliable measurements of temperature and humidity. The DTH11 sensor consists of a humidity sensing component and a thermistor, which is used to measure the ambient temperature. The sensor is designed to provide a digital output in the form of a single-wire serial interface, which can be easily connected to microcontroller or other electronics.

Specifications:

- Operating voltage: 3.3V to 5V DC
- Current consumption: less than 1mA

- Humidity measuring range: 20% to 90% RH
- Humidity measurement accuracy: $\pm 5\%$ RH
- Temperature measuring range: -40°C to 80°C
- Response time: within 2 seconds for temperature and 5 seconds for humidity
- Dimensions: 23mm x 12mm x 5mm
- Weight: about 1 gram

4.1.9 PRESSURE SENSOR – BMP 180



Fig.4.9 Pressure Sensor

The BMP180 is a digital pressure and temperature sensor that is commonly used in various electronic projects and applications. It is a low-cost, easy-to-use sensor that provides accurate and reliable measurements of atmospheric pressure and temperature.

The BMP180 sensor consists of a piezo-resistive sensor and a temperature sensor that are used to measure the atmospheric pressure and temperature, respectively. The sensor is designed to provide a digital output in the form of a two-wire I2C interface, which can be easily connected to microcontroller or other electronics.

Specification

- Operating voltage: 1.8V to 3.6V DC
- Current consumption: less than 5 μA
- Pressure measuring range: 300 hPa to 1100 hPa
- Pressure measurement accuracy: ± 0.12 hPa
- Sampling rate: up to 128 samples per second

- Dimensions: 3.6mm x 3.8mm x 0.93mm
- Weight: about 0.03 gram

4.1.10 RC RECEIVER



Fig.4.10 RC Receiver

An RC (radio- controlled) receiver is an electronic device that receives signals from an RC transmitter and converts them into control signals for the RC vehicle or device being controlled. The receiver generally operates on a specific frequency, similar as 2.4 GHz or 72 MHz, and has a number of channels that correspond to different functions on the RC vehicle.

Specifications:

- Frequency: The receiver must be compatible with the frequency used by the RC transmitter. For illustration, if the transmitter operates on 2.4 GHz, the receiver must also operate on that frequency.
- Channel count: The number of channels needed depends on the number of functions or controls demanded for the RC vehicle or device. Common channel counts include 4, 6, and 8.
- Signal range: The range of the receiver is an important consideration, especially for larger RC vehicles or boats. Look for receivers with a longer range if you need to control your RC device over longer distances.
- Compatibility: The receiver must be compatible with the type of RC device or vehicle being controlled, similar as buses, boats, or aeroplanes

- Size and weight: The size and weight of the receiver are important considerations for lower RC vehicles and bias. Look for receivers that are featherlight and compact, but still have the necessary features and capabilities.
- Antenna type: The type of antenna used by the receiver can impact its signal range and strength. Some receivers have erected- in antennas, while others have external antennas that can be deposited for better event.

4.1.11 Li Po BATTERY



Fig.4.11 Li Po Battery

A LiPo battery(short for lithium polymer battery) with a voltage standing of 11.1 volts is a type of rechargeable battery generally used in colourful operations similar as remote control vehicles, quadcopters, and RC aero planes. LiPo batteries are known for their high energy viscosity, which allows them to store a lot of energy in a small package.

Specification :

- Battery Type: Lithium Polymer
- No of Cells: 3
- Voltage : 11.1 V
- Max Voltage : 12.5 v
- Current Discharge Rate : 35C
- Max Endurance : 10 to 15 Min
- Connector Type: T (XT60)

4.1.12 GLOBAL POSTITIONING SYSTEM (GPS)



Fig.4.12 GPS

GPS (Global Positioning System) is a satellite- grounded navigation system that allows druggies to determine their precise position and navigate to specific destinations. The GPS system consists of a network of satellites ringing the earth, ground control stations, and GPS receivers.

Specifications:

- Onboard Compass
- Assistance Assist Now GNSS Online
- Receiver type 72-channel MB engine
- Galileo-ready E1B/C (NEO-M8N)
- lowest noise figure
- Supported antennas Active and passive

4.1.13 AVOINICS RCB 6i2.4 Ghz



Fig.4.13 Avionic RCB6i

An Avionic RCB6i transmitter is a popular type of remote-control transmitter used in the layman RC(radio- controlled) community for controlling RC vehicles similar as buses, exchanges, boats, and aero planes. Specifically, the FlySky2.4 GHz transmitter operates on the 2.4 GHz frequency band, which offers advanced range, trustability, and hindrance resistance compared to aged 27 MHz and 72 MHz radio systems.

Specifications:

- Band: 2.4 GHz
- Channel: 6
- Range: 900 M (Radius)
- Mode: Fixed wing/Heli /Sailplanes /Quad
- Digital trims Option: 4 main channels.
- Simulator: PPO port
- Binding: FS 6ch Receiver

4.2 ADVANTAGES OF HEXACOPTER

The hexacopter has six propellers that are placed in a circle around the hex copter's main body. The machine's bottom has a brace of leg- suchlike accessories that allow it to land safely on the ground. Because of its six propellers, the quadcopter is a more important leaflet than the quadcopter and can carry bigger loads. The hexacopter has a substantial advantage that indeed if one of the propellers fails, the craft can still fly because of the other five propellers. This implies that if one of the propellers fails, the drone won't crash to the ground, causing damage to the outfit attached to it. The gimmick won't be suitable to fly if two propellers fail, but it'll stay stable enough to land safely. A hexacopter can go hastily and reach advanced mound than a quadcopter. Because hexacopters are more precious, these are generally employed to transport more precious weight that cannot be destroyed in the event of a crash. They're also larger and more complex to assemble and store than quadcopters. The hexacopter has the eventuality for other capabilities similar as independent flight, object shadowing, and it can capture upstanding data demanded for numerous of the Vision Lab's exploration systems. Drone surveillance provides real- time sapience into security and exigency situations for better control, accurate intelligence gathering, comprehensive situational mindfulness, and more informed decision timber.

