IMPLEMENTATION OF QUADCOPTER

Dissertation submitted in partial fulfillment of the requirement for the degreeof

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Sumit Sharma (121039)

Shailendra Pratap Singh (121040)

Mudit Agarwal(121058)

UNDER THE GUIDANCE OF

Mrs. Vanita Rana

(Assistant Professor)

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

MAY,2016

TABLE OF CONTENTS

ACKNOWLEDGEMENT…………………………………………………..i

LIST OF ABBREVIATIONS……………………………………………ii

LIST OF FIGURES…………………………………………………..iii

LIST OF TABLES…………………………………………………..v

ABSTRACT…………………………………………………………vi

RELATED WORK…………………………………………………...vii

CHAPTER 1:INTRODUCTION…………………………...……………………1

1.1 QUADCOPTER BASICS…………………………………………..………..1

1.2PROBLEM STATEMENT……………………….……………………………….2

1.3 PROJECT OBJECTIVES………………………………….……………………..2

1.4 PROJECT CONSTRANTS…………………………………………..…...2

1.5 APPLICATION…….…………………………………………….…………....2

CHAPTER 2: EMBEDDED SYSTEMS……………………………………4

2.1 EMBEDDED SYSTEM………..4

2.2 PARTS OF EMBEDDED SYSTEM 4

2.3 MICROPROCESSOR...6

2.4 MICROCONTROLLER...7

2.5 MICROPROCESSOR VS MICROCONTROLLER 9

2.6 INTRODUCTION TO AVR 9

CHAPTER 3: HARDWARE DESCRIPTION 11

CHAPTER 4:IMPLEMENTATION 25

4.1 DESIGN OVERVIEW..25

4.2 WORKING PRINCIPLE……………………………………………..…...…26

4.3 THRUST AND STANDARD FLIGHT OPERATIONS..26

4.4 FLIGHT CONTROL...30

CHAPTER 5: SOFTWARE DESCRIPTION...36

5.1 EMBEDDED C...41

5.2 CODEVISION AVR……….……………………………………………….…37

5.3 PROTEUS…………………………………………..……………...…….37

CHAPTER 6: RESULT AND FUTURE SCOPE……………………………………...38

CONCLUSION……………………..……………………………………....39

REFERENCE………………………………………………………….…...40

ACKNOWLEDGEMENT

It is our proud privilege and duty to acknowledge the kind of help and guidance received from several people in preparation of this report. It would not have been possible to prepare this report in this form without their valuable help, cooperation and guidance.

The topic **" Fundamentals of Embedded Systems "** was very helpful to us in giving the necessary background information and inspiration in choosing this topic for the project. Our sincere thanks to **Mrs.Vanita Rana,** Project Guide and Project Coordinator for having supported the work related to this project. Their contributions and technical support in preparing this report are greatly acknowledged.

SIGNATURE:

LIST OF ABBREVIATIONS

CCW	Counter-clockwise
CMAC	Cerebellar Model Articulation controller
CW	Clockwise
DAC	Digital-to-analog converter
DSP	Digital signal processor
EMI	Electromagnetic interference
GA	Genetic Algorithm
GPIO	General purpose input/output pins
GUI	Graphical User Interface
IC	Single integrated circuit
LiPo	Lithium Polymer
MDF	Medium-density fibreboard
OTP	One Time Progarmmable
PID	Propotional Integral Derivative
PWM	Pulse Width Modulation
SAR	Search and Rescue
UART	Universal Asynchronous Receiver and Transmitter
UAV	Unmanned Aerial Vehicle

LIST OF FIGURES

FIGURE NO.	CAPTION	PAGE NO.
2.1	Input Units	5
2.2	Processing Units	5
2.3	Output Units	5
2.4	Block diagram of a microprocessor	6
2.5	Basic microcontroller	7
3.1	Arduino Uno	11
3.2	Arduino pin diagram	13
3.3	Conceptual design	15
3.4	Overview of DCbrushless motors	19
3.5	LiPo Battery	20
3.6	Overview of an ESC	21
3.7	Overview ofpropeller	23
3.8	6 channel receiver	24
3.9	6 channel transmitter	25
4.1	Design overview	26
4.2	Body frame	27
4.3	Inertial frame	28
4.4	Rotational Direction of Propellers	29
4.5	Pitch and Roll angles	30
4.6	Take off Motion of Quadcopter	33
4.7	Landing Motion of Quadcopter	34

4.8	Foraward Motion of Quadcopter	34
4.9	Backward Motion of Quadcopter	35
4.10	Right Motion of Quadcopter	35
4.11	Left Motion of Quadcopter	36

LIST OF TABLES

TABLE NO.	CAPTION	PAGE NO.
2.1	Comparison between Microprocessor and Microcontroller	9
2.2	Comparison of major AVRs Series	10
3.1	Technical Specification	14
3.2	First design component details	29
4.1	Shows the different orientation of the quadcopter are related to range of angles	34
4.2	Tabular Form of all the Motion of Quadcopter	35

ABSTRACT

Quadcopters is an aerial vehicle operated to fly independently and is one of the representations of a UAV (Unmanned Aerial Vehicles).

Drones are actually very fascinating and in this project we are going to study about them, their components and about its widespread applications that determine its scope for the future. They are a mixture of streams of Electronics, Mechanical and especially Aviation.

A quadcopter or a quadrotor helicopter is a multirotor copter that is lifted and propelled by four rotors. All the four arms have a motor and a propeller at their ends each. The lift is generated by a set of rotors and vertically oriented propellers, hence quadcopters are classified to rotorcrafts.A quadcopter uses 2 sets of identical fixed pitched propellers , 2 clockwise (CW) or in one direction and 2 counter-clockwise (CCW) or opposite direction. This helps the machine to hover in a stable formation.

