ARDUINO BASED DRONE

Project report submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION

We hereby declare that the work reported in the B.Tech Project Report entitled **“Arduino Based Drone”** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Prof. Dr. Rajiv Kumar**. We have not submitted this work elsewhere for any other degree or diploma.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Prof. Dr. Rajiv Kumar

Date:

Head of the Department/Project Coordinator

ACKNOWLEDGEMENT

It is my team's honor to express the feelings of gratitude and thankfulness towards our project Supervisor **Prof. Dr. Rajiv Kumar**, who with his sincere guidance and knowledge helped us in completing this project report on the topic "Arduino Based Drone".

Without his motivation, this work would not have possible. Me, along with my team, am forever indebted for his kind guidance and encouragement.

I would also like to mention the sincere contribution of the teammates, who with their hard work and dedication made this project report possible. This study has indeed helped us explore and develop more knowledge avenues related to our project work and I am certain it will help us in the future.

THANK YOU

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ABSTRACT

Technological advancements in fields of emergency rescue operations as well as in remote package delivering systems where physical presence is not possible has led us to the development of a quadcopter drone. The quadcopter's flight controller is an Arduino UNO R3 and its flight movements can be controlled using a transmitter-receiver setup. The quadcopter is designed mainly for the purpose of search and rescue operations as well as for or gathering digital information or transferring messages.

One major flexibility that a drone offers is that it is highly customizable. This customization is majorly done by modifying the sensors on the drone. Needless to say, this change in sensors will also lead to changes in software implementation. Initially, we have used MPU6050, which is a 3-axis Accelerometer & Gyroscope.

Not only what is mentioned above, a quadcopter includes many other key components which will be further discussed. Furthermore, software implementation is a little complicated yet a very versatile portion of the work as it can be done in various programming languages.

The objective behind this project is to create a multi-functional drone with least amount of expenses, something which is highly customizable, and can be directed towards a practical mindset of what drones are needed for.

CHAPTER 1

Introduction

1.1 Introduction to the Technology

When you hear the word ‘drone’, most people’s first thought is some kind of high-tech military weapon, flying above the clouds while the pilot sits in a control room hundreds of miles away. That’s not quite what we’re talking about here. More recently, the same term has been used to describe quadcopters: remote-control aircraft with four propellers. As the algorithms determining flight stability and control have become more sophisticated, these miniature aircraft have become cheaper and more accessible.

From 2011 onwards, companies such as Parrot, DJI and 3DR began to attach cameras to drones and aerial photography as we know it today was born. Now, it’s not only high-definition cameras that can be attached to drones. They can also carry thermal imaging units; sensors and all sorts of tools now being used in all sorts of industries.

Undoubtedly, the biggest advantage that a drone has over other technologies is that it breaks the barrier of two-dimensions and operates in three-dimensions. Now the question arises in contrast to that statement, is it easy to operate a drone? Absolutely. While the overall designing of a drone can be a complicated task, but if the synchronization, it is fairly easy to operate drones.

1.1.1 Objective

The main objective of our project is to make a quad copter which could be used in rescue missions as well as in package delivering operations. The quadcopter will be controlled by an Arduino microcontroller which will be program flexible according to the user. The flight will be made stable with the accumulation of various sensors like the gyroscope, accelerometer and magnetometer.

1.1.2 Future Scope

Such amalgamation promises a great future for extensive use of drones in providing services especially in areas that are remote or cannot have humans serving physically. They had been in the nascent stage up until now, however, mass adoption of such services will see a huge uptick in the future. Increased work efficiency and productivity, decreased production costs, improved accuracy, refined service, better customer relations and security are a few major advantages that drones offer industries globally.

According to the Drone Industry Insights Report 2020, the worldwide drone industry is predicted to increase at a 13.8 percent CAGR to $42.8 billion by 2025. With Ministry of Civil Aviation updating the Drone Rules 2021, efforts are to make India a global drone hub by 2030. By 2025, India is anticipated to be the world's third-largest drone market, according to the results. The unmanned aerial vehicle market in India is expected to grow at a CAGR of 20.9% between 2020 and 2026 which further gives us an estimate on the investments from industrial conglomerates, chip companies, IT consulting firms, etc.