4.2.1 DISADVANTAGES OF HEXACOPTER

Hexacopters can fly at advanced mound and pets. Since they've six rotors, they can land safely indeed if one(in some cases two) of their rotors stops working. Their main disadvantages are redundant cost and increase in size due to the redundant two rotors. One major concern that has increased as drones make it to mainstream use is sequestration. UAVs can be commandeered or manipulated. They can also trespass into authorized areas similar as airfields and military zones. While accessible surveillance is a profitable use of drones, it can come a disadvantage

4.3 DESIGN PROCESS

The first step in designing the hexacopter was to determine the conditions. The hexacopter demanded to be suitable to carry a high- description camera, transmit live videotape to a ground station, and remain stable in windy conditions. After determining the conditions, we designed the frame using carbon fiber material. We chose six high- power motors with electronic speed regulators (ESCs) to give the necessary thrust for the hexacopter. A flight regulator was also named to stabilize the hexacopter during flight. The design process for a hexacopter for surveillance purposes generally involves the following way

- Determine the conditions : The first step in the design process is to determine the specific conditions of the hexacopter for surveillance purposes. This includes relating the cargo capacity, flight time, range, and other factors necessary for successful surveillance operations.
- Select the factors : Grounded on the conditions, the factors necessary for the hexacopter can be named. This includes choosing the motors, propellers, frame, battery, flight regulator, GPS, camera, and other necessary factors. Each element should be precisely named grounded on its comity, trustability, and performance.
- Design the frame : The frame design is pivotal for the stability and project of the hexacopter. The frame should be featherlight, sturdy, and aerodynamic to ensure stable flight and support the cargo. The hexacopter frame can be designed using CAD software and also 3D published or cut from carbon fiber material.
- Assemble the hexacopter : The factors should be assembled on the frame, taking care to ensure that everything is securely mounted and connected. The wiring should be neat and systematized, and the factors should be calibrated to work together effectively.
- Test the hexacopter : Before planting the hexacopter for surveillance purposes, it should be completely tested to ensure that it's working rightly. The testing process should include a hang test, a range test, and a cargo test. The hexacopter should also be tested in different rainfall conditions to ensure that it can operate in colorful surroundings. utensil safety features Safety features similar as fail-safe systems, GPS shadowing, and handicap avoidance should

be enforced to help accidents and increase the safety of the surveillance operations.

In summary, the design process for a hexacopter for surveillance purposes involves determining the conditions, opting the factors, designing the frame, assembling the hexacopter, testing it, and enforcing safety features. Each step should be precisely planned and executed to insure the successful deployment and operation of the hexacopter for surveillance purposes.

4.4 COMPONENT SELECTION

- **Flight time:** A pollution monitoring hexacopter will need to fly for extended periods of time to effectively monitor pollutants in the air. Therefore, it is important to select components such as batteries and motors that can provide long flight times.
- **Payload capacity:** The hexacopter will need to carry sensors, cameras, and other monitoring equipment. Therefore, it is important to select components that can support the weight of the payload.
- **Sensors:** The selection of sensors will depend on the specific pollutants being monitored. For example, sensors to detect carbon monoxide, nitrogen oxide, and particulate matter will be necessary. It is important to select high-quality sensors that are accurate and reliable
- **Communication:** The hexacopter will need to transmit data to a ground station in real-time. Therefore, it is important to select components that can provide reliable and fast communication.
- **Navigation:** The hexacopter will need to be able to navigate accurately and autonomously. Therefore, it is important to select components such as GPS and flight controllers that can provide precise navigation.
- **Durability:** The hexacopter will need to withstand harsh weather conditions and potential crashes. Therefore, it is important to select components that are durable and can withstand wear and tear.

4.5 FABRICATION PROCESS

The hexacopter was fabricated using fiber and nylon mixed material. The motor arms and central frame were cut and assembled using a CNC machine for perfection and delicacy. The sensor mount was 3D printed using a high- strength hair. The electronic factors, including the motors, propellers, flight regulator, and battery, were sourced from estimable manufacturers and assembled according to the manufacturer's instructions. The hexacopter was also tested for stability, project, and continuity.

4.6 ASSEMBLY

The assembly process involved mounting the motors, ESCs, flight regulator, and other factors onto the frame. We wired everything together and mounted the pollution monitoring sensors onto the hexacopter. We also calibrated the ESCs, flight regulator, and radio transmitter to ensure that everything was working rightly. The assembly process of a hexacopter for pollution monitoring purposes generally involves the following way

- **Frame assembly:** The hexacopter frame should be assembled according to the manufacturer's instructions. This involves attaching the arms to the center plate, installing the motor mounts, and mounting the wharf gear.
- **Motor installation:** The motors should be installed on the motor mounts and secured with screws. The propellers should also be attached to the motors.
- **Flight regulator installation:** The flight regulator should be installed on the frame, generally on a vibration- damping mount. The power and signal cables should be connected to the motors and other factors.
- **Battery installation:** The battery should be securely mounted on the frame, generally underneath the center plate. The power cables from the battery should be connected to the flight regulator.
- **GPS installation:** The GPS should be installed on the frame, generally on a mast above the center plate. The cables from the GPS should be connected to the flight regulator.

- **Sensor's installation:** The sensors should be mounted generally underneath the hexacopter. The cables from the sensors should be connected to a micro controller unit , which should be mounted on the frame.
- **Radio control system installation:** The radio control receiver should be installed on the frame, generally on top of the center plate. The cables from the receiver should be connected to the flight regulator.
- **Estimation:** The flight regulator and other factors should be calibrated according to the manufacturer's instructions. This involves configuring the flight regulator settings, setting up the radio control system, and calibrating the compass and GPS.
- **Final checks:** Before flying the hexacopter, all connections should be checked, and the safety features should be tested. The propellers should be balanced, and the hexacopter should be test flown in a safe and open area.

In summary, the assembly process of a hexacopter for surveillance purposes involves assembling the frame, installing the motors, flight regulator, battery, GPS, camera, and radio control system, calibrating the factors, and performing final checks. Each step should be precisely executed to ensure that the hexacopter is assembled rightly and safely for surveillance operations

4.7 TESTING

Before flying the hexacopter, we conducted several tests to ensure that everything was working rightly. We tested the stability of the hexacopter and calibrated the detectors. We also tested the sensors to ensure that the reading feeds was clear . The testing process of a pollution monitoring Hexacopter system involves testing the entire system, including the sensors. The testing process generally involves the following way

- **Pre-flight checks:** Before each flight, the hexacopter should suffer a series of pre-flight checks. These checks include vindicating that the battery is completely charged, the motors and propellers are securely attached, and the safety features are performing rightly.