Control of motion of vehicle is achieved by altering the rotation rate of one or motor discs, thereby changing its torque load and thrust/lift characteristics. The use of four rotors in a quadcopter allow the individual rotors to have a smaller diameter than the equivalent helicopter rotor, which allows them to possess less kinetic energy during flight.

Quadcopters have different structures and designs according to the work needed to be done by it. Components like motors, batteries, electronic speed controllers (ESC.s) also vary according to the power needed and work done by the quadcopter. Also enhancements like GPS trackers or cameras or infrared cameras are used so that they could add value to missions like disaster relief, search and rescue, agriculture and 3D mapping of the geography of an area.

RELATED WORK

Nowadays, studies on UAV has attracted researchers and academia due to its broad of applications. One kind of UAV is Quadcopter. The research related to Quadcopter covers the areas of design, control, stability, communication systems and collision avoidance. The using of GUI for controlling of Quadcopter has been widely used. Reference studied on designing GUI control of UAV based on genetic algorithm (GA). The GUI developed is multi remote control and multi button. Reference learned GUI control of Quadcopter for test purpose. The GUI is analyzed using GA. Reference investigated GUI for convenient detection and control of the leak bottle detection equipment and embedded in ARM processor. Reference focused their study on the 3-DOF attitude control free-flying vehicle. The characteristic to be heavily coupled with inputs and outputs, and the serious non-linearity appear in the flying vehicle and due to this non-linear control, multi variable control or optimal control for the attitude control of flying Quadcopter. Reference developed of nonlinear model and nonlinear control strategy for a 6-DOF Quadcopter aerial robot. The nonlinear model of Quadcopter aerial robot isbased on Newton-Euler formalism. Model derivation comprises determining equations of motion of the Quadcopter in three dimensions and seeking to approximate actuation forces through modeling of the aerodynamic coefficients and electric motor dynamics.

Reference is done research on control of Quadcopter by visual tracking using stereo camera. The motion of a Quadcopter is control based on visual feedback and measurement of inertial sensor. In this research, active markers were finely designed to improve visibility under various perspectives. A fuzzy control is designed and implemented to control a simulation model of the Quadcopter. The inputs are the desired values of the height, roll, pitch and yaw. The outputs are the power of each of the four rotors that is necessary to reach the specifications. Simulation results prove the efficiency of this intelligent control strategy. References are done research to analyze the dynamic characteristics and PID controller performance of a Quadcopter. This paper is describe the architecture of Quadcopter and analyzes the dynamic model on it. Besides that, this paper also designs a controller which aim to regulate the posture (position and orientation) of the 6-DOF Quadcopter.

Quadcopters, sometimes called quadrotors or quadrotor helicopters, are currently a very popular platform for robotics research. Their small size and mechanical simplicity (i.e. compared to a helicopter or airplane, variable-pitch propeller blades and complex mechanical linkages are avoided) makes them attractive. In addition, the dynamics of the system are nonlinear and difficult to model. Further complicating the control problem is the number of control inputs (the four propeller speeds) is fewer than the number of degrees of freedom (linear and angular velocities), resulting in an underactuated system. The most common solution to this control problem is to use a series of PID controllers, each concerned with one of the quadcopter's state variables: roll, pitch, yaw, altitude, position. This approach has been successful, and commercial implementations of such controllers exist, such as the KKmulticopter hardware used in . However, as attested in , the integration and optimization of these controllers is a time-consuming and laborious process, especially in the presence of unmodeled system dynamics and sensor noise. Even PID controllers may have trouble in operating conditions that are too far from the optimal hover point. Therefore, several researchers have attempted to use neural network-based controllers to avoid the problems with PID controllers. This is an attractive solution from an engineering standpoint because it requires even less hardcoded knowledge of the system than a PID controller. If successful, this would also be an impressive demonstration of the capabilities of neural networks as an implementation strategy for adaptive robots.

In 2008 Nicol et al tested a neural network controller against more traditional methods of developing controllers, in the face of underspecified 3 system parameters and simulated wind. They use a special type of neural network, the CMAC (Cerebellar Model Articulation controller) and online training. More recently, Shepherd and Tumer investigate the use of NEAT to train neural network controllers, and test them on a simulated quadcopter following waypoints. This work is similar to the work presented in this paper, except that Shepherd and Tumer restrict the role of their neural network controllers in a quite strict fashion. Their controller is hierarchical, with a position controller providing desired roll, pitch, and vertical velocity. These are used to create error functions for the state variables roll, pitch, yaw and height, which are inputs to lower-level controllers that command the motors directly.

The lower-level controllers are proxies for PID controllers, in that their inputs are the error function, its derivative, and its integral; additionally, learning starts by training the networks to imitate PID controllers. This approach works and Shepherd and Tumer demonstrate impressive results with respect to disturbance rejection and waypoint following, but it seems desirable to reduce the amount of the controller design that must be prescribed, and directly transferred from the PID controller (i.e. the controller hierarchy and the separate networks for each state variable).

CHAPTER 1: INTRODUCTION

1.1 QUADCOPTER BASICS

A quadcopter or a quadrotor helicopter is a multirotor copter that is lifted and propelled by four rotors. All the four arms have a motor and a propeller at their ends each. The lift is generated by a set of rotors and vertically oriented propellers, hence quadcopters are classified to rotorcrafts.

They are also referred to as pre-programmed missions.

