

**ORNITHOPTER
SMART QUADCOPTER FOR ENVIRONMENTAL MONITORING
USING IOT TECHNOLOGY**

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering Degree in **Electronics and Communication Engineering**

By

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)
Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

MARCH 2021

(i)



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **NOONI MADHAVA RAJU SAI THARUN (37130288)** and **PULASANI VISWESWARA REDDY (37130327)** Who carried out the project entitled **“ORNITHOPTER SMART QUADCOPTER FOR ENVIRONMENTAL MONITORING USING IOT TECHNOLOGY”** under our supervision from December 2020 to March 2021.

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DECLARATION

We, **NOONI MADHAVA RAJU SAI THARUN (37130288)** and **PULASANI VISWESWARA REDDY (37130327)** hereby declare that the Project Report entitled “**ORNITHOPTER SMART QUADCOPTER FOR ENVIRONMENTAL MONITORING USING IOT TECHNOLOGY**” done by us under the guidance of **Dr.S.KARTHIKEYAN** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

1)

2)

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

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We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr.S.KARTHIKEYAN ,Associate professor, Department of Electronics and Communication Engineering** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of the project work.

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ABSTRACT

Aerial drones are emerging as an effective tool for environmental monitoring and enforcement because of their ability to reach areas that would be otherwise inaccessible or cost-prohibitive. As EPA and other agencies consider using drones to monitor industrial sites and farmland, many landowners claim it would be an invasion of privacy. Air pollution monitoring has recently become an issue of utmost importance in our society. Despite the fact that crowd sensing approaches could be an adequate solution for urban areas, they cannot be implemented in rural environments. Instead, deploying a fleet of UAVs could be considered an acceptable alternative. Embracing this approach, this paper proposes the use of UAVs equipped with off-the-shelf sensors to perform air pollution monitoring tasks. In particular, it is able to find the most polluted areas with more accuracy and provides a higher coverage within the time bounds defined by the UAV flight time. Together, they allow automatically performing the monitoring of a specified area using UAVs.

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LIST OF ABBREVIATIONS

UAS	-	Unmanned Aerial Systems
SFM	-	Structure from Motion
BEC	-	Battery Eliminator Circuit
BLDC	-	Brushless DC Motor
ESC	-	Electronic Speed Control
IOT	-	Internet of Things
FEA	-	Finite Element Analysis
UAV-		Unmanned Aerial Vehicle

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CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION:

Over the last decade, lightweight unmanned aerial systems (UAS) have evolved to become an integral element of spatially distributed environmental monitoring. UAS systems are increasingly a routine component of remote sensing tool-kits, providing a unique earth observation capacity that has been incorporated across a large number of applications, including the mapping and monitoring of both natural ecosystems and managed forest plantations, precision agriculture, river and stream flow measurements, topographic surveys , and natural hazard mapping , to highlight just a few examples. The expanding use of UAS in environmental studies has produced a diversity of approaches for collection, processing and analysis, which emphasizes the need to develop standardized protocols for UAS mapping. Within the last few years, a range of UAS survey protocols have emerged across specific environmental studies, such as the mapping of glacial geomorphology, river landscape mapping, classification of wetland vegetation, and routine vegetation is monitoring using multispectral sensors. In parallel, standardized workflows and reviews have been developed for the many different processes undertaken within UAS surveys, whether these are radiometric calibrations, optimizing topographic surveys, or best classification methods assessments.

Despite the diversity of environmental UAS surveys, the majority of applications cluster around a few core areas, such as topographic mapping, precision agriculture or forestry; yet we are still far from the definition of standard protocols that can be translated across different contexts and environments. Observed that many surveys paid little attention to the planning and processing of UAS imagery; perhaps the key steps need to be taken with forethought and care to ensure useable imagery. Given the emerging nature of this technology, it is not surprising that many studies may lack the use of standardized georeferencing procedures, radiometric and atmospheric correction, sensors calibration and error characterization, or even a classification accuracy assessment.

Such procedures constitute a constellation of interconnected, and often interdependent, tasks that requires a structure and framework to describe and develop a robust collection, characterization and processing methodology, such aggregation of experience can help to inform the description and establishment of accepted protocols for mapping environmental features.

1.2 About the Project:

Quadcopter, also known as quadrotor helicopter or quadrotor, is a multirotor helicopter that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors. In a quadcopter, two of the propellers spin in one direction (clockwise) and the other two spin the opposite direction (counterclockwise) and this enables the machine to hover in a stable formation. Firstly the motors which we used have an obvious purpose: to spin the propellers. Motors are rated by kilovolts, the higher the kV rating, the faster the motor spins at a constant voltage. Next the Electric Speed controller or ESC, is what tells the motors how fast to spin at any given time. We need four ESCs for a quadcopter, one connected to each motor. The ESCs are then connected directly to the battery through either a wiring harness or power distribution board. Many ESCs come with a built in battery eliminator circuit (BEC), which allows you to power things like your flight control board and radio receiver without connecting them directly to the battery. Because the motors on a quadcopter must all spin at precise speeds to achieve accurate flight, the ESC is very important. Our Quadcopter uses four propellers, each controlled by its own motor and electronic speed controller. Using accelerometers we are able to measure the angle of the Quadcopter in terms of X, Y and Z and accordingly adjust the RPM of each motor in order to self-stabilize itself. The Quadcopter platform provides stability as a result of the counter rotating motors. For Hovering over the skies the flight controller which is used is the „brain“ of the quadcopter. It houses the sensors such as gyroscopes and accelerometers that determine how fast each of the quadcopter's motors spin.

Its purpose is to stabilize the aircraft during flight and to do this, it takes signals from on-board gyroscopes (roll, pitch and yaw) and passes these signals to the Atmel644PA processor, which in-turn processes signals according the users selected firmware (e.g. Quadcopter) and passes the control signals to the installed Electronic Speed Controllers (ESCs) and the combination of these signals instructs the ESCs to make fine adjustments to the motors rotational speeds which in-turn stabilizes the craft. For measuring the amount of Carbon dioxide present in the atmosphere we used carbon dioxide gas sensor. The most common principles for sensors are infrared gas sensors and chemical gas sensors. Measuring carbon dioxide is important in monitoring indoor air quality, the function of the lungs in the form of a capnography device, and many industrial processes. Quadcopter hovering over skies installed with gas sensor measure the amount of carbon dioxide present.

CHAPTER-2

LITERATURE SURVEY

2. LITERATURE SURVEY:

1. on the Use of Unmanned Aerial Systems for Environmental Monitoring. Remote Sensor.

Authors: Manfreda, S.; McCabe, M.; Miller, P.; Lucas, R.; Pajuelo Madrigal, V.; Mallinis, G.; Ben Dor, E.; Helman, D.; Estes, L.; Ciraolo, G.

Environmental monitoring plays a central role in diagnosing climate and management impacts on natural and agricultural systems; enhancing the understanding of hydrological processes; optimizing the allocation and distribution of water resources; and assessing, forecasting, and even preventing natural disasters. Nowadays, most monitoring and data collection systems are based upon a combination of ground-based measurements, manned airborne sensors, and satellite observations. These data are utilized in describing both small- and large-scale processes, but have spatiotemporal constraints inherent to each respective collection system. Bridging the unique spatial and temporal divides that limit current monitoring platforms is key to improving our understanding of environmental systems. In this context, Unmanned Aerial Systems (UAS) have considerable potential to radically improve environmental monitoring.