Drones are being used by the Indian defense forces since 1999, therefore they aren't new in the system. Besides that, there was not much use because they were restricted due to security concerns and the absence of a robust UAV ecosystem in the country. It was in 2018 when drones were legally allowed to fly for business purposes. Now, that the Government of India has issued fresh guidelines, drones are going to be the next big thing for India.

1.2 Literature Review

The earliest invention of the quadcopter dates back to 1907 when Louis Breguet invented and flew the first quad rotor helicopter. The drones were then used mainly by the US army for military purposes. The literal introduction of quadcopter was in this century where advances in electronics allowed the production of low-cost lightweight flight controllers which had the capability of flying an UAV. Furthermore, a number of sensors were incorporated into the flight controller in order to increase the stability of the quadcopter.

The introduction of the advanced and stable sensors helped in increasing the hovering stability of the drone. The hover control was achieved by the PID controller design using a microcontroller. This led to the increase in demand of drones in the field of agriculture to monitor crops of an area. But still the drones were not upgraded enough to perform specific tasks. There were scopes of further developments in the future.

Several advancements have been achieved in the field of quadcopters over the last decade as they have evolved in designs as well as in flight controllability. This is due to the fact that better microcontrollers are being used along with better sensors attached. The drones proved useful in the military in remote package delivering missions. With the passage of time, Arduino became a popular microcontroller in making the drones because of its flexibility in programming. Besides that, additional sensors like a camera; an ultrasonic sensor can be attached to the drones. This helped the drones in calculating distance from the ground which previously were unable to achieve.

1.3 Requirements

1.3.1 Hardware Requirements

S.R. NO	QUANTITY	COMPONENT NAME	SPECIFICATION

1	1	Power Distribution Board.	Robodo QP40 RC
2	-	Wires	Breadboard Jumper Wires
3	1	Quadcopter Frame	Invento F450
4	4	Propellers	Techleads 1045/1045r
5	1	Arduino UNO Microcontroller	Arduino UNO R3
6	-	Sensors	MPU-6050
7	1	Transmitter/Receiver	
8	1	Battery	2800 Mah
9	4	DC Motor	1000 kV
10	4	Electronic Speed Controllers	30 Amps

Table 1.1: Hardware Components

1.3.2 Software Requirement

S.R. NO	COMPONENT NAME	SPECIFICATION
1	RAM	2GB

2	Processor	Core 2 Duo (Minimum)
3	Programming Language	C/Python
4	Software	Arduino IDE

Table 1.2: Software Components

NOTE: The above-mentioned specifications of components should be more than enough for most quadcopter drones. However, the specifications may vary depending on the overall level and requirement of the quadcopter made. For example, a more powerful quadcopter will require higher-powered ESCs and DC motors, and hence a more powerful battery too.

CHAPTER 2

Overview of The Project

2.1 Understanding the Components

2.1.1 Quadcopter Frame

Quadcopter frame is important component of quadcopter, there are a lot of quadcopter frame sizes and no thumb rule for size of the frame, but the most common is from 180 mm to 800 mm. Each quadcopter frame with different attributes is designed for different style quadcopter such as fpv, sport racing, cameras, mini etc. Size of wheelbase is quadcopter size. Here talk about quadcopter frame sizes with you.

Frame -The structure that holds all the components together. One of the most important parts of quadcopter is its frame because it supports motors and other electronics and prevents them from vibrations. You have to be very precise while making it. It is crucial that the quadcopter frame is lightweight but strong and rigid. Most available materials for the frame are Carbon Fiber, Aluminum, Wood, Plastic & PVC – Fiberglass. For this project, we'll be using Invento F450 Quadcopter MultiCopter.