A quadcopter uses 2 sets of identical fixed pitched propellers; 2 clockwise (CW) or in one direction and 2 counter-clockwise (CCW) or opposite direction. This helps the machine to hover in a stable formation. This is unlike most helicopters. Control of vehicle motion is achieved by altering the rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics. These use variation of RPM unit (revolutions per minute) to control lift and torque.

Quadcopters are known by different names, including: quadrocopter, quadrotor, quad-copter, UAV (Unmanned Aerial Vehicle), UAS, or drone. There are series of bicopters(two blades), tricopters (three blades), quadcopters(four blades), hexacopters (six blades), and octocopters (eight blades). The multirotors with a high number of blades are designed to carry a heavier payload, for efficient yaw smoothness and for efficient lift capacity. According to the efficiency needed for a particular task, respective series may be used.

A helicopter has one big rotor to provide all the lifting power and a little tail rotor to offset the aerodynamic torque generated by the big rotor. Without it the helicopter would spin almost as fast as the propeller. But a quadrotor‟s all four rotors work together to produce upward thrust and only 1/4 of the weight is lifted by each rotor. So less powerful motors are used, making it cost efficient. The quadrotor‟s movements are controlled by varying the relative thrusts of each rotor. The quadcopter allows a more stable platform, making it ideal for tasks such as surveillance and aerial photography, attributing to its unique design.

1.2 PROBLEM STATEMENT

The main problem in Quadcopter is the balancing and stability system. Most of Quadcopter will be unbalance and lost stability in case there are disturbance direct on itsuch as wind. In this research, to solve above problem the full system of Quadcopter isdesign and construct. Graphical user interface (GUI) is design in this research to makecontrol task of Quadcopter easier.

1.3 PROJECT OBJECTIVES

The objectives of this project are:

(a) To design Quadcopter that can control wireless base on computer.

(b) To design graphical user interface to communicate and controlQuadcopter.

(c) To test the performance of designed Quadcopter.

1.4 PROJECT CONSTRAINS

The scopes include the weather condition, distance and space:

(a) Quadcopter only can operate in sunny day or dry condition.

(b) Quadcopter operate distance not more than 100m in eye sight from the wireless receiver.

(c) Quadcopter is control by Arduino base microcontroller.

(d) Quadcopter is operated by brushless motor control by electronic speedcontroller.

1.5APPLICATIONS

Quadcopters have variety of applications in the field of research, military and many more. Quadcopter designs have become a cynosure as to most research fields as they are an important concept of unmanned aerial vehicle (UAV). They use an electronic control system and electronic sensors to stabilize the aircraft. Their small size and agile maneuverability prove a great strength to these quadcopters and they can be flown indoors as well as outdoors.

Some of their applications include:

1) 3-D Mapping- Small and lightweight drones help in surveying large landscapes with thousands of digital images that can be stitched together into a string of 3-D maps. Though military and other government satellites produce similar maps, but the stupendous outcomes of UAV technology outshines them repeatedly.

2) Search and Rescue- Drones are a widespread application to rescue patients during injury or any calamity, manmade or natural. Drones have the ability to help assist, locate and save victims, faster with more efficiency than any other option. There are campaign missions to provide a string product line of Search and Rescue (SAR) Drones. Advanced technology is used to create drones that can reach people in small spaces and supply food, water and medicine to trapped victims. Many advances like water-resistance, high definition GPS tracker and cameras in quadcopters prove a great benefactor especially in the search and rescue aim.

3) Farming- In agriculture technology helps in great precision to monitor fields, increase yields and also save money. Moreover, drones also help precise applications of pesticides, water, or fertilizers by identifying exactly where such resources are needed and delivering them there too. Cameras in drones are able to spot nitrogen levels (low or high) or watch the growth of a particular section. Infrared light cameras inform about plant health by measuring the efficiency of photosynthesis in various plants. These infrared cameras also detect which land is suitable for appropriate growth of which plant.

CHAPTER 2: EMBEDDED SYSTEMS

2.1 EMBEDDED SYSTEM

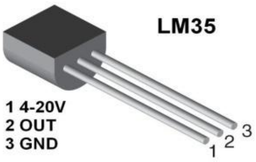
- An embedded system is a combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular function.
- Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys (as well as the more obvious cellular phone) are the possible hosts of an embedded system.
- Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.
- Embedded systems that are programmable are provided with programming interfaces and embedded programming is a specialized occupation.
- It is embedded as part of a complete device often including hardware and mechanical parts.
- The key characteristic is being dedicated to handle a particular task.
- The embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.
- Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

2.2 PARTS OF EMBEDDED SYSTEM

- An embedded system consists of three parts:
  I. Input
  II. Processing Unit
  III. Output

- The INPUT devices are responsible for providing input to the embedded system which is then processed by the processing unit to produce a desired output.
- In general, we use sensors as input devices while dealing with microcontrollers.

- A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.
- PROCESSING UNIT process the input provided by the input devices and produces the output.
- All the decisions are taken by this devices depending upon the algorithm provided by the user.
- OUTPUT devices show the result of our algorithm. A number of devices can be used. Some of them include LEDs, Motors (DC, Stepper, Servo) etc.
- All the decisions are taken by this devices depending upon the algorithm provided by the user.
- OUTPUT devices show the result of our algorithm. A number of devices can be used. Some of them include LEDs, Motors (DC, Stepper, Servo) etc



TEMPERATURE SENSOR

KEYPAD

Fig 2.1 Input units

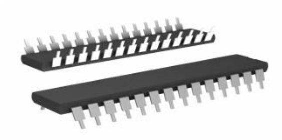


Fig 2.2 Processing unit

LEDs

LCD

Fig 2.3 Output unit

2.3 MICROPROCESSOR

A **microprocessor** is a computer processor which incorporates the functions of a computer's central processing unit (CPU) on a single integrated circuit (IC), or at most a few integrated circuits.The microprocessor is a multipurpose, clock driven, register based, programmable electronic device which accepts digital or binary data as input, processes it according to instructions stored in its memory, and provides results as output. Microprocessors contain both combinational logic and sequential digital logic. Microprocessors operate on numbers and symbols represented in the binary numeral system.