2. A meta-analysis and review of unmanned aircraft system (UAS) imagery for terrestrial applications. Int. J. Remote Sens.

Authors: Singh, K.K.; Frazier, A.E

Over the past decade, the remote-sensing community has eagerly adopted unmanned aircraft systems (UAS) as a cost-effective means to capture imagery at spatial and temporal resolutions not typically feasible with manned aircraft and satellites. The rapid adoption has outpaced our understanding of the relationships between data collection methods and data quality, causing uncertainties in data and products derived from UAS and necessitating exploration into how researchers are using UAS for terrestrial applications.

3. Use of Unmanned Aerial Systems for multispectral survey and tree classification.

Authors: Gini, R.; Passoni, D.; Pinto, L.; Sona, G.

In the frame of project FoGLIE (Fruition of Goods and Landscape in Interactive Environment), UAS were used to survey a park area in its less accessible zones, for scenic and stereoscopic videos, 3D modeling and vegetation monitoring. For this last application, specifically, through the acquisition of very high resolution images taken with two UAS-borne compact cameras (RGB and NIR), a DSM of a small vegetated area and the corresponding orthoimages were produced and co-registered.

4. Optimal Altitude, Overlap, and Weather Conditions for Computer Vision UAV Estimates of Forest Structure. Remote Sens.

Authors: Dandois, J.; Olano, M.; Ellis, E.

Ecological remote sensing is being transformed by three-dimensional (3D), multispectral measurements of forest canopies by unmanned aerial vehicles (UAV) and computer vision structure from motion (SFM) algorithms. Yet applications of this technology have out-paced understanding of the relationship between collection method and data quality. Here, UAV-SFM remote sensing was used to produce 3D multispectral point clouds of Temperate Deciduous forests at different levels of UAV altitude, image overlap, weather, and image processing. Error in canopy height estimates was explained by the alignment of the canopy height model to the digital terrain model due to differences in lighting and image overlap.

5. Template for high-resolution river landscape mapping using UAV technology. Measurement 2018.

Authors: Rusnák, M.; Sládek, J.; Kidová, A.; Lehotský, M.

This presents the template for high-resolution mapping of a river landscape by Unmanned Aerial Vehicle (UAV) technology with the following five steps: (i) reconnaissance of the mapped site; (ii) pre-flight field work; (iii) flight mission; (iv) quality check and processing of aerial data; and (v) operations above the processed layers and landforms (objects) mapping (extraction).

6. Radiometric Assessment of a UAV-Based Push-Broom Hyperspectral Camera Sensors 2019.

Authors: Barreto, M.A.P.; Johansen, K.; Angel, Y.; McCabe, M.F.

The use of unmanned aerial vehicles (UAVs) for Earth and environmental sensing has increased significantly in recent years. This is particularly true for multi- and hyperspectral sensing, with a variety of both push-broom and snap-shot systems becoming available. However, information on their radiometric performance and stability over time is often lacking. The authors propose the use of a general protocol for sensor evaluation to characterize the data retrieval and radiometric performance of push-broom hyperspectral cameras, and illustrate the workflow with the Nano-Hyperspec (Headwall Photonics, Boston USA) sensor. The objectives of this analysis were to: (1) assess dark current and white reference consistency, both temporally and spatially; (2) evaluate spectral fidelity; and (3) determine the relationship between sensor-recorded radiance and spectroradiometer-derived reflectance.

CHAPTER-3

AIM & SCOPE OF THE

PRESENT

INVESTIGATION

3.1 Aim:

The goal of our project is to design, implement, and test a stable flying Quadcopter that can be used to collect the gases range. Our plan was to choose an existing Quadcopter kit and add the required components to give the Quadcopter the capabilities to gather and log data autonomously. If this goal is accomplished, our team would also like to design and implement some autonomous commands that may help aid a user in collecting the data. These commands include the auto-landing command, auto-move command, auto-homing command, and hold position command. The effect of air pollution on the environment, economic and health of the people in the affected countries cannot be overemphasized investigates large scale air pollution elimination to remove pollutants that are already in existence in the environment. This method involves the use of environmental drones to autonomously monitor the air quality at a specific location. The drones flies up to a predetermined height every hour, measures the air pollutants at that location, implements on board pollution abatement solutions for pollutants above the recommended threshold, and then flies back down to its location on the ground. The advantages of this system is its ability to measure air pollution to detect when they are too high and implement on board pollution abatement solutions as needed. This system's novelty lies in the fact that it not only detects when there are excessive pollution, but it also automatically deals with and abates the detected air pollution above earth. When multiple drones are used in different locations can be used for present and long term environmental analysis.

3.2 Scope of the present Investigation:

This project created a platform to learn about the unmanned aerial vehicles such as a Quadcopter. This expands the scope of the electrical engineering education to include the control and the understanding of the mechanical components. The Quadcopter has many applications that we are interested to develop like mapping and video streaming especially in a disaster and dangerous area.

It also opens up the possibilities to broaden the understanding and applications of control systems, stabilization, artificial intelligence and GPS navigation as it applies to the

Quadcopter. Quadcopter unmanned aerial vehicles are used for surveillance and reconnaissance by military and law enforcement agencies, as well as search and rescue missions in urban environments. The military use of unmanned aerial vehicles (UAVs) has grown because of their ability to operate in dangerous locations while keeping their human operators at a safe distance. The larger UAVs also provide a reliable long duration, cost effective, platform for reconnaissance as well as weapons. They have grown to become an indispensable tool for the military. One such example is the Aeryon Scout, created by Canadian company Aeryon Labs which is a small UAV that can quietly hover in place and use a camera to observe people and objects on the ground. In addition to the military uses of the small UAV, we were interested in evaluating applications in the commercial and industrial sector. Our premise was that if smaller and cheaper UAVs become readily available, new markets and uses will emerge. Potential new markets in commercial and industrial applications include inspecting pipelines or even inspecting dangerous areas like a meltdown site at a nuclear power plant. Disaster relief or crop assessment seems also to be likely areas where small UAVs could be useful. We were also motivated by on-campus uses such as monitoring parking or quick-look video of an incident, or monitoring hard to reach locations, or exploration of a collapsed building or other dangerous location.

CHAPTER-4

MATERIALS

&

METHODS

MATERIALS AND METHODS:

4.1 Materials:

In this section, the parameters and elements considered to perform are explained. In the first subsection, an overview of the available types of drones that can be utilized in PA and the description of the flight plan of the considered scenario is provided. In the second subsection, the characteristics of commercial nodes that can be utilized for our proposed scenario are detailed. In the third subsection, the background on the antenna radiation model and the best antenna types for the scenario are presented. Furthermore, the theoretical framework used to perform the calculations is described

4.2 Existing System:

In 1916, A. M. Low's "Aerial Target" was one of the first unmanned aerial vehicle. The birth of U.S. UAVs began in 1959 when United States Air Force officers were concerned about losing pilots over hostile territory and they thought of unmanned flights. In the year 1964, U.S Navy initiated America's highly classified 'Red Wagon' UAVs into their first combat missions of the Vietnam war. If we focus specifically on research using quadrotor multicopters, authors like Gupte et al. and Colomina and Molina consider that, given their high maneuverability, compactness, and ease of use, different applications for these devices are being found in areas including civil engineering, search and rescue, emergency response, national security, military surveillance, border patrol, and surveillance, as well as in other areas such as Earth Sciences, where they can be used to study climate change, glacier dynamics, and volcanic activity or for atmospheric sampling, among others.