2.1.2 Arduino Uno Microcontroller

Arduino Uno R3 is one kind of ATmega328P based microcontroller board. ATmega328p is one of the most famous 8-bit microchip technologies, which includes a 32-bit memory. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started.

The main advantage of this board is if we make a mistake, we can change the microcontroller on the board without changing much in the program. This is because of the fact that this specific microcontroller has a huge support from the Arduino community, and hence allows easy transition. Additionally, it has minimum power consumption and an easily

programmable interface. The programming of an Arduino Uno R3 can be done using Arduino's IDE software, which is further described in software implementation.

The Arduino Uno R3 pin diagram is shown below:

It comprises 14-digit I/O pins. From these pins, 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.

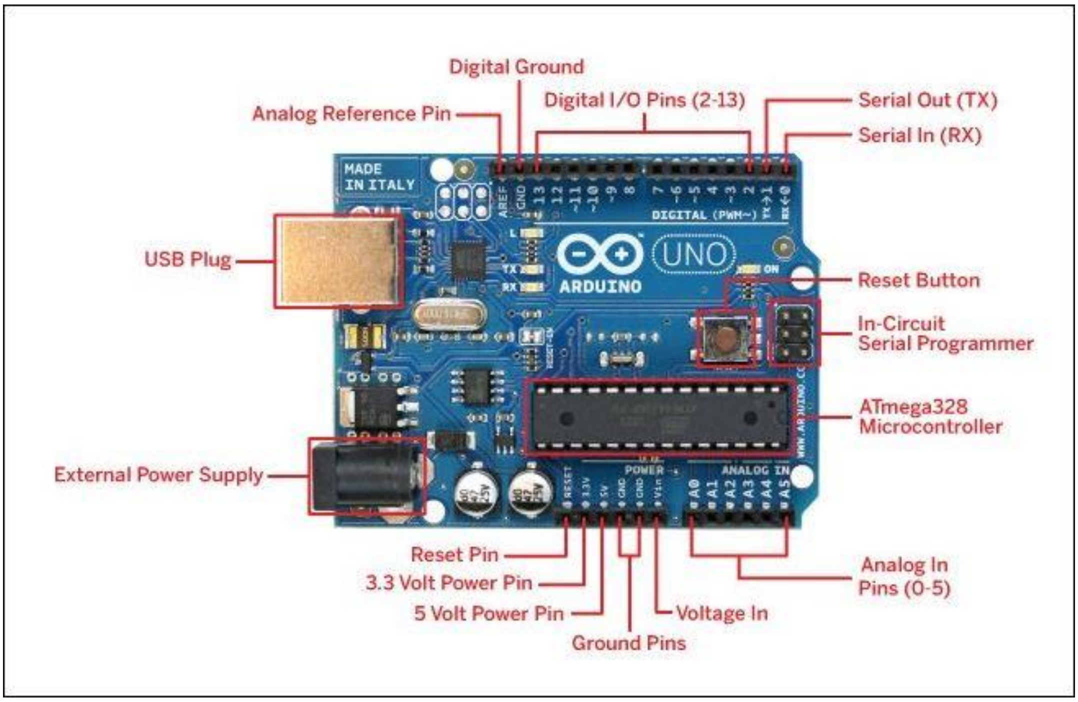

Figure 2.1: Arduino UNO R3 Pin Diagram

2.1.3 MPU-6050

The MPU-6050 contains both a 3-Axis Gyroscope and a 3-Axis accelerometer allowing measurements of both independently, but all based around the same axes, thus eliminating the problems of cross-axis errors when using separate devices.

In our project, we have used the MPU-6050 to help in balancing the flight of the quadcopter and maintain its flight dynamics. MPU-6050 is used in different industrial projects and electronic devices to control and detect the 3-D motion of different objects, that is yaw, pitch, and roll.