- Camera testing : The FPV camera should be tested to ensure that it provides high- quality videotape footage. The camera should be tested in different lighting conditions to ensure that it can capture clear images or vids.
- Videotape transmitter testing : The videotape transmitter should be tested to ensure that it can transmit the videotape footage from the camera to the ground receiver. The transmitter should be tested for range, hindrance, and signal strength.
- Videotape receiver testing : The videotape receiver should be tested to ensure that it can admit the videotape signal from the transmitter. The receiver should be tested for range, hindrance, and signal quality.
- Examiner or goggles testing : The examiner or goggles should be tested to ensure that they can display the videotape footage from the camera. The display should be tested for clarity, brilliance, and discrepancy.
- Flight testing : Once the FPV system has been tested for its camera, transmitter, receiver, and display performance, the hexacopter should be flown in a safe and open area to test the entire system's performance. The system should be tested in different rainfall conditions, wind pets, and mound.
- Safety testing : The safety features of the hexacopter, similar as fail-safe systems, GPS shadowing, and handicap avoidance detectors, should be tested to ensure that they serve rightly.
- Functional testing: Once the hexacopter has been tested for its flight and safety performance, it should be tested for its functional performance while using the sensors. This includes testing the data outputs and transmitted by the system to ensure that it's suitable for monitoring operations.

In summary, the testing process of a pollution monitoring hexacopter involves conducting pre-flight checks, sensor testing, data transmitter testing, data receiver testing, flight testing, safety testing, and functional testing

4.8 ALGORITHM

- Determine the types of pollutants to be monitored: Before designing an algorithm for a pollution monitoring hexacopter, you need to determine the types of pollutants that you want to monitor. For example, you may want to monitor air quality for particulate matter, carbon monoxide, nitrogen dioxide, and ozone, or water quality for pH, temperature, and dissolved oxygen levels.
- Select appropriate sensors: Once you have identified the types of pollutants to be monitored, you need to select appropriate sensors for each pollutant. The sensors should be capable of measuring the pollutant concentration accurately and reliably.
- Determine the sampling rate: The sampling rate is the frequency at which the hexacopter takes measurements. The sampling rate will depend on the speed of the hexacopter, the size of the area being monitored, and the desired level of detail in the data.
- Create a flight plan: Based on the area to be monitored, the sampling rate, and the desired altitude, create a flight plan that ensures complete coverage of the area while minimizing the number of flights required.
- Develop an algorithm: The algorithm should take inputs from the sensors and the hex copter's GPS and use this information to calculate the pollutant concentration at each location. The algorithm should be able to integrate the data from multiple sensors and account for the hex copter's movement to produce accurate and meaningful results.
- Data analysis and visualization: After the hexacopter completes its flights, the collected data should be analyzed and visualized to provide meaningful insights into the pollution levels in the area. This can involve creating maps, charts, or graphs to show the distribution of pollutants and identify any hotspots or trends.
- Continuous monitoring and improvement: Finally, it's important to continuously monitor and improve the algorithm over time to ensure that it remains accurate

and reliable. This can involve fine-tuning the sensor selection, adjusting the sampling rate, or refining the algorithm itself.

In summary, the algorithm for a pollution monitoring hexacopter system involves data processing, navigation, and control. By combining these factors into a cohesive system, a hexacopter can give effective and dependable pollution monitoring operations.

4.9 BLYNK

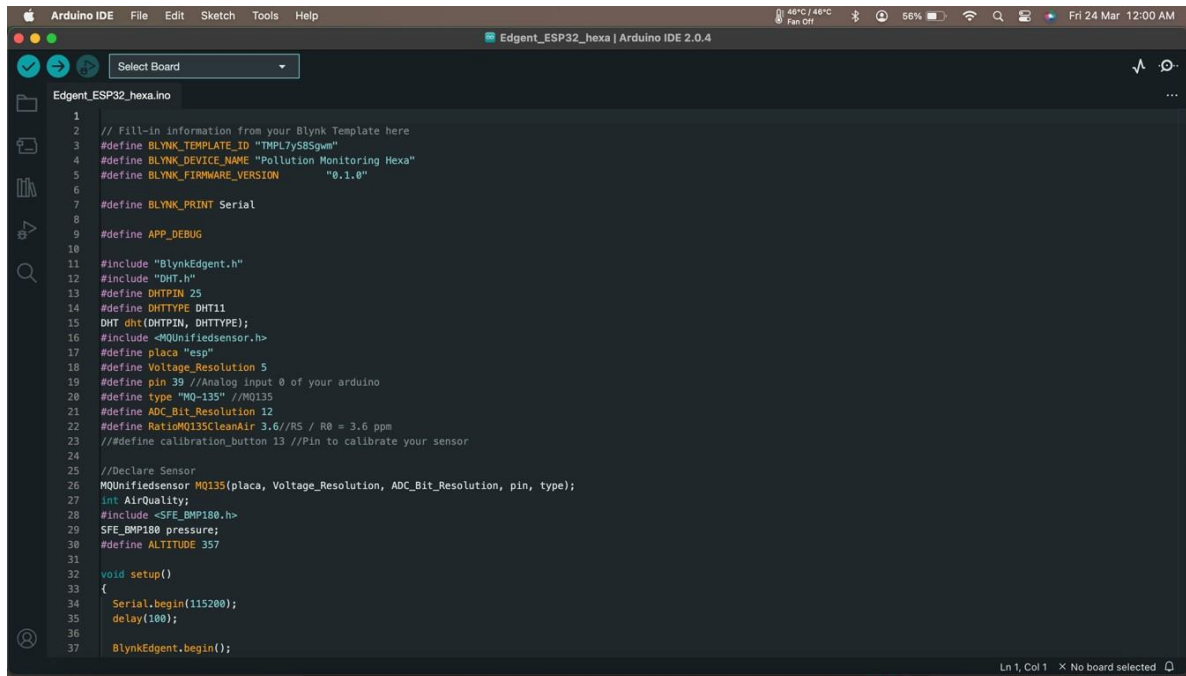


Fig.4.14

Blynk is a smartphone or tablet software that allows users to remotely operate hardware and Internet of Things (IoT) devices. Dmitry Dumansky, Sergey Adzhiev, and Alexey Domoratskiy founded it in 2015. The Blynk software has a simple drag-and-drop interface for creating personalized user interfaces and control panels for IoT devices. It works with a variety of hardware platforms, including as Arduino, Raspberry Pi, ESP8266, and Particle. The software also connects with other well-known cloud providers, including Amazon Web providers, Google Cloud, Microsoft. Users may use Blynk to construct virtual dashboards to remotely operate their IoT devices. They can also receive push notifications from their devices and set up bespoke alerts depending on certain parameters. Blynk also comes with a number of widgets, including as buttons, sliders, and graphs, that may be used to build bespoke user interfaces for IoT applications. Overall, Blynk is a strong tool for Internet of Things enthusiasts and developers looking to design bespoke control interfaces for their connected devices. It makes it easier to establish and maintain IoT projects by simplifying the process of creating remote control interfaces.