4.3 Problem Statement:

- Domestic drones violate right to privacy. Ø some drones are lethal and not just used for surveillance.
- People feel paranoid and like they're being watched by the government.

- With drones being unmanned flying machines, less aviation jobs are needed.
- They're very expensive and a rarity among the world.

4.4 Proposed System:

Quadcopter is a device with an intense mixture of electronics, mechanical and mainly on the principle of aviation. The environmental monitoring is carried out by the sensors attached to the Arduino microcontroller. Quadcopter has four motors whose speed of rotation and the direction of rotation changes according to the user's desire to move the device in particular Direction take off motion, landing forward motion, backward motion right motion. The rotation of motor changes as per the transmitted signal send the form the four channel transmitter. The signal from micro controller goes to ESC which in turn controls the speed of motor the program for which is written in the ATMEGA 16 chip The sensors data's uploaded to the cloud for monitoring purposes. Then location of the drone will be send to the cloud space with sms alert .

4.5 Description:

The circles represent the spinning rotors of the quadcopter and the arrows represent the rotation direction. Motors one and three rotate in a clockwise direction using pusher rotors. Motor two and four rotate in a counterclockwise direction using puller rotors. Each motor produces a thrust and torque about the center of the quadcopter. Due to the opposite spinning directions of the motors, the net torque about the center of the quadcopter is ideally zero, producing zero angular acceleration. This eliminates the need for yaw stabilization. A vertical force is created by increasing the speed of all the motors by the same amount of throttle. As the vertical forces overcome the gravitational forces of the earth, the quadcopter begins to rise in altitude. The vertical movement of the quadcopter. As above, the circles represent the spinning rotors, the larger arrows represent the direction the rotors are spinning, and the black arrows represent the forces caused by the spinning rotors. Pitch is provided by increasing (or decreasing) the speed of the front or rear motors.

BLOCK DIAGRAM OF QUADCOPTER

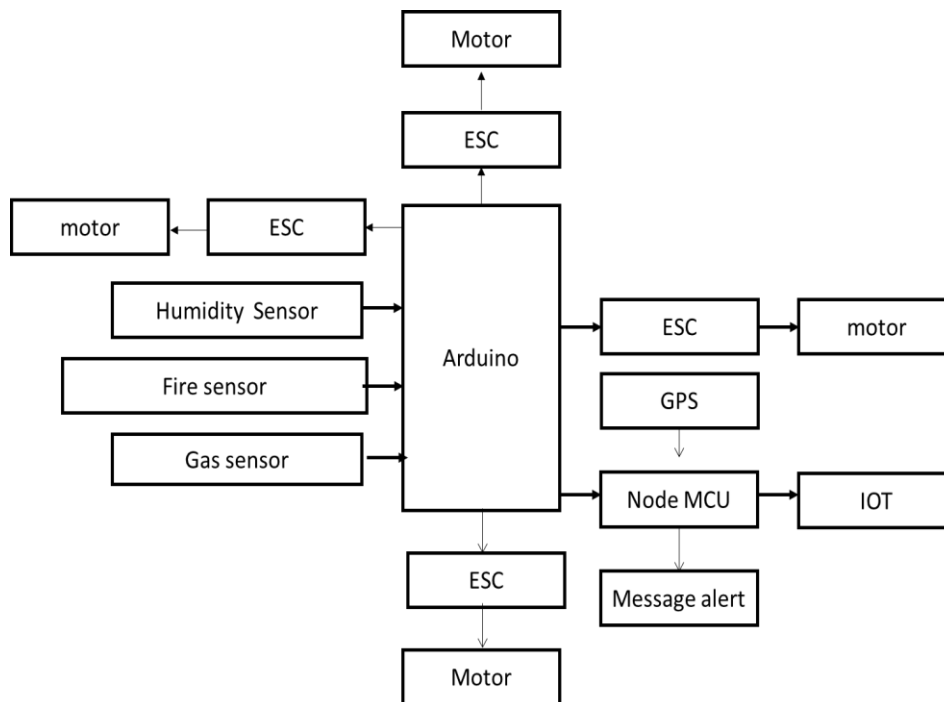


Figure-4.1

4.6 System Description:

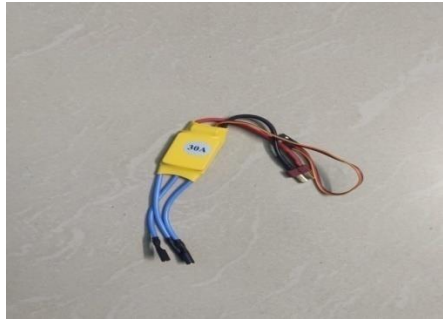
1. BLDC: The brushless motors are multi-phased, normally 3 phases, so direct supply of DC power will not turn the motors on. BLDC electric motor also known as electronically commutated motors.



BLDC motor

Figure-4.2

2. ESC: The ESC generating three high frequency signals with different but controllable phases continually to keep the motor turning. The ESC is also able to source a lot of current as the motors can draw a lot of power.



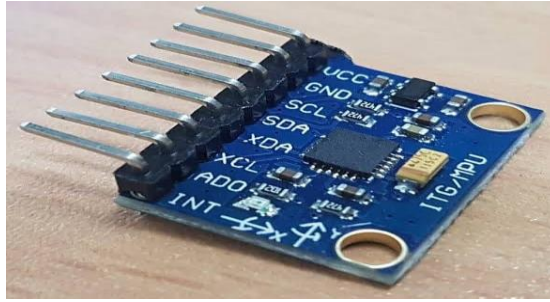
ESC

Figure-4.3

3. DC: 30PRM 12 v DC geared motors for robotics application. Very Easy to use and available in standard size. A power supply is an electronic device that supplies electric energy to an electrical load.

4. Accelerometer Sensor: The accelerometer measures acceleration and also force, so the downwards gravity will also be sensed. As the accelerometer has three axis sensors, we can work out the orientation of the device.

5. Gyroscope Sensor: A gyroscope measure angular velocity, in other words the rotational speed around the three axis. A gyroscope is a device that uses Earth's gravity to help determine orientation. Its design consists of a freely-rotating disk called arotor, mounted onto a spinning axis in the center of a larger and more stable.



Gyroscope Sensor

Figure-4.4

6. LIPOBattery: LiPo battery can be found in a single cell (3.7V) to in a pack of over 10 cells connected in series (37V). A popular choice of battery for a Quadcopter is the 3SP1 batteries which means three cells connected in series as one parallel, which should give us 11.1V.