The MPU-6050 pin diagram is shown below:

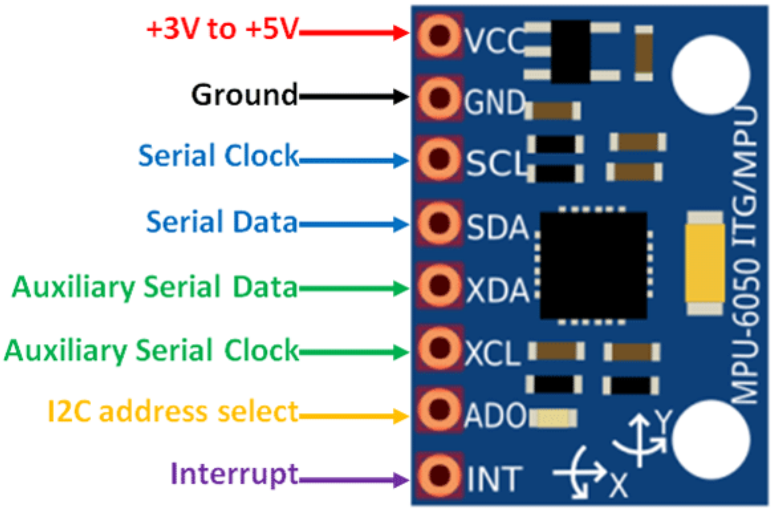

Figure 2.2: MPU-6050 Pin Diagram

Wiring MPU-6050 Module with Arduino is fairly simple. Start by connecting VCC pin to the 3V or 5V output on the Arduino and connect GND to ground.

Now we are remaining with the pins that are used for I2C communication. Note that each Arduino Board has different I2C pins which should be connected accordingly.

On the Arduino boards with the R3 layout, the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin.

2.1.4 DC Motor

Powered by DC current, DC motors for drones convert power from batteries or power supplies into mechanical energy to enable flight. DC motors are commonly used to spin the propellers of quadcopters and other multirotor drones. In order to achieve flight, small DC motors are required to generate enough thrust to counteract the drone’s weight and so achieve liftoff.

Figure 2.3: Brushless DC Motor 1000kV

In quadcopters specifically, brushless DC motors are preferred as they are lightweight, thereby decreasing the overall weight of the device. Not only that, they are also power efficient compared to regular DC motors.

In our project, we require 4 exactly similar such motors. As there are four corners to a quadcopter, one motor is needed for each direction. For a regular quadcopter, DC motors of 1000kV each is sufficient.

2.1.5 Electronic Speed Controller (ESCs)

Electronic speed controllers (ESCs) are devices that allow drone flight controllers to control and adjust the speed of the aircraft’s electric motors. A signal from the flight controller causes the ESC to raise or lower the voltage to the motor as required, thus changing the speed of the propeller.

ESCs can also convert mechanical energy into electrical energy that can be used to recharge the drone’s battery. During periods where the drone is decelerating, the motor can act as a generator, and the ESC handles the excess current that can be fed back into the battery.

Figure 2.4: 30 Amps ESC

ESCs for drones are typically rated for a maximum current. ESCs that can handle a larger current draw will usually be larger and heavier, which may be an important consideration for smaller UAVs. Similar to that of DC motors, 4 ESCs are needed, one for each DC motor. For a regular quadcopter, 30 Amps ESCs are sufficient.

2.1.6 Propellers

Drone propeller blades are most commonly constructed from plastic or carbon fiber. Plastic propellers are cheaper and more flexible, allowing them to absorb impact better. The

increased stiffness of carbon fiber propellers, although providing less durability, decreases vibration thus improving the flight performance of the drone and making it quieter. Carbon fiber is also lighter than plastic, allowing weight savings.

Propeller speeds are varied by changing the voltage supplied to the propeller's motor, a process that is handled by an Electronic Speed Controller (ESC). Varying the speed of these propellers allows the drone to hover, ascend, descend, or affect its yaw, pitch and roll. There are two clockwise and two anticlockwise propellers.

Figure 2.5: Two clockwise and two anti-clockwise propellers

2.1.7 Battery

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly and others), is a rechargeable battery of lithium-ion technology. These batteries provide higher specific energy than other lithium battery types and are used in applications where weight is a critical feature, like mobile devices and radio-controlled aircraft. In our project as well, the weight is a crucial consideration and hence it is perfect. We'll be using a 2500 Mah battery.