The integration of a whole CPU onto a single chip or on a few chips greatly reduced the cost of processing power. Integrated circuit processors are produced in large numbers by highly automated processes resulting in a low per unit cost. Single-chip processors increase reliability as there are many fewer electrical connections to fail. As microprocessor designs get faster, the cost of manufacturing a chip (with smaller components built on a semiconductor chip the same size) generally stays the same.

Before microprocessors, small computers had been built using racks of circuit boards with many medium- and small-scale integrated circuits. Microprocessors combined this into one or a few large-scale ICs. Continued increases in microprocessor capacity have since rendered other forms of computers almost completely obsolete (see history of computing hardware), with one or more microprocessors used in everything from the smallest embeddedsystems and handheld devices to the largest mainframes andsupercomputers.

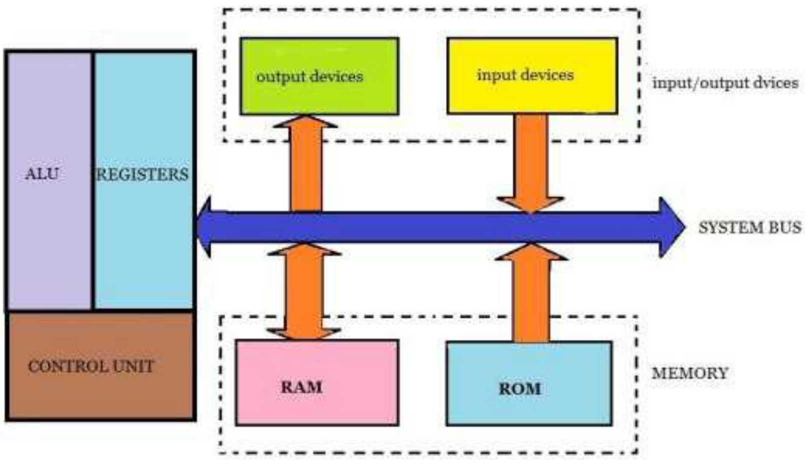


Fig 2.4:Block diagram of a microprocessor

2.4 MICROCONTROLLER

A **microcontroller** (or **MCU**, short for microcontroller unit) is a small computer (SoC) on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROMis also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

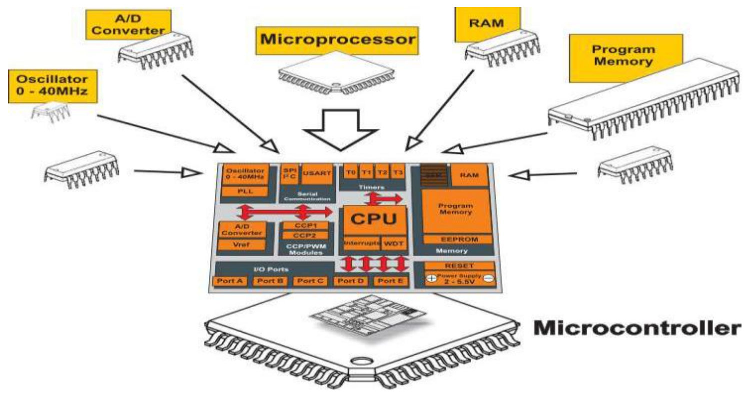


Fig 2.5: Basic microcontroller

2.4.1MICROCONTROLLER FEATURES

Microcontrollers usually contain from several to dozens of general purpose input/output pins (GPIO). GPIO pins are software configurable to either an input or an output state. When GPIO pins are configured to an input state, they are often used to read sensors or external signals. Configured to the output state, GPIO pins can drive external devices such as LEDs or motors, often indirectly, through external power electronics.

Many embedded systems need to read sensors that produce analog signals. This is the purpose of the analog-to-digital converter (ADC). Since processors are built to interpret and process digital data, i.e. 1s and 0s, they are not able to do anything with the analog signals that may be sent to it by a device. So the analog to digital converter is used to convert the incoming data into a form that the processor can recognize. A less common feature on some microcontrollers is a digital-to-analog converter (DAC) that allows the processor to output analog signals or voltage levels.

In addition to the converters, many embedded microprocessors include a variety of timers as well. One of the most common types of timers is the Programmable Interval Timer(PIT). A PIT may either count down from some value to zero, or up to the capacity of the count register, overflowing to zero. Once it reaches zero, it sends an interrupt to the processor indicating that it has finished counting. This is useful for devices such as thermostats, which periodically test the temperature around them to see if they need to turn the air conditioner on, the heater on, etc.

A dedicated Pulse Width Modulation (PWM) block makes it possible for the CPU to control power converters, resistive loads, motors, etc., without using lots of CPU resources in tight timer loops.

Universal Asynchronous Receiver/Transmitter (UART) block makes it possible to receive and transmit data over a serial line with very little load on the CPU. Dedicated on-chip hardware also often includes capabilities to communicate with other devices (chips) in digital formats such as Inter-Integrated Circuit (I^2C), Serial Peripheral Interface (SPI), Universal Serial Bus (USB), and Ethernet.