Lipo Battery

Figure-4.5

4.7 Hardware Description:

1. ATmega328 High Performance, Low Power AVR® 8-Bit Microcontroller. Advanced RISC Architecture. 131 Powerful Instructions – Most Single Clock Cycle Execution Six PWM Channels. 6-channel 10-bit ADC in PDIP Package. Programmable Serial USART Master/Slave SPI Serial Interface.

2. BLDC (3000mAh, 25C) Brushless DC electric motor also known as electronically commutated motors are synchronous motors that are powered by a DC electric source via integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. A BLDC motors for quadcopter is constructed with a permanent magnet rotor and wire wound stator poles.

3. ESC ESC is used to control BLDC motor. It takes signal from microcontroller and breaks into 3 parts and sends it to the BLDC motor. We would require 4 ESCs as we are using 4 BLDC motor. The ESC is an inexpensive motor controller board that has a battery input and a three phase output for the motor. Each ESC is controlled independently by a PPM signal (similar to PWM). The frequency of the signals vary, but for a Quadcopter it is recommended the controller should support high enough frequency signal, so the motor speeds can be adjusted quick enough for optimal stability.

4. Accelerometer Sensor Digital-output triple-axis accelerometer with a programmable full scale range of $\pm 2g$, $\pm 4g$, $\pm 8g$ and $\pm 16g$ Integrated 16-bit ADCs enable simultaneous sampling of accelerometers while requiring no external multiplexer Accelerometer normal operating current: $500\mu A$ Low power accelerometer mode current: $10\mu A$ at $1.25Hz$, $20\mu A$ at $5Hz$, $60\mu A$ at $20Hz$, $110\mu A$ at $40Hz$ Orientation detection and signaling Tap detection User-programmable interrupts High-G interrupt User self-test.

5. Gyroscope Sensor Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full scale Range of ± 250 , ± 500 , ± 1000 , and $\pm 2000^\circ/sec$ External sync signal connected to the FSYNC pin supports image, video and GPS synchronization Integrated 16-bit ADCs enable simultaneous sampling of gyros Enhanced bias and sensitivity temperature stability reduces the need for user calibration Improved low- frequency noise performance Digitally-programmable low-pass filter Gyroscope operating current: $3.6mA$ Standby current: $5\mu A$.

6. Radio receiver this receives 2.4GHz signals coming from the transmitter side. It has got 6 independent channels to receive the signal from the transmitter and then send the signal to the microcontroller for further processing. Its current consumption is less than 40 mA and works on 5 volt power supply.



Radio Receiver & Transmitter

Figure-4.6

7. LIPO Battery Lithium batteries are the preferred power sources for most electric modelers today. They offer high discharge rates and a high energy storage/weight ratio. However, using them properly and charging them correctly is no trivial task.

8. DC Voltage Supply A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power. 30 RPM Side Shaft 37mm Diameter Compact DC Gear Motor is suitable for small robots automation systems. It has sturdy construction with gear box built to handle stall torque produced by the motor. Drive shaft is supported from both sides with metal bushes. Motor runs smoothly from 4V to 12V and gives 30 RPM at 12V. Motor has 6mm diameter, 22mm length drive shaft with D shape for excellent coupling. 30RPM 12VDC motors with Gearbox 6mm shaft diameter with internal whole 125gm weight.

9. Frame:

Quadcopter frame modeling is beneficial to research the responsibility of body frame half and to help determine the type of rotor and propeller so as to assure the mandatory flight acceleration. Quadcopter flight stability is influenced by the resulting thrust, by the space between each rotor propeller and conjointly by the frame rigidity; the frame has been designed to be as light-weight as possible, in the meantime maintaining the strength to hold the load. Solid works code has been used to design and analyze using Finite Element Analysis (FEA) method the quadcopter frame - having folded size of 560 (mm) square - conjointly a 406x127 (mm) propeller and rotor's angular rate and air flow produced around the propeller. The FEA methodology showed that the presence of rotational velocities in every propeller flow field can significantly affect the thrust potency which might cause flight instability or body frame vibration.



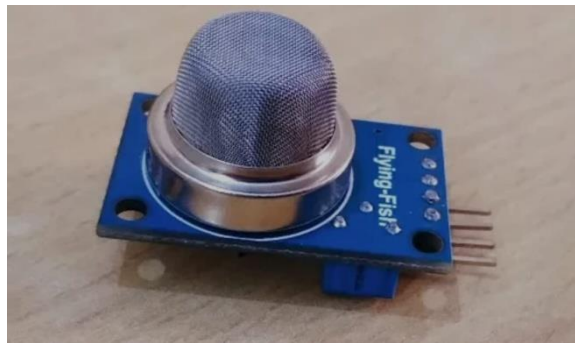
Frame

Figure-4.7

10. Gas Sensor:

In current technology state of affairs, observance of gases create is incredibly necessary. From home appliances such as air conditioners to electric chimneys and safety systems at industries observance of gases is incredibly crucial. Gas sensors square measure important a part of such systems. Tiny sort of a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at airlike state.

Gas sensors square measure accessible in wide specifications reckoning on the sensitivity levels, variety of gas to be detected, physical dimensions and various alternative factors. This Insight covers a methane gas sensor that can sense gases such as ammonia which might get create from Methane. Once a gas interacts with this sensor, it's 1st ionized into its constituents and is then adsorbate by the sensor. This sorption creates a possible difference on the element which is sent to the processor unit through output pins in kind of current.



Gas Sensor

Figure-4.8

4.8 SOFTWARE REQUIREMENTS:

Arduino IDE

Embedded C programming language

4.9 HARDWARE REQUIREMENTS:

Arduino Microcontroller

Circuit board

DC brushless motors

Electronic speed controllers

Remote control

Transmitter/ Receiver

Rechargeable battery

Fire sensor

Humidity sensor

Gas sensor

GPS

Connecting Wires

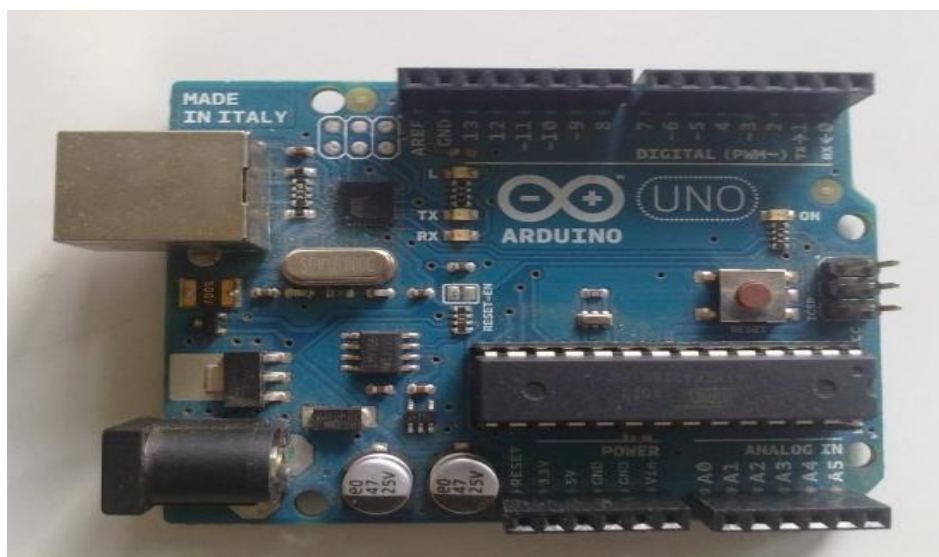
HARDWARE DESIGN:

4.10 ARDUINO UNO AND ITS PROGRAMMING:

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicating with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

Arduino Uno:



ARDUINO UNO

Figure-4.9

4.11 Overview:

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the

This is what the Arduino board looks like.