2.1.8 Power Distribution Board (PDB)

PDB's essentially distribute the power from the battery to the drone esc. But the technology has improved so much in recent days that PDB's also distribute power to some other peripherals such as FPV Video Transmitters, FPV Cameras and the Quadcopter Flight Controller itself. Some modern FC's have integrated PDB's, are limited by space and can only accommodate so much that they do not do a very good job at filtering the voltage spikes from the insane current draws from our quads.

PDB's come in the usual 20x20mm and 30.5x30.5mm sizes. But the 30.5x30.5 is more popular and the current draws in the smaller quads are very little and hence can mostly getaway by using an FC integrated PDB

2.1.9 Transmitter Receiver

Transmitter: It is and held controller that sends the pilots inputs to the airplane. The transmitter converts the pilot's movements into a radio signal in a process called modulation. The transmitter then broadcasts this signal to the receiver.

Receiver: It is electronic unit that is placed in the quadcopter. It receives signals from the transmitter and send these signals to the Arduino board in order to control the motors. The receiver inside the quadcopter picks up this signal. The receiver pulls the information from the radio waves and relays this information to the flight controller.

2.2 Block Diagram

The following block diagram (Figure 2.6) shows how all the components are interconnected with each other

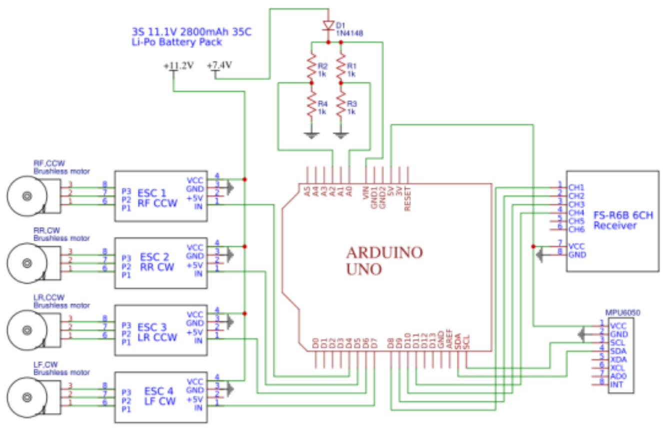

Figure 2.6: Interconnection of all the components

CHAPTER 3

Working

3.1 Methodology and Flight Mechanism

A Quadcopter, or any drone for instance, has 2 clockwise and 2 anti-clockwise motors. Drones use rotors for propulsion and control. Now, a drone can do three things within the vertical plane: hover, climb or descend. To hover, the internet thrust of the four rotors pushing the drone up must be adequate to the gravity pulling it down. Now let's understand the basic concept of flight mechanism which is illustrated using the following movements:

Pitch

Pitch refers to the perpendicular movement of the drone, or any object for that matter, which means upwards and downwards movement. In order to lift the drone off the ground perpendicularly, we will provide all the DC motors with same speed through ESCs that will generate a lift greater than the weight of the drone. This will cause the drone to move up.

Similarly, to move the drone downwards, we'll reduce the speed of DC motors so that the lift is less than the weight of the drones. This is illustrated in Figure