2.5 MICROPROCESSOR VS MICROCONTROLLER

MICROPROCESSOR	MICROCONTROLLER
• CPU is stand-alone, RAM, ROM, I/O, timer are separate. • Designer can decide on the amount of ROM, RAM and I/O ports. • Expensive • Versatility • General-purpose	• CPU, RAM, ROM, I/O and timer are all on a single chip**.** • Fix amount of on-chip ROM, RAM, I/O ports • For applications in which cost, power and space are critical • Not versatile • Single-purpose

Table 2.1 Comparison between Microprocessor and Microcontroller

2.6 INTRODUCTION TO AVR

- AVR was developed in the year 1996 by Atmel Corporation
- AVR derives its name from its developers and stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller.
- They are also known as Advanced Virtual RISC.
- The AT90S8515 was the first microcontroller which was based on AVR architecture.
- AVR microcontrollers are available in three different categories:
    - Tiny AVR – Less memory, small size, suitable only for simpler applications.
    - Mega AVR – These are the most popular ones having good amount of memory (up to 256 KB), higher number of inbuilt peripherals and suitable for moderate to complex applications.
    - Xmega AVR – Used commercially for complex applications, which require large program memory and high speed.

SERIES	**PINS**	**FLASH MEMORY**
Tiny AVR	6-32	0.5-8 KB
Mega AVR	28-100	4-256 KB
Xmega AVR	44-100	16-384 KB

Table 2.2 Comparison of major AVRs Series

CHAPTER 3: HARDWARE DESCRIPTION

The main HARDWARE used for construction of a quadcopter are the frame, propellers (either fixed-pitch or variable-pitch), and the electric motors. For best performance and simplest control algorithms, the motors and propellers should be placed equidistant. Recently, carbon fiber composites have become popular due to their light weight and structural stiffness. The electrical components needed to construct a working quadcopter are similar to those needed for a modern RC helicopter, which include the electronic speed control module, on-board computer or controller board, and battery. The HARDWARE are elaborately described as follows:

3.1 ATMEGA328p

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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 Atmega8U2 programmed as a USB-to-serial converter.

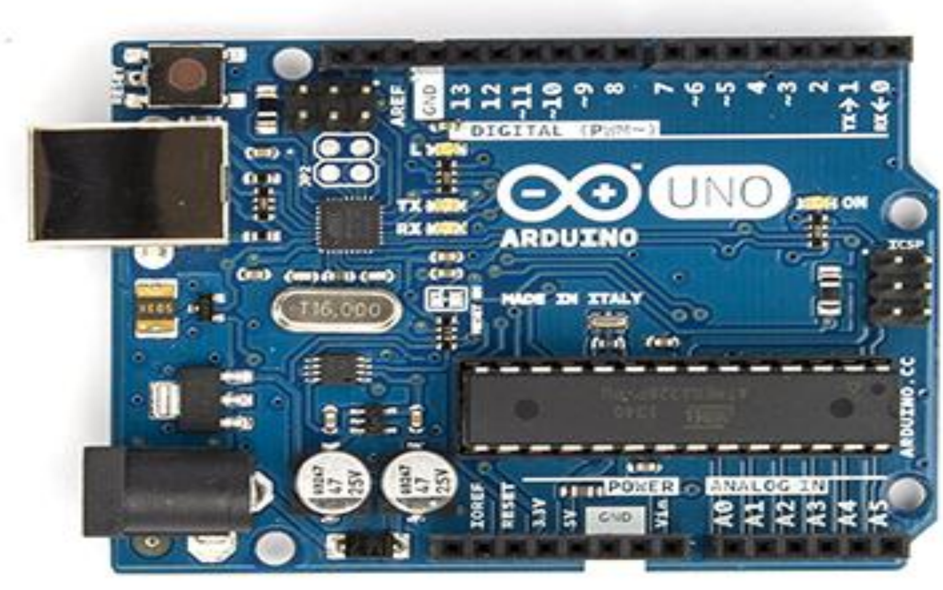


Figure 3.1: ARDUINO UNO

Arduino is a open source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. It's an open-source physical computing platform based on a microcontroller board, and a development environment for writing software for the board.

In simple words, Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeaker ,microphones, etc., They can either be powered through the USB connection from the computer or from a 9V battery.They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently. Anyone can buy this device through online auction site or search engine.Since the Arduino is an open-source hardware designs and ccreate their own clones of the Arduino and sell them,so the market for the boards is competitive.An official Arduino costs about $30,and a clone often less than $20. The name "Arduino" is reserved by the originalmakers. However, clone Arduino designs often have the letters "duino" on the end of their name,for example, Freeduino or DFRduino.The software for programming your Arduino iseasy to use and also freely available for Windows,Mac, and LINUX computers at no cost.

Microcontroller can be described as a computer embedded on a rather small circuit board.To describe the function of a microcontroller more precisely,it is a single chip that can perform various calculations and tasks,and send/receive signals from other devices via the available pins.Precisely what tasks andcommunication with the world it does, is what is governed by what instructions we give to the Microcontroller. It is this job of telling the chip what to do, is what we refer to as programming on it.However, the uC by itself, cannot accomplish much; it needs several externalinputs: power, for one; a steady clock signal, for another. Also, the job of programming ithas to be accomplished by an external circuit. So typically, a uC is used along with a circuitwhich provides these things to it; this combination is called a microcontroller board.The Arduino Uno that you have recieved, is one such microcontroller board. The actual microcontroller at its heart is the chip called Atmega328. The advantages that Arduino offers over other microcontroller boards are largely in terms of reliability of the circuit hardware as well asthe ease of programming and using it.