Figure-4.10

The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins.

There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors. The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

4.12 Summary:

Microcontroller ATmega328

Operating Voltage 5V

Input Voltage (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin 40 mA

DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM 2 KB (ATmega328)

EEPROM 1 KB (ATmega328)

Clock Speed 16 MHz

4.13 Pin Configuration:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

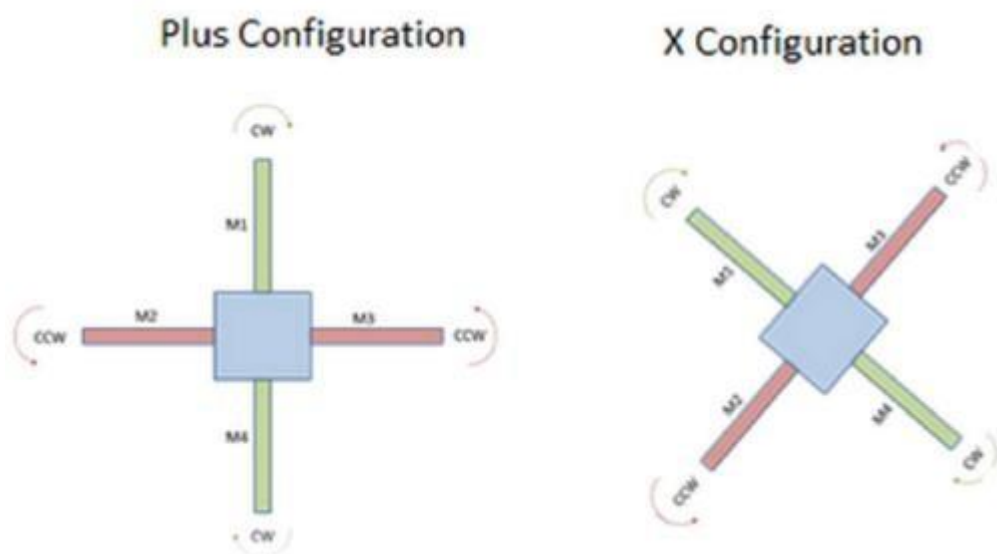
The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50mA.

- **GND.** Ground pins.
- **IOREF.** This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

4.14 METHODS:

Unmanned Aerial Vehicles have four arms and fixed pitch propellers which are set in an X or + configuration with X being the preferred configuration.



Quadcopter Configurations

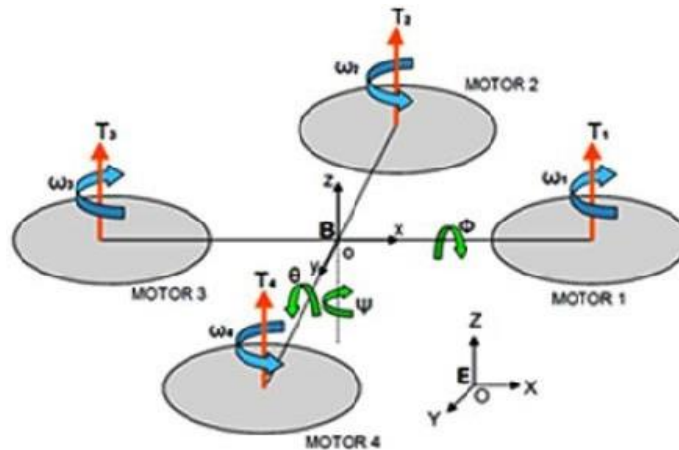
Figure 4.11

They are sometimes referred to as Drones, Quadrotors or Quadrocopters. In the standard format two propellers will spin in a clockwise direction with the other two spinning in an anticlockwise direction allowing the craft to vertically ascend, hover in the air and fly in a designated direction. The Quadcopter is a simple format with very few moving parts and has rapidly become a favorite vehicle for remote control enthusiasts and is widely being used as an effective Aerial photographic platform. A large majority of the Quadcopters were originally built by hobbyists who understood the simplicity of the vehicle.

By adding four motors and four propellers to a lightweight frame constructed of light wood, carbon fiber, or fiber glass then connecting it to a remote control transmitter via a small control board fitted with a gyroscopic stabilization system and connected to a Lipo battery these craft were relatively simple to construct. Experimentation has led to the configuration of variations of the Quadcopter by using different amounts of arms we have seen Tricopters, Hex copters and Octocopters (with eight arms). Other configurations include a Vtail and an H frame variation. The rapid advances in computing power, the efficiency of the coreless or brushless motors, smaller microprocessors the development of batteries and gyroscopic and accelerometer technology has all led to a proliferation of Quadcopter designs. The first Quadcopters were not designed for acrobatic flight as the development was concentrated on simple stable flight patterns but now this has all changed. Micro and even Nano Quadcopters are being produced mainly in China that can perform intricate aerobatic moves, flips and barrel rolls that years ago would have been unthinkable. Chinese companies like Hubsan have made tiny Nano Quadcopters. Quadcopters differ from conventional helicopters which use rotors which are able to vary the pitch of their blades dynamically as they move around the rotor hub. In the early days of flight, quadcopters (then referred to as 'quadrotors') were seen as possible solutions to some of the persistent problems in vertical flight; torque-induced control issues (as well as efficiency issues originating from the tail rotor, which generates no useful lift) can be eliminated by counter-rotation and the relatively short blades are much easier to construct.

4.15 Flight Quadcopter Dynamics:

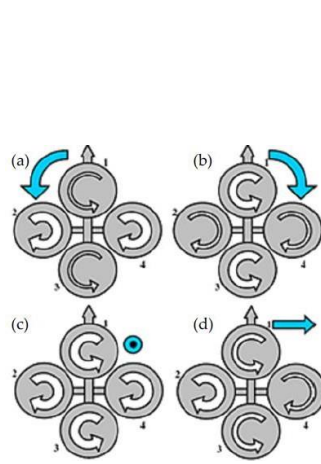
The basic thrust acting diagram for a quadcopter is presented below which shows the forces acting upon the system in various state of its motion such as in case of variable flight, hovering cases, rolling or pitching motions and several other cases. In case of hovering flight, the forces generated by all the four different motors are the same. In case of rolling motion there is a subtle difference in the front and back motors thrust generated. In pitching motion, there is a difference in the motors speed for the left and right side of the motors speed and thus the thrust generated.



Quadcopter Body Diagram

Figure-4.12

Though this seems to be quite simple to naked eyes, but in reality there are several considerations that has to be taken into account in order to maintain a stable flight at high altitude levels. The major challenge will be to keep the system stable at high heights.