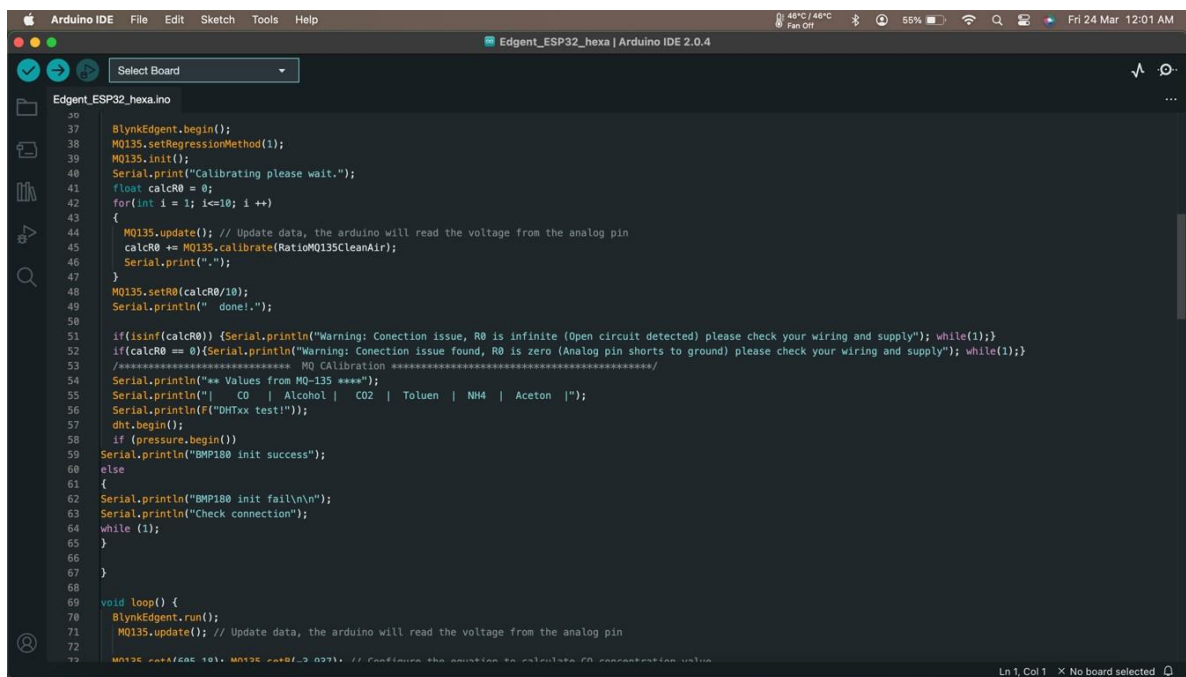
4.10 Coding

The coding was done in Arduino software , the separate codes of each sensors were included in the coding and the output is shown in BLYNK app.



```
1 // Fill-in information from your Blynk Template here
2 #define BLYNK_TEMPLATE_ID "TMPL7yS8Sgwm"
3 #define BLYNK_DEVICE_NAME "Pollution Monitoring Hexa"
4 #define BLYNK_FIRMWARE_VERSION "0.1.0"
5 #define BLYNK_PRINT Serial
6
7 #define APP_DEBUG
8
9 #include "BlynkEdgent.h"
10 #include "DHT.h"
11 #define DHTPIN 25
12 #define DHTTYPE DHT11
13 DHT dht(DHTPIN, DHTTYPE);
14 #include <MQUnifiedSensor.h>
15 #define placa "esp"
16 #define Voltage_Resolution 5
17 #define pin 39 //Analog input 0 of your arduino
18 #define type "MQ-135" //MQ135
19 #define ADC_Bit_Resolution 12
20 #define RatioMQ135CleanAir 3.6/R5 / R0 = 3.6 ppm
21 //define calibration_button 13 //Pin to calibrate your sensor
22
23 //Declare Sensor
24 MQUnifiedSensor MQ135(placa, Voltage_Resolution, ADC_Bit_Resolution, pin, type);
25 int AirQuality;
26 #include <SFE_BMP180.h>
27 SFE_BMP180 pressure;
28 #define ALTITUDE 357
29
30 void setup()
31 {
32   Serial.begin(115200);
33   delay(100);
34   BlynkEdgent.begin();
35 }
```

Fig . 4.15 coding 1



```
36 BlynkEdgent.begin();
37 MQ135.setRegressionMethod(1);
38 MQ135.init();
39 Serial.print("Calibrating please wait.");
40 float calcR0 = 0;
41 for(int i = 1; i<=10; i++)
42 {
43   MQ135.update(); // Update data, the arduino will read the voltage from the analog pin
44   calcR0 += MQ135.calibrate(RatioMQ135CleanAir);
45   Serial.print(".");
46 }
47 MQ135.setR0(calcR0/10);
48 Serial.println(" done!");
49
50 if(!isnan(calcR0)) {Serial.println("Warning: Connection issue, R0 is infinite (Open circuit detected) please check your wiring and supply"); while(1);}
51 if(calcR0 == 0){Serial.println("Warning: Connection issue found, R0 is zero (Analog pin shorts to ground) please check your wiring and supply"); while(1);}
52 //***** MQ Calibration *****
53 Serial.println("** Values from MQ-135 **");
54 Serial.println(" CO | Alcohol | CO2 | Toluen | NH4 | Aceton |");
55 Serial.println(F("DHTxx test!"));
56 dht.begin();
57 if (pressure.begin())
58   Serial.println("BMP180 init success");
59 else
60 {
61   Serial.println("BMP180 init fail\n\n");
62   Serial.println("Check connection");
63   while (1);
64 }
65
66 void loop() {
67   BlynkEdgent.run();
68   MQ135.update(); // Update data, the arduino will read the voltage from the analog pin
69   //***** MQ Calibration *****
70   Serial.println("MQ135 R0: " + String(calcR0));
71 }
```