Open-source hardware shares much of the principles and approach of free and open-source software.The founders of Arduino wanted people to study their hardware,to understand how it works,make changes to it,and share those changes with the world.To facilitate this,they release all of the original design files(Eagle CAD)for the Arduino hardware.These files are licensed under a Creative Common Attribution Share-Alike license,which allows for both personal and commercial derivative works,as long as they(people) credit Arduino and release their designs under the same license.

The Arduino software is also oen-source.The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

3.1.1 ARDUINO PIN DIAGRAM

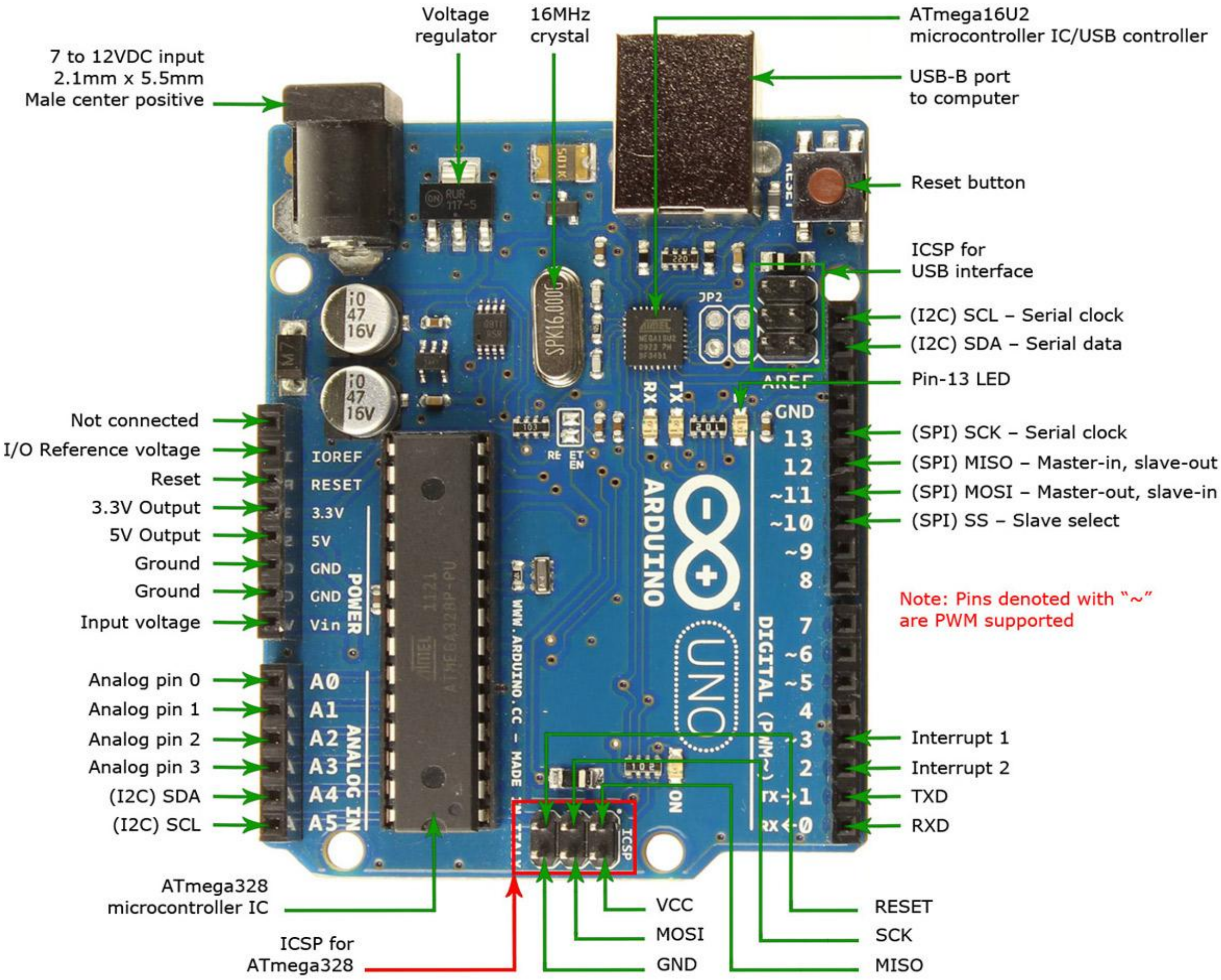


Figure 3.2: Arduino pin diagram

3.1.2 TECHNICAL SPECIFICATION

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table 3.1: Technical Specification

3.2 FRAME

It is the structure that holds or houses all the components together. They are designed to be strong and lightweight. To decide the appropriate frame for the copter 3 factors, i.e. weight, size and materials used are considered. The frame should be rigid and able to minimize the vibrations from the motors. It consists of 2-3 board (PDB) that allows for a clean and easy build is highly recommended. Parts and accessories that are 100% compatible and interchangeable are always preferred.Frames are usually made of: Carbon Fiber- Carbon fiber is the most rigid and vibration absorbent but it is the most expensive parts which are not necessarily of the same material: The center plate where the electronics are mounted Four arms mounted to the center plate Four motor brackets connecting the motors to the end of the arms Strong, light and sensible configuration including a built-in power distribution too. Aluminium- Hollow aluminium square rails are the most popular for the arms due to its light weight, rigidness and affordability. However aluminium can suffer from motor vibrations, as the damping effect is not as good as carbon fiber. In cases of severe vibration problem, it could mess up sensor readings. Wood/ Plywood /MDF (Medium-density fibreboard)- Wood boards like MDF plates could be used for the arms as they are better at absorbing the vibrations than aluminium. Unfortunately the wood is not a very rigid material and can break easily if the quadcopter crashes.