Torque Mechanism

Figure-4.13

Quad-rotor dynamics, (a) and (b) different forces generated to change the yawing angle (ψ); (c) hover motioning and vertically propulsion due to the balancing torque; and d) different thrust to change the pitching angle (θ) the rolling angle (fi).

CHAPTER-5

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1 Procedure for compiling arduino software code for the quadcopter:

Arduino Software:

1. Arduino IDE as shown below Open Arduino IDE

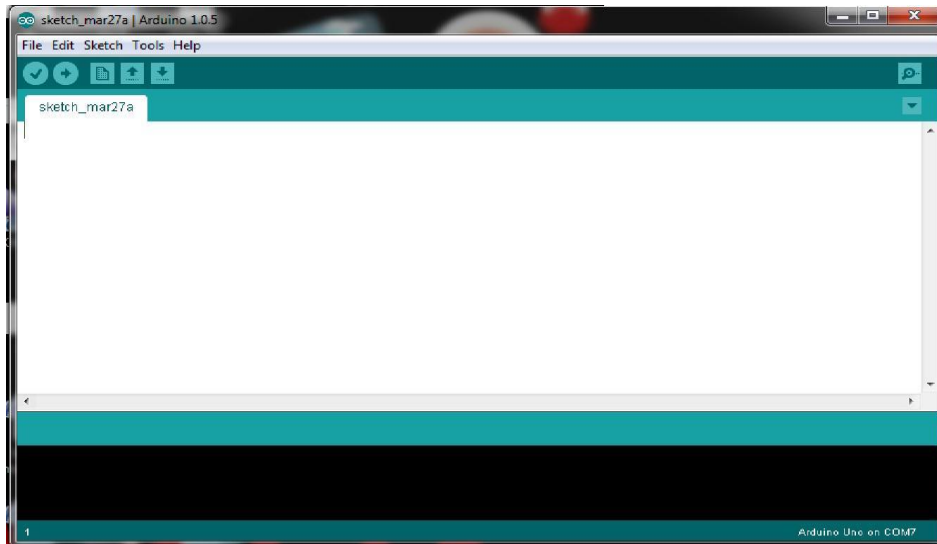


Figure-5.1

2. Select the COM Port from tool

Select the COM Port

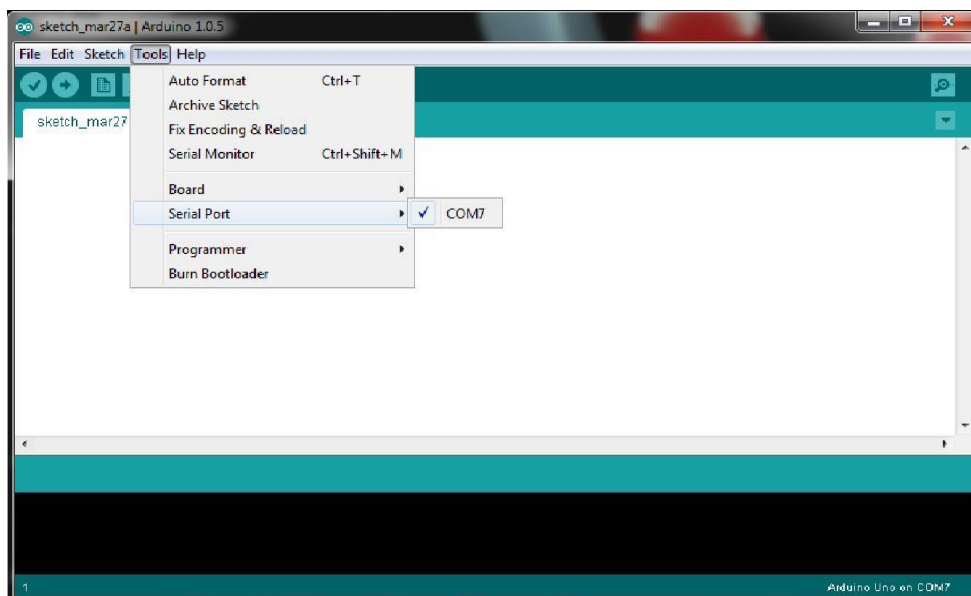


Figure-5.2

3. Select the required Arduino board from Tools as shown below

Select the required Arduino board

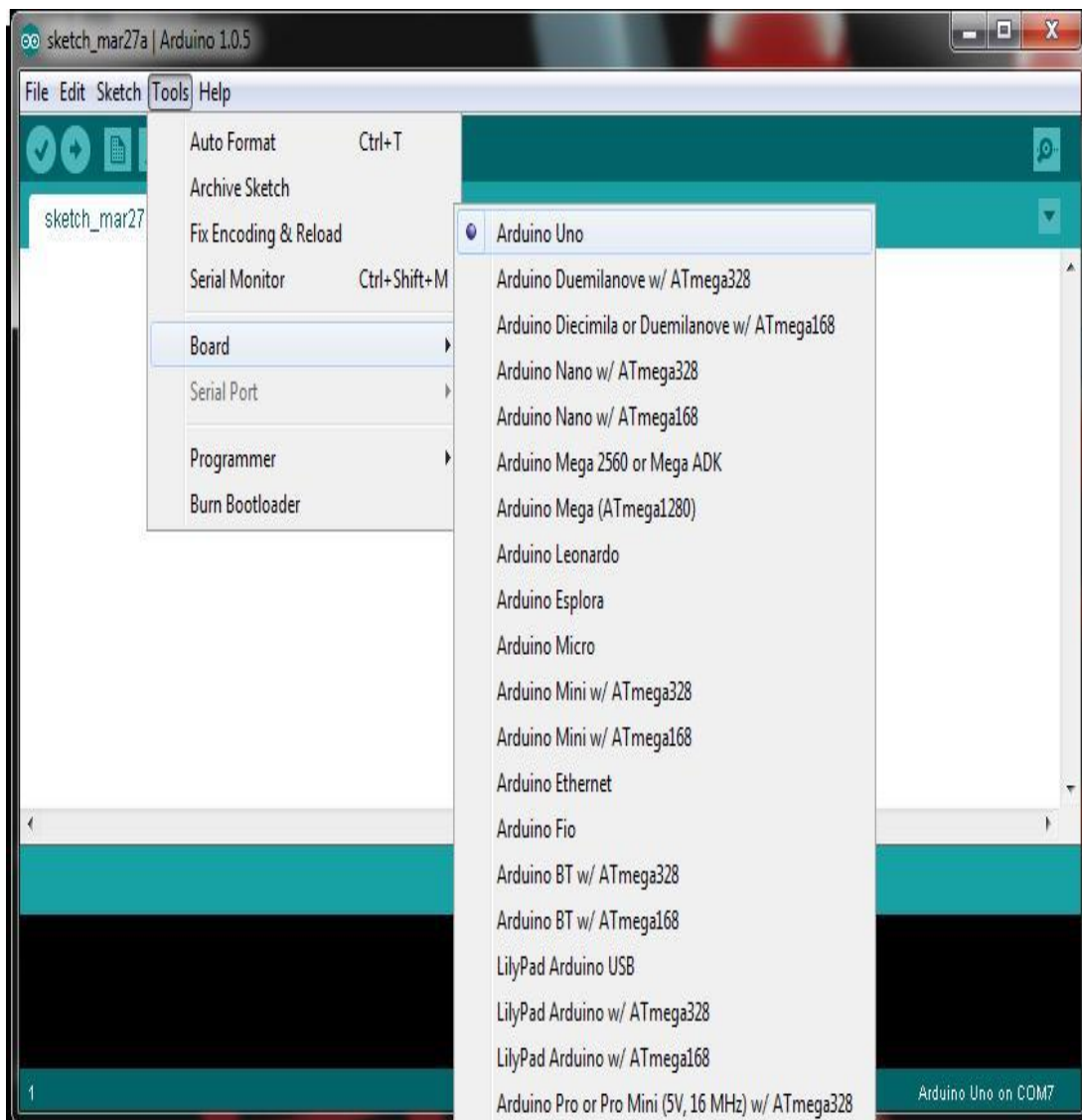
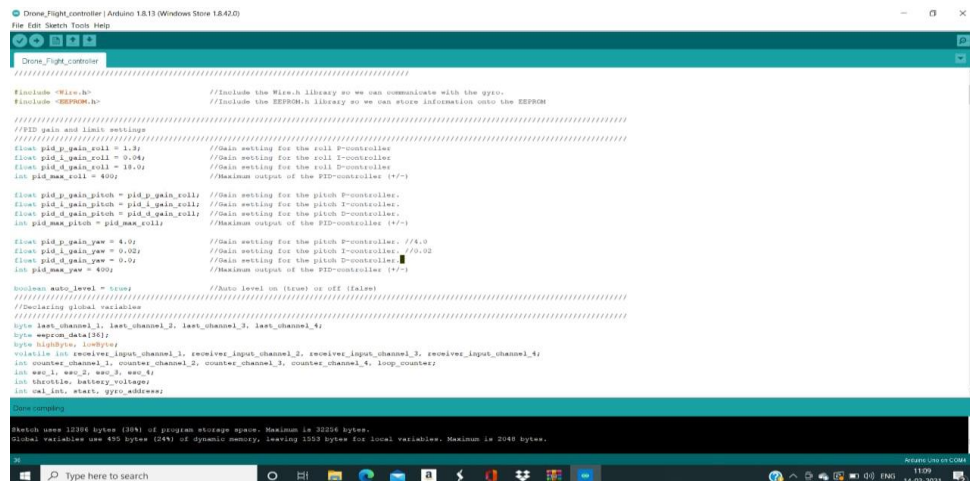