Fig.4.16 coding 2

```

72
73 MQ135.setA(605.18); MQ135.setB(-3.937); // Configure the equation to calculate CO concentration value
74 float CO = MQ135.readSensor(); // Sensor will read PPM concentration using the model, a and b values set previously or from the setup
75
76 MQ135.setA(77.255); MQ135.setB(-3.18); //Configure the equation to calculate Alcohol concentration value
77 float Alcohol = MQ135.readSensor(); // SSensor will read PPM concentration using the model, a and b values set previously or from the setup
78
79 MQ135.setA(118.47); MQ135.setB(-2.862); // Configure the equation to calculate CO2 concentration value
80 float CO2 = MQ135.readSensor(); // Sensor will read PPM concentration using the model, a and b values set previously or from the setup
81
82 MQ135.setA(44.947); MQ135.setB(-3.445); // Configure the equation to calculate Toluene concentration value
83 float Toluen = MQ135.readSensor(); // Sensor will read PPM concentration using the model, a and b values set previously or from the setup
84
85 MQ135.setA(102.2); MQ135.setB(-2.473); // Configure the equation to calculate NH4 concentration value
86 float NH4 = MQ135.readSensor(); // Sensor will read PPM concentration using the model, a and b values set previously or from the setup
87
88 MQ135.setA(34.668); MQ135.setB(-3.369); // Configure the equation to calculate Acetone concentration value
89 float Acetone = MQ135.readSensor(); // Sensor will read PPM concentration using the model, a and b values set previously or from the setup
90 Serial.print("\n"); Serial.print(CO);
91 Blynk.virtualWrite(V0, CO);
92 Serial.print("\n"); Serial.print(Alcohol);
93 Blynk.virtualWrite(V1, Alcohol);
94 Serial.print("\n"); Serial.print(CO2 + 400);
95 Blynk.virtualWrite(V2, CO2 + 400);
96 Serial.print("\n"); Serial.print(Toluen);
97 Blynk.virtualWrite(V3, Toluen);
98 Serial.print("\n"); Serial.print(NH4);
99 Blynk.virtualWrite(V4, NH4);
100 Serial.print("\n"); Serial.print(Acetone);
101 Blynk.virtualWrite(V5, Acetone);
102 Serial.println("\n");
103
104 /*
105 | Exponential regression:
106 | GAS | a | b
107 | CO | 605.18 | -3.937
108 | Alcohol | 77.255 | -3.18
109 | CO2 | 118.47 | -2.862
110 | Toluen | 44.947 | -3.445
111 | NH4 | 102.2 | -2.473
112 | Acetone | 34.668 | -3.369
113 */
114
115 delay(2000); //Sampling frequency
116
117 float h = dht.readHumidity();
118 float t = dht.readTemperature();
119 float f = dht.readTemperature(true);
120 if (isnan(h) || isnan(t) || isnan(f)) {
121   Serial.println(F("Failed to read from DHT sensor!"));
122   return;
123 }
124 float hif = dht.computeHeatIndex(f, h);
125 float hic = dht.computeHeatIndex(t, h, false);
126 Serial.print(F("Humidity: "));
127 Serial.print(h);
128 Blynk.virtualWrite(V6, h);
129 Serial.print(F("% Temperature: "));
130 Serial.print(t);
131 Blynk.virtualWrite(V7, t);
132 Serial.print(F("°C "));
133 Serial.print(f);
134 Serial.print(F("°F Heat index: "));
135 Serial.print(hic);
136 Blynk.virtualWrite(V8, hic);
137 Serial.print(F("°C "));
138 Serial.print(hif);
139 Serial.println(F("°F"));
140 char status;
141 double T, P, p0, a;

```

Fig.4.17coding 3

```

104
105 | Exponential regression:
106 | GAS | a | b
107 | CO | 605.18 | -3.937
108 | Alcohol | 77.255 | -3.18
109 | CO2 | 118.47 | -2.862
110 | Toluen | 44.947 | -3.445
111 | NH4 | 102.2 | -2.473
112 | Acetone | 34.668 | -3.369
113 */
114
115 delay(2000); //Sampling frequency
116
117 float h = dht.readHumidity();
118 float t = dht.readTemperature();
119 float f = dht.readTemperature(true);
120 if (isnan(h) || isnan(t) || isnan(f)) {
121   Serial.println(F("Failed to read from DHT sensor!"));
122   return;
123 }
124 float hif = dht.computeHeatIndex(f, h);
125 float hic = dht.computeHeatIndex(t, h, false);
126 Serial.print(F("Humidity: "));
127 Serial.print(h);
128 Blynk.virtualWrite(V6, h);
129 Serial.print(F("% Temperature: "));
130 Serial.print(t);
131 Blynk.virtualWrite(V7, t);
132 Serial.print(F("°C "));
133 Serial.print(f);
134 Serial.print(F("°F Heat index: "));
135 Serial.print(hic);
136 Blynk.virtualWrite(V8, hic);
137 Serial.print(F("°C "));
138 Serial.print(hif);
139 Serial.println(F("°F"));
140 char status;
141 double T, P, p0, a;

```

Fig.4.18 coding 4

```

Arduino IDE File Edit Sketch Tools Help
Edgent_ESP32_hexa | Arduino IDE 2.0.4
48°C / 48°C Fan Off 55% Fri 24 Mar 12:01 AM

Select Board

Edgent_ESP32_hexa.ino
141 status = pressure.startTemperature();
142 if (status != 0)
143 {
144   delay(status);
145   status = pressure.getTemperature(T);
146   if (status != 0)
147   {
148     status = pressure.startPressure(3);
149     if (status != 0)
150     {
151       delay(status);
152       status = pressure.getPressure(P, T);
153       if (status != 0)
154       {
155         Serial.print("Absolute Pressure: ");
156         Serial.print(P, 2);
157         Serial.print(" hpa = ");
158         double pa = P*100;
159         Serial.print(pa, 2);
160         Serial.print(" pa = ");
161         double atm = P * 0.00986923;
162         Serial.print(atm, 2);
163         Serial.print(" atm = ");
164         double mmHg = P * 0.750063755;
165         Serial.print(mmHg, 2);
166         Serial.print(" mmHg = ");
167         double torr = P * 0.750061683;
168         Serial.print(torr, 2);
169         Serial.print(" torr = ");
170         Blynk.virtualWrite(V12, torr);
171         double psi = P * 0.014503774;
172         Serial.print(psi, 2);
173         Serial.println(" psi");
174         p0 = pressure.seaLevel(P, ALTITUDE); // we're at 943.7 meters
175         Serial.print("Relative (sea-level) pressure: ");
176         Serial.print(p0, 2);
177         Serial.println(" hpa ");
178       }
179     }
180   }
181 }
182 else Serial.println("error retrieving pressure measurement\n");
183 }
184 else Serial.println("error starting pressure measurement\n");
185 }
186 else Serial.println("error retrieving temperature measurement\n");
187 }
188 else Serial.println("error starting temperature measurement\n");
189 Blynk.virtualWrite(V9, p0);
190 Blynk.virtualWrite(V10, a);
191 }
192 }
193 }