Fig.3.3 Conceptual design

The first design Quadcopter consisted of a circular rod,clamps, motor base etc. Detailed description of each component is shown in the table below.

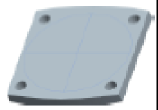
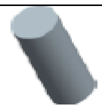
Sr No	Component	Dimensions (l*b*h mm)	Mass (gm.)/ quantity	Image
1	Circular hollow section	300*12.8*12.2	9.8/4	
2	Plate	100*100*3	83.8/3	
3	Clamps	30*8*8	4.17/16	
4	Motor base	30*30*3	7.9/8	
5	Studs	15*6	1.18/4	

Table3.2. First design component details

3.3 ROTORS OR MOTORS

The purpose of motors is to spin the propellers. Brushless DC motors provide thenecessary thrust to propel the craft. Each rotor needs to be controlled separatelyby a speed controller. A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller replaces the brush/commutator assembly of the brushed DC motor, which continually switches the phase to the windings to keep the motor turning. The controller performs similar timed power distribution by using a solid-state circuit rather than the brush/commutator system.

Brushless motors offer several advantages over brushed DC motors, including high torque to weight ratio, more torque per watt (increased efficiency), increased reliability, reduced noise, longer lifetime (no brush and commutator erosion), elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference(EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling. This in turn means that the motor's internals can be entirely enclosed and protected from dirt or other foreign matter.

Brushless motor commutation can be implemented in software using a microcontroller or microprocessor computer, or may alternatively be implemented in analogue hardware, or in digital firmware using an FPGA. Commutation with electronics instead of brushes allows for greater flexibility and capabilities not available with brushed DC motors, including speed limiting, "micro stepped" operation for slow and/or fine motion control, and a holding torque when stationary. Controller software can be customized to the specific motor being used in the application, resulting in greater commutation efficiency.

The maximum power that can be applied to a brushless motor is limited almost exclusively by heat, too much heat weakens the magnets and may damage the winding's insulation.

When converting electricity into mechanical power, brushless motors are more efficient than brushed motors. This improvement is largely due to the brushless motor's velocity being determined by the frequency at which the electricity is switched, not the voltage. Additional gains are due to the absence of brushes, which reduces mechanical energy loss due to friction. The enhanced efficiency is greatest in the no-load and low-load region of the motor's performance curve. Under high mechanical loads, brushless motors and high-quality brushed motors are comparable in efficiency.

Environments and requirements in which manufacturers use brushless-type DC motors include maintenance-free operation, high speeds, and operation where sparking is hazardous (i.e. explosive environments) or could affect electronically sensitive equipment.

Because the controller must direct the rotor rotation, the controller requires some means of determining the rotor's orientation/position (relative to the stator coils). Some designs use Hall effect sensors or a rotary encoder to directly measure the rotor's position. Others measure the back-EMF in the undriven coils to infer the rotor position, eliminating the need for separate Hall effect sensors, and therefore are often called sensorless controllers.

In a brushless DC motor, two coils are energized at a time with equal and opposite polarities: one pushes the rotor away from it while the other attracts the rotor towards it. This increases the overall torque capacity of the motor and Hall effect sensors or a rotary encoder determine which two coils have to be energized to achieve this strategy.

A typical controller contains 3 bi-directional outputs (i.e., frequency controlled three phase output), which are controlled by a logic circuit. Simple controllers employ comparators to determine when the output phase should be advanced, while more advanced controllers employ a microcontroller to manage acceleration, control speed and fine-tune efficiency.Controllers that sense rotor position based on back-EMF have extra challenges in initiating motion because no back-EMF is produced when the rotor is stationary. This is usually accomplished by beginning rotation from an arbitrary phase, and then skipping to the correct phase if it is found to be wrong. This can cause the motor to run briefly backwards, adding even more complexity to the startup sequence. Other sensorless controllers are capable of measuring winding saturation caused by the position of the magnets to infer the rotor position.