Figure-5.3

4. Compile and upload the given arduino code.



```
Drone_Flight_Controller.ino
// Drone_Flight_Controller.ino

// Include the Wire.h library so we can communicate with the gyro.
#include <Wire.h>
// Include the EEPROM.h library so we can store information onto the EEPROM

// PID gain and limit settings
// Main setting for the roll P-controller
float pid_p_gain_roll = 1.5;
// Main setting for the roll I-controller
float pid_i_gain_roll = 0.04;
// Main setting for the roll D-controller
float pid_d_gain_roll = 10.0;
// Maximum output of the PID-controller (*7-)
int pid_max_roll = 400;

// Main setting for the pitch P-controller.
float pid_p_gain_pitch = pid_p_gain_roll;
// Main setting for the pitch I-controller.
float pid_i_gain_pitch = pid_i_gain_roll;
// Main setting for the pitch D-controller.
float pid_d_gain_pitch = pid_d_gain_roll;
// Maximum output of the PID-controller (*7-)
int pid_max_pitch = pid_max_roll;

// Main setting for the yaw P-controller.
float pid_p_gain_yaw = 4.0;
// Main setting for the yaw I-controller.
float pid_i_gain_yaw = 0.02;
// Main setting for the yaw D-controller.
float pid_d_gain_yaw = 0.0;
// Maximum output of the PID-controller (*7-)
int pid_max_yaw = 400;

// Auto level on (true) or off (false)
bool auto_level = true;

// Declaring global variables
// Declaring global variables
byte last_channel_1, last_channel_2, last_channel_3, last_channel_4;
byte rxpin_data[16];
byte lightpin;
volatile int receiver_input_channel_1, receiver_input_channel_2, receiver_input_channel_3, receiver_input_channel_4;
int counter_channel_1, counter_channel_2, counter_channel_3, counter_channel_4, loop_counter;
int aux_1, aux_2, aux_3, aux_4;
int throttle, battery_voltage;
int val_int, static_gyro_address;

// New comments
// Sketch uses 11396 bytes (10%) of program storage space. Maximum is 114544 bytes.
// Global variables use 450 bytes (2%) of dynamic memory, leaving 1530 bytes for local variables. Maximum is 2048 bytes.
```

Figure-5.4

After uploading this code arduino the drone will fly with the help of radio receiver and transmitter.

After configuring all the parts, assembling as required, configuring Software, finally we obtained our quadcopter which is shown below. We need to test the Acceleration Calibration every time when we change the ground surface area.



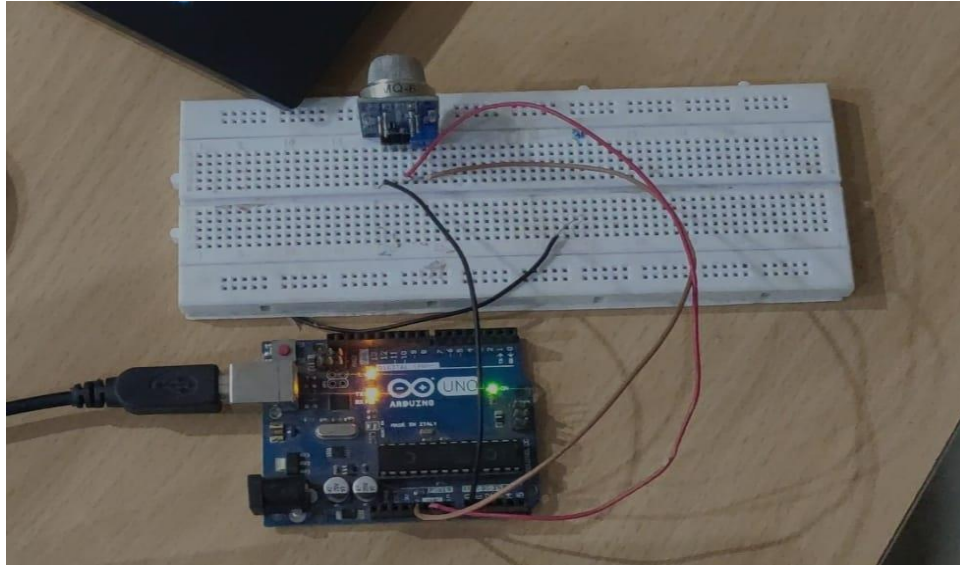
Quadcopter

Figure-5.5

The above shown figure is the complete formed configuration of hardware components of drone with the help of arduino software.