```

Fig.4.19 coding 5

```

Arduino IDE File Edit Sketch Tools Help
Edgent_ESP32_hexa | Arduino IDE 2.0.4
48°C / 48°C Fan Off 55% Fri 24 Mar 12:01 AM

Select Board

Edgent_ESP32_hexa.ino
157 Serial.print(" hpa = ");
158 double pa = P*100;
159 Serial.print(pa, 2);
160 Serial.print(" pa = ");
161 double atm = P * 0.00986923;
162 Serial.print(atm, 2);
163 Serial.print(" atm = ");
164 double mmHg = P * 0.750063755;
165 Serial.print(mmHg, 2);
166 Serial.print(" mmHg = ");
167 double torr = P * 0.750061683;
168 Serial.print(torr, 2);
169 Serial.print(" torr = ");
170 Blynk.virtualWrite(V12, torr);
171 double psi = P * 0.014503774;
172 Serial.print(psi, 2);
173 Serial.println(" psi");
174 p0 = pressure.seaLevel(P, ALTITUDE); // we're at 943.7 meters
175 Serial.print("Relative (sea-level) pressure: ");
176 Serial.print(p0, 2);
177 Serial.println(" hpa ");
178 a = pressure.altitude(P, p0);
179 Serial.print("Altitude: ");
180 Serial.print(a, 0);
181 Serial.println(" meters ");
182 }
183 else Serial.println("error retrieving pressure measurement\n");
184 }
185 else Serial.println("error starting pressure measurement\n");
186 }
187 else Serial.println("error retrieving temperature measurement\n");
188 }
189 else Serial.println("error starting temperature measurement\n");
190 Blynk.virtualWrite(V9, p0);
191 Blynk.virtualWrite(V10, a);
192 }
193 }

```

Fig.4.20 coding 6

4.11 WEIGHT ESTIMATION

The overall weight of a hexacopter has been estimated. Weight estimation is one of the important parameters in the hexacopter theoretical calculation and also it plays a vital role in selection of hexacopter components. Based on the top up approach, the entire design calculation is done.

- Payload weight - 0.5 to 1.5 KG
- Weight of propeller - 0.1 to 0.3 KG
- Weight of the motor - 1.2 KG (6*0.2)
- Weight of the battery - 0.5 KG
- Weights of the Hexa Structure - 1 KG
- Overall weight (approx.) - 2 to 2.5 KG
- Height of the landing bed - 7 cm

4.12 MODES OF HEXACOPTER

There are several modes of operation that a hexacopter can use for FPV system surveillance. Then are some of the most common modes

4.12.1 Manual Mode

In homemade mode, the driver has full control over the hex copter's movements, including its altitude, direction, and speed. This mode is best suited for educated aviators who bear full control over the drone's movements.

4.12.2 Altitude Hold Mode

In altitude hold mode, the drone maintains a steady altitude, allowing the driver to concentrate on controlling its direction and speed. This mode is useful for landing stable footage and images.

4.12.3 Position Hold Mode

In position hold mode, the drone maintains its position in space, using GPS or other detectors to hold its position indeed in windy conditions. This mode is useful for landing footage or images of a stationary object or position.

4.12.4 Waypoint Mode

In waypoint mode, the drone follows a predefined flight path, stopping at designated points to capture footage or images. This mode is useful for surveying a large area or following a specific path.

4.12.5 Follow Me Mode

In follow me mode, the drone follows the driver or another designated object, using detectors to maintain a safe distance and altitude. This mode is useful for landing footage or images of a moving object or person.

4.12.6 Return to Home Mode

In return to home mode, the drone automatically returns to its starting point, using GPS or other detectors to navigate back to its takeoff position. This mode is useful for icing the safe return of the drone in case of low battery or lost connection.

These are some of the modes that a hexacopter can use for FPV system surveillance, and the specific mode used will depend on the specific conditions of the surveillance charge.

These are some of the modes that a hexacopter can use for FPV system surveillance, and the specific mode used will depend on the specific conditions of the surveillance charge.

4.13 DESIGN OF HEXACOPTER

Six motors are mounted to the frame by arms and rotate the propeller at high speeds to provide thrust. Three motors are set to revolve clockwise (CW) and anticlockwise (CCW) to ensure stability. It is possible to negate the net moment about the drone's yaw axis using this configuration. BLDC motors are used in multi-rotors, and the rotational speed is regulated by three separate phases of current. The programmed rotational speed of the motors is maintained using ESCs (Electronic Speed Controllers). ESCs continually monitor the feedback current from the motor and make minute adjustments to the motor's input current. The Inertial Measurement Unit (IMU), which consists of an accelerometer and a gyroscope, is used for calculating short-term movement.