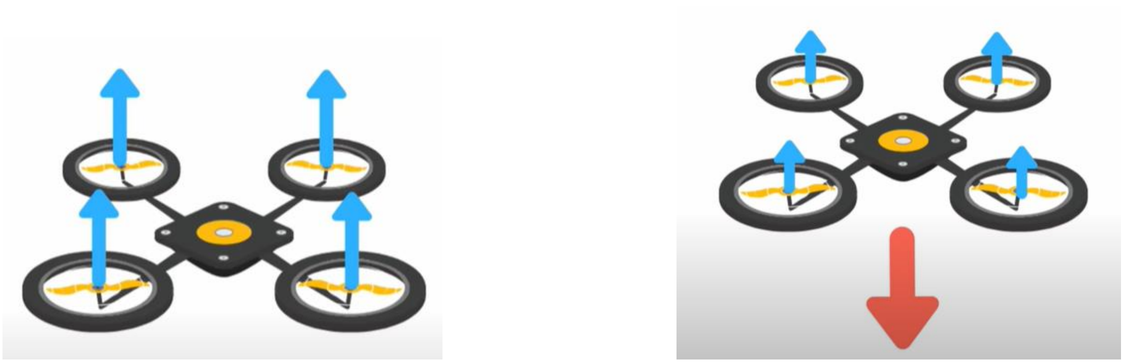

Figure 3.1: Representation of upwards and downwards movement of a quadcopter

Yaw

Yaw refers to the axis movement of the drone, or any object for that matter, which means rotating left and right on its own axis. In order to rotate the drone in the right direction, we will increase the speed of clockwise DC motors and decrease the speed of anticlockwise DC motors. The more the difference is in their speeds, the faster the drone will rotate.

Similarly, to rotate the drone in anti-clockwise direction, the same process will be followed but by reversing the speed of DC motors. This is illustrated in Figure

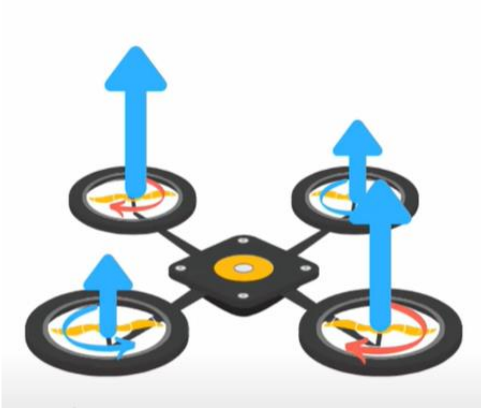

Figure 3.2: Representation of right rotational movement of a quadcopter

Roll

Yaw refers to the tilting movement of the drone, or any object for that matter, which means moving forwards, backwards, left, or right. In order to tilt the drone in any particular direction, we increase the speed of two adjacent DC motors in the opposite and decrease the speed of the other two motors. For example, if we need to move the drone in forward direction, we will increase the speed of two backwards DC motors and decrease the speed of front DC motors.

Similar, the speed of DC motors will be adjusted to tilt in a particular direction.

NOTE: In the case of tilting, we cannot make any DC motor's speed as 0 as the drop will flip right away.

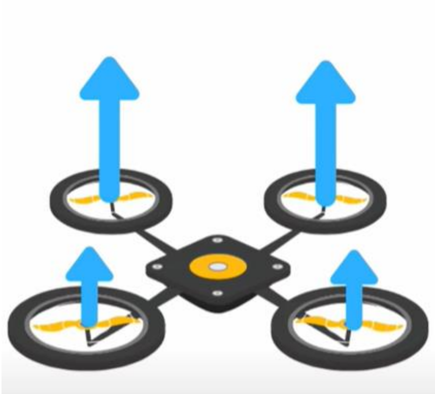

Figure 3.3: Representation of backward movement of a quadcopter

3.2 Principle

As discussed earlier there are 3 motions in quadcopter viz. Pitch, Yaw, and Roll. These motions are controlled by the help on a radio control transmitter. The transmitter transmits the data to the receiver which is placed over the quadcopter The receiver then sends the data to the flight control board. The flight controller is an inbuilt microprocessor that manipulates the signals received by it and commands the BLDC motors through the ESCs. After the command is received the motors act according to the signal transmitted by the remote. The throttle is created by rotating all 4 rotors at the same speed. An elevator is created by rotating the 2 rear rotors at greater speed compared to the front rotors whereas for backward motion the front rotors have higher speed than rear rotors. Aileron is created by rotating the left 2 rotors to rotate at a higher speed than the right rotors for the right turn and vice versa for the left turn. Rudder action is created by rotating the diagonally situated rotors moving with the same spin to rotate at a greater speed than the other two.