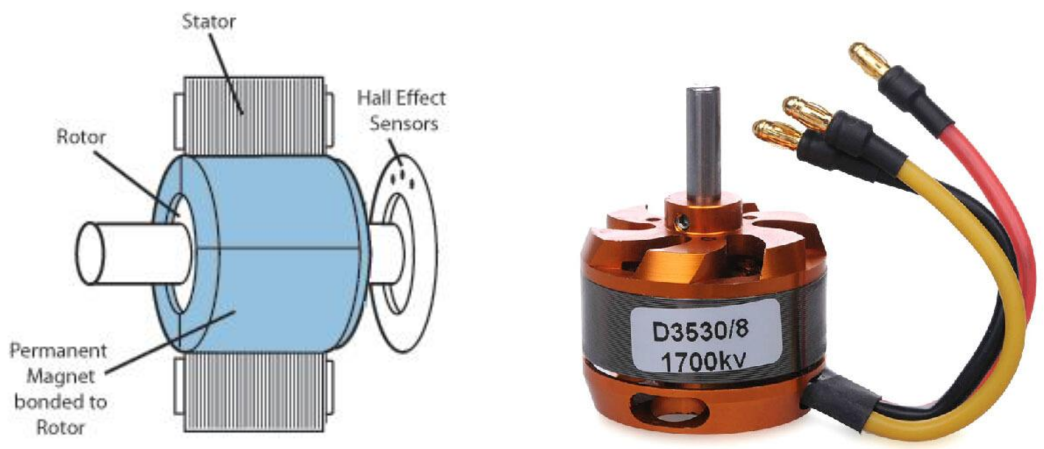


Figure3.4 Overview of DC brushless motors

Brushless motors can be constructed in several different physical configurations: In the 'conventional' (also known as inrunner) configuration, the permanent magnets are part of the rotor. Three stator windings surround the rotor. In the outrunner (or external-rotor) configuration, the radial-relationship between the coils and magnets is reversed; the stator coils form the center (core) of the motor, while the permanent magnets spin within an overhanging rotor which surrounds the core. The flat or axial flux type, used where there are space or shape limitations, uses stator and rotor plates, mounted face to face. Outrunners typically have more poles, set up in triplets to maintain the three groups of windings, and have a higher torque at low RPMs. In all brushless motors, the coils are stationary.There are two common electrical winding configurations; the delta configuration connects three windings to each other (series circuits) in a triangle-like circuit, and power is applied at each of the connections. The Wye (*Y*-shaped) configuration, sometimes called a star winding, connects all of the windings to a central point (parallel circuits) and power is applied to the remaining end of each winding.A motor with windings in delta configuration gives low torque at low speed, but can give higher top speed. Wye configuration gives high torque at low speed, but not as high top speed.Although efficiency is greatly affected by the motor's construction, the Wye winding is normally more efficient. In delta-connected windings, half voltage is applied across the windings adjacent to the driven lead (compared to the winding directly between the driven leads), increasing resistive losses. In addition, windings can allow high-frequency parasitic electrical currents to circulate entirely within the motor. A Wye-connected winding does not contain a closed loop in which parasitic currents can flow, preventing such losses.

3.4 BATTERY – POWER SOURCE

LiPo (Lithium Polymer) batteries are used because it is light. NiMH(Nickel Metal Hydride) is also possible.They are cheaper, butt heavier than LiPo. LiPo batteries also have a C rating and a power rating in mAh (which stands for milliamps per hour). The C rating describes the rate at which power can be drawn from the battery, and the power rating describes how much power the battery can supply. Larger batteries weigh more so there is always a tradeoff betweenflight duration and total weight.

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated variously as LiPo, LIP, Li-poly and others), is a rechargeable battery of lithium-ion technology in a pouch format. Unlike cylindrical and prismatic cells, LiPos come in a soft package or pouch, which makes them lighter but also less rigid.

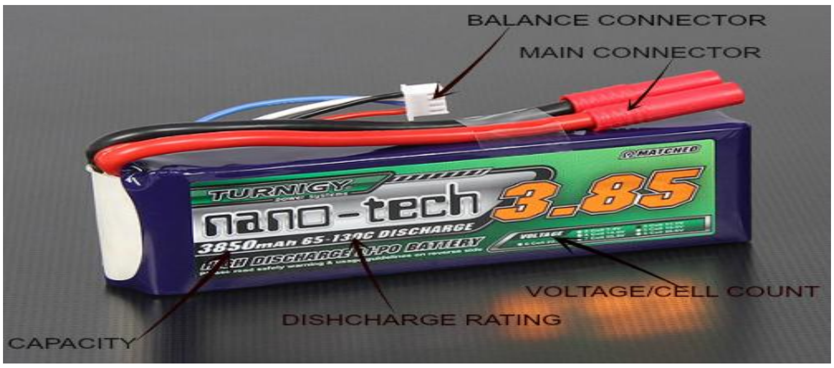


Figure3.5 LiPo Battery

The designation "lithium polymer" has caused confusion among battery users because it can be interpreted in two ways. Originally, "lithium polymer" represented a developing technology using a polymer electrolyte instead of the more common liquid electrolyte. The result is a "plastic" cell, which theoretically could be thin, flexible, and manufactured in different shapes, without risk of electrolyte leakage. The technology has not been fully developed and commercializedand research is ongoing.

The second meaning appeared after some manufacturers applied the "polymer" designation to lithium-ion cells contained in a non-rigid pouch format. This is currently the most popular use, in which "polymer" refers more to a "polymer casing" (that is, the soft, external container) rather than a "polymer electrolyte". While the design is usually flat, and lightweight, it is not truly a polymer cell, since the electrolyte is still in liquid form, although it may be "plasticized" or "gelled" through a polymer additive.These cells are sometimes designated as "LiPo"; however, from a technological point of view, they are the same as the ones marketed simply as "Li-ion", since the underlying electrochemistry is the same.

This article concerns the second, more extended meaning (among the general public), while the first meaning (understood in research and academia) is discussed only in the last section.

The name "lithium polymer" (LiPo) is widespread among users of radio-controlled models, for which it may indicate a single cell or abattery pack with cells connected in series or parallel. The more general term "lithium-ion" (Li-ion) is used almost everywhere else, including consumer electronics such as mobile phones and notebook computers, and battery-powere electric vehicles.

3.5ESC- ELECTRONIC SPEED CONTROLLER

The electronic speed controller controls the speed of the motor or tells the motors how fast to spin at a given time. For a quadcopter, 4 ESCs are needed, oneconnected 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 to power things like the 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. This firmware in a ESC changes the refresh rate of the ESC so the motors get many more instructions per second from the ESC, thus have greater control over the quadcopter"s behavior. The frequency of the signals

also vary a lot, but for a quadcopter it is preferred if the controller supports high enough frequency signal,so the motor speed can be adjusted quick enough for optimal stability.
Precise speeds to achieve accurate flight, the ESC is very important. This firmware in a ESC changes the refresh rate of the ESC so the motors get many more instructions per second from the ESC, thus have greater control over the quadcopter‟s behavior. The frequency of the signals also vary a lot, but for a quadcopter it is preferred if the controller supports high enough frequency signal, so the motor speed can be adjusted quick enough for optimal stability.