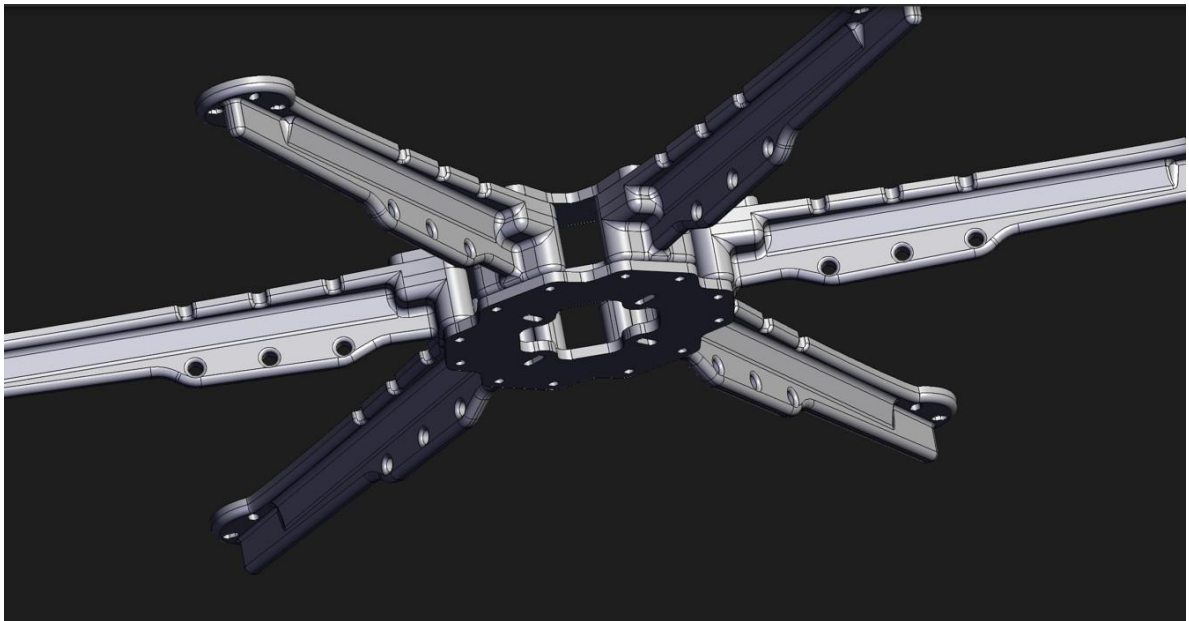


Fig.4.21 side view of the frame

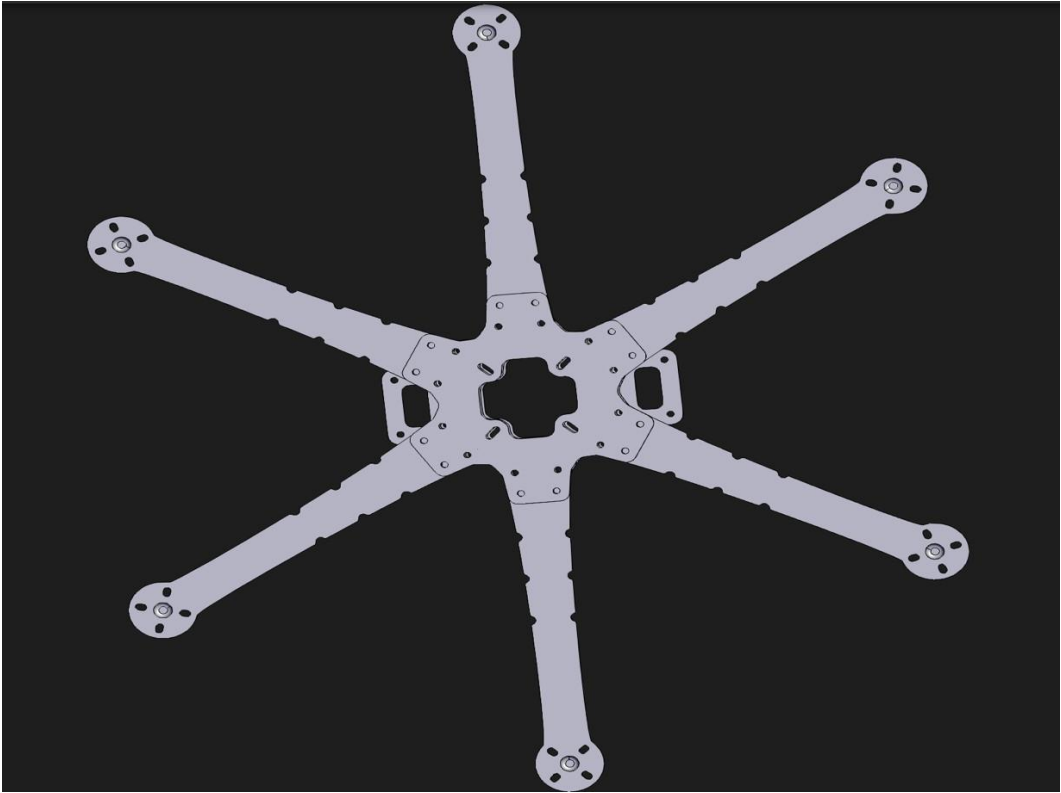


Fig. 4.22 top view of the frame

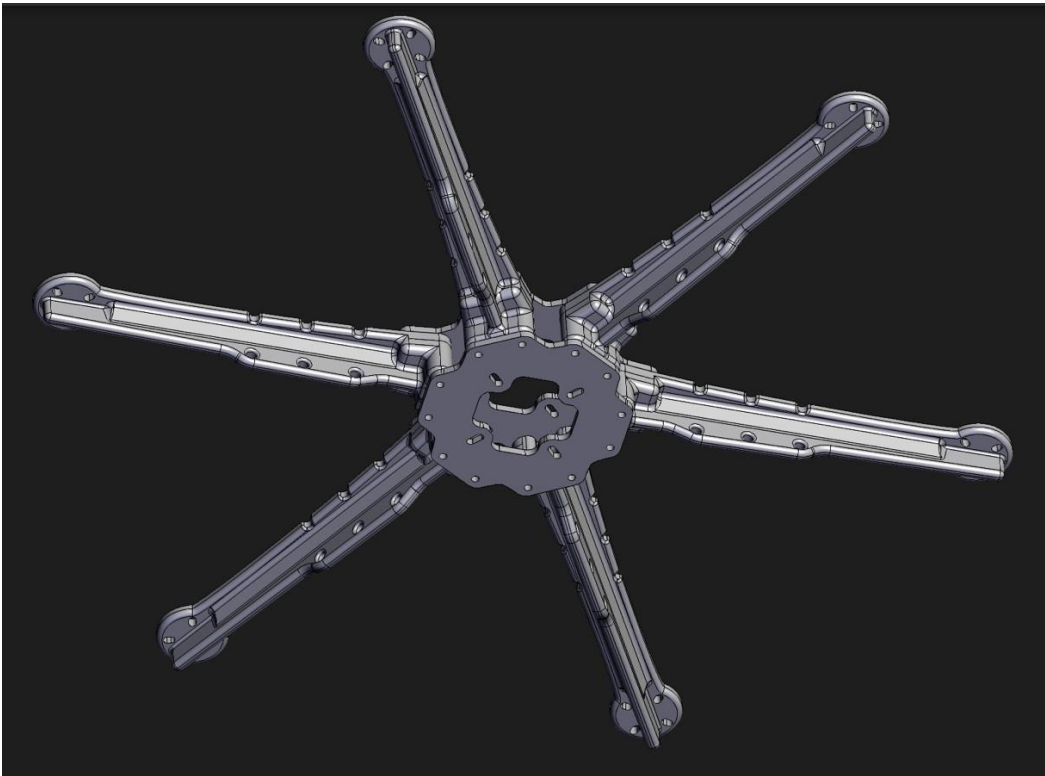


Fig. 4.23 bottom view of the frame



Fig. 4.24 Building process of the hexacopter



Fig. 4.25 finished product

CHAPTER 5

RESULT AND DISCUSSIONS

5.1 RESULTS AND DISCUSSION

The further research about the pollution monitoring UAV has many potentials in different area such as advancements in sensor technology, integration of artificial intelligence, development of autonomous drones, interdisciplinary studies, integration with other environment monitoring technologies, legal and ethical implication. Artificial intelligence can be used to analyze the data collected by pollution monitoring drones. This could help in identifying patterns and trends in pollution levels, predicting future pollution events, and providing insights for policy-makers. Autonomous drones can operate without human intervention, making them ideal for monitoring pollution in hazardous or hard-to-reach areas. Further research is needed to improve the reliability and safety of autonomous drones. Collaboration between environmental scientists, engineers, and computer scientists is essential to developing Future studies could focus on interdisciplinary approaches to designing and testing drone-based pollution monitoring systems. Pollution monitoring drones can be used in conjunction with other environmental monitoring technologies such as satellite imaging, ground-based sensors, and citizen science initiatives. Research is needed to determine how to integrate these technologies effectively to provide a comprehensive picture of pollution levels. The use of drones for pollution monitoring raises legal and ethical questions related to privacy, data ownership, and the use of drones in public spaces. Future studies could explore these issues and develop guidelines for responsible and ethical use of pollution monitoring drones. there is more room for improvement on the coding system by adding more code lines to the current system and physically integrating raspberry pi 4 to the drone to test the code while the drone is in flying mode. The results and output data are seen in an app called BLYNK