CHAPTER 4

Implementation

4.1 Setting up Arduino UNOR3

Step 1: Download and Install the IDE

Since the Arduino uses a USB to serial converter, the Arduino board is compatible with most computers that have a USB port. Of course, you will need the IDE first. Luckily, the Arduino designers have released multiple versions of the IDE for different operating systems, including Windows, Mac, and Linux. In this tutorial, we will use Window 11, so ensure that you download the correct version of the IDE if you do not have Windows 11.

Once downloaded, install the IDE and ensure that you enable most (if not all) of the options, including the drivers.

Figure 4.1: Official Download page for Arduino IDE

Step 2: Get the Arduino COM Port Number

Next, you'll need to connect the Arduino Uno board to the computer. This is done via a USB B connection. Once it's recognized, we will need to find out what port number it has been assigned. The easiest way to do this is to type "Device Manager" into Windows Search and select Device Manager when it shows. In Device Manager, the Arduino shows up as COM5 in our project, which is port 5.

NOTE: The Arduino won't always be recognized automatically. If your Arduino is not recognized. then uninstall the driver, remove the Arduino, reinsert the Arduino, find the unrecognized device, right click "Update driver", and then click "Search automatically".

Step 3: Configure the IDE

Now that we have determined the COM port that the Arduino is on, it's time to load the Arduino IDE and configure it to use the same device and port. Start by loading the IDE. Once it's loaded, navigate to Tools > Board > Arduino Uno.

Next, you must tell the IDE which COM port the Arduino is on. To do this, navigate to Tools > Port > COM7.

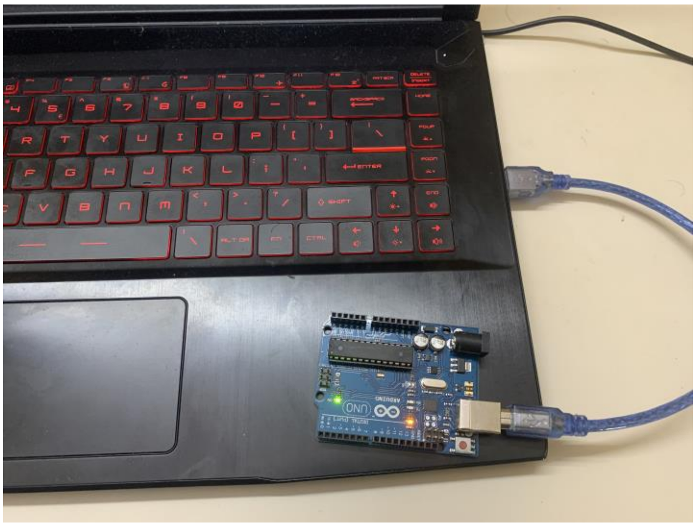

Figure 4.2: Arduino UNO R3 glowing on successful identification

Step 4: Loading a Basic Example

For the sake of simplicity, we will load an example project that the Arduino IDE comes with. This example will make the onboard LED blink for a second continuously. To run this, we'll simply write the code and compile.