5.2 output for Gas Sensor:

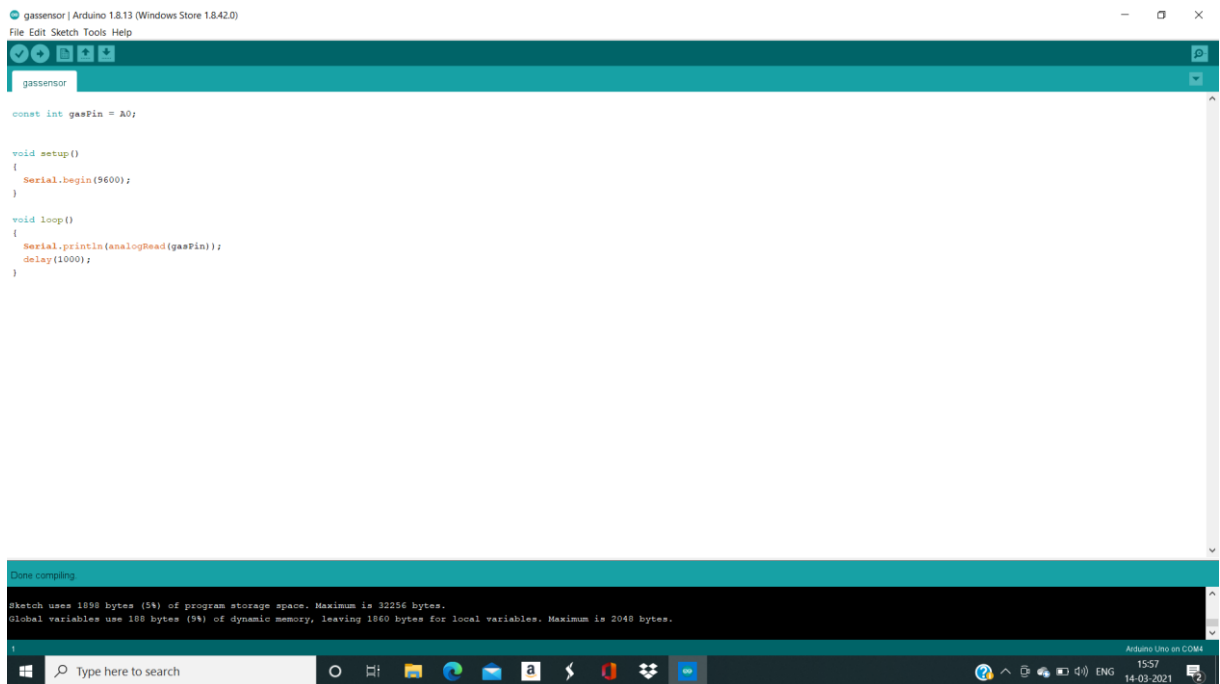
The gas sensor helps us to detects the various amounts of gases range which present in the environment. The below shown is the diagram for the gas sensor connection.



Gas Sensor connection with Arduino

Figure-5.6

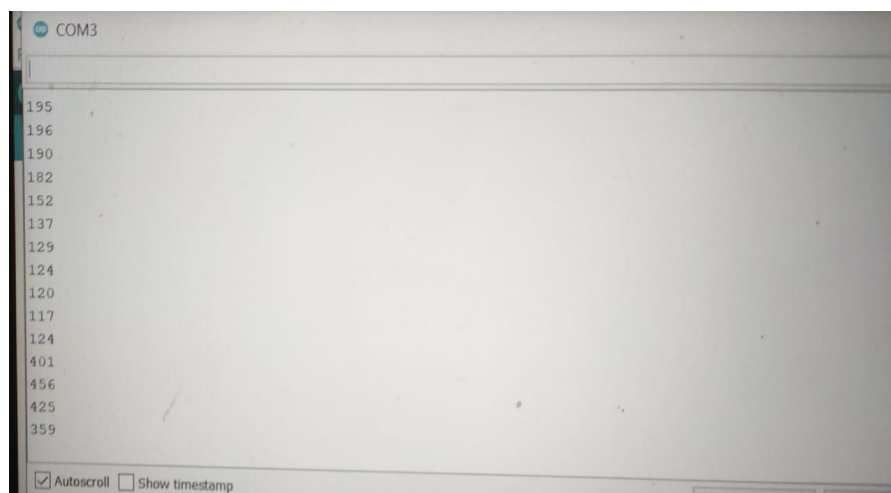
As shown in the above diagram, we can see the connections for the gas sensor with arduino, In the above figure- we used a gas sensor, arduino, connecting wires and bread board. If there is any change in gases range in the environment, there is a change in the gas sensor range. This leads to detection of gas in the environment around us.



Arduino Code for Gas Sensor

Figure-5.7

The above shown code is the code for detecting the gas using arduino. After compiling and uploading the given code, we can see there is a change in the reading of gas sensor.



Output Reading of Gas Sensor shown in Arduino

Figure-5.8

As, We can see there is a Sudden increase in the values of gases range in the arduino from **124 to 401**, this leads to detection of gases by the gas sensor. Thus we can detect the gases easily if there is a change in reading from the arduino output.

5.3 TABULATION OF OUTPUT

SL.NO	VARIOUS TYPES OF GASES	INITIAL RANGE WITH GAS SENSOR	FINAL RANGE WITH GAS SENSOR
1	Air	62	62
2	Alcohol (Sanitizer)	155	456
3	Smoke	134	478

Output of Gas Sensor

Figure-5.9

5.4 Result Analysis:

The above table shows the various ranges of gases by the gas sensor. The initial reading shows without the detection, where as the final reading shows the range with the detection of gas sensor, for the various gases like Air, Alcohol (Sanitizer), and smoke. Thus we can detect the gases in the environment around us.

CHAPTER-6

SUMMARY

&

CONCLUSIONS

6.1 Summary:

As per the design specifications, the quadcopter self stabilizes using the array of sensors integrated on it. It attains an appropriate lift and provides surveillance of the terrain through the camera mounted on it. It acts appropriately to the user specified commands given via a remote controller. Its purpose is to provide real time audio/video transmission from areas which are physically in-accessible by humans. Thus, its functionality is monitored under human supervision, henceforth being beneficial towards military applications. It is easy to manoeuvre, thereby providing flexibility in its movement. It can be used to provide surveillance at night through the usage of infrared cameras. The system can further be enhanced for future prospects. This project required members not only to interface and program the components of the quadcopter, but also exposed them to mechanical components and reality of project management to accomplish the project objectives.

6.2 Conclusions and Future work:

This project aimed to design and fabricate a UAV-based air monitoring system to monitor air pollutant emissions over an oil field. The main objective of this project is to use off-the-shelf sensors and microcontrollers to build a functional unit that can sense a certain type of pollutants, to accomplish this goal, the sensors must be power efficient, low cost, lightweight and effective. The development system has no restriction on installation location or installation space. The development system observes the atmospheric environment elements similarly, even though it is difficult to directly compare the observation results of the two systems due to the different locations in the measurement sites of the two systems. The development system can easily change measuring sensors, and compatible with various communication systems for the transmission of the measurement results.

It is expected that the development system will be effectively utilized in atmospheric environment based services by installing the developed measurement devices at public facilities such as schools and homes.

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