5.2 OBSERVATION

The data obtained by the system is viewed in the BLYNK app as follows

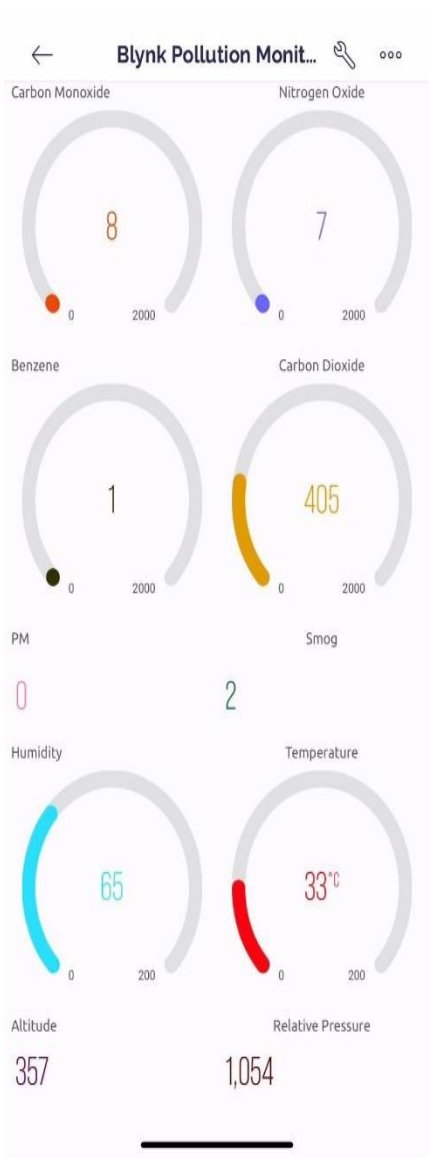


Fig : 5.1 readings

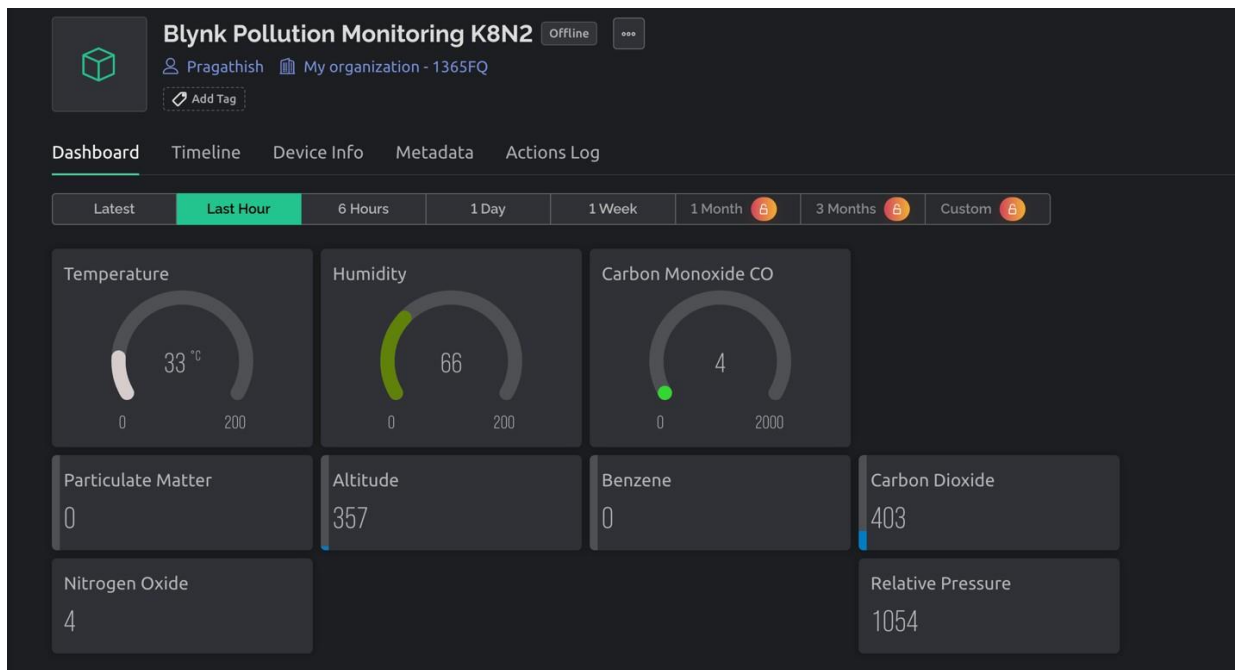


Fig : 5.2 reading

The above readings were taken at different places at different times. Here, **fig 5.1** shows the readings taken at our college campus when our drone was tested whereas **fig 5.2** shows the readings taken at Palakkad, Kerala . comparing the readings, we conclude that the air quality in Palakkad is better than Chennai's air quality .

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

The pollution monitoring hexacopter is an innovative new device that has the potential to assist solve the rising problem of air pollution. Its capacity to collect real-time data on air quality and contaminants might give useful insights for policymakers and researchers in developing successful pollution-reduction plans.

6.2 FUTURE WORK

There are several areas where the pollution monitoring hexacopter can be improved and further developed. Here are some suggestions for future work:

1. Improved sensor technology: The hexacopter may be outfitted with more modern and sensitive sensors capable of detecting a broader variety of contaminants such as volatile organic compounds (VOCs) and fine particulate matter (PM_{2.5}).
2. Autonomous flying: Creating an autonomous flight system that can navigate and gather data without human involvement can increase data collecting accuracy and efficiency.
3. Machine learning algorithms: Using machine learning algorithms to analyze data acquired by the hexacopter can give important insights into pollution causes and trends.
4. Integration with other technologies: To give a more thorough picture of air pollution, the hexacopter may be combined with other technologies such as weather stations and satellite photography.

Overall, the pollution monitoring hexacopter has the potential to revolutionize the monitoring and control of air pollution. With further study and development, it has the potential to become a vital weapon in the battle against air pollution.

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