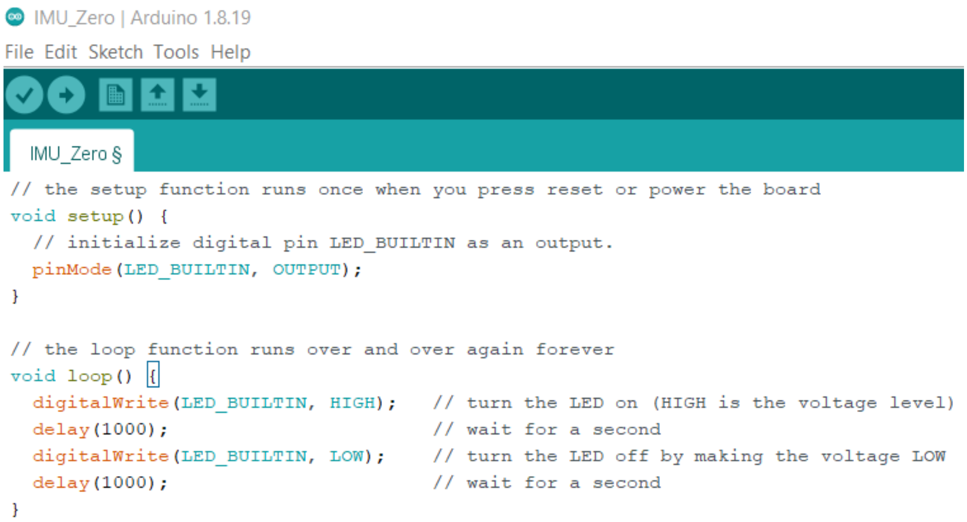

Figure 4.3: Basic Code to glow the LED

On successful compilation, the following message illustrated in figure will show:

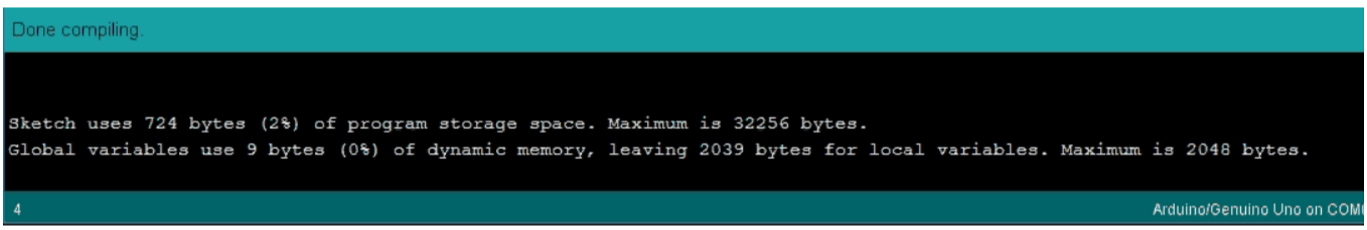

Figure 4.4: Appeared Window after successful compilation

With the code compiled, you must now upload it the Arduino Uno. To do this, click the arrow next to the check mark.

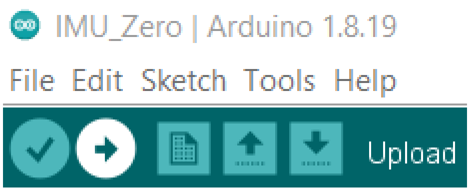

Figure 4.5: Upload KeyPoint in IDE

Similarly, all other codes required for ESCs, flight controllers, sensors, etc., will be uploaded.

4.2 Assembly

We need to follow the following steps only in the mentioned stepwise order. It is the safest, and most feasible way to assemble the structure.

Step 1: Assemble the frame. Attach the power distribution board to it

Step 2: Mount the DC motors to the frame. Mind clockwise and anticlockwise directions. They should be mounted opposite to each other, which is crucial.

NOTE: Do not install propellers yet.

Step 3: Connect ESCs to motors and plug ESCs to power distribution board (or solder them to the frame).

Step 4: Install PDB on the frame. One end should be plugged to power distribution board (or soldered to the frame) and the other end to the battery.

Step 5: Install flight controller on the center of the frame. In our project, we'll be using Arduino UNOR3.

Step 6: Plug cable from power module to POWER port of your flight controller.

Step 7: Binding process for controlling the drone depends on the type of controller used. It can be done using mobile applications too. Nevertheless, what is similar is that we need to connect transmitter and receiver port to Tx and Rx ports respectively on Arduino R3.

4.3 Calibration Process

Once the assembly is done, we need to calibrate the ESCs, sensors, and flight controller. To do that, we'll connect the assembled drone to the system and after identifying, we'll upload the code on the quadcopter using Arduino IDE as was represented in the example project mentioned in the figure.

After the code is uploaded, the value for ESCs determining the speed will purely be an experimental process. It cannot be determined before assembly of all the components.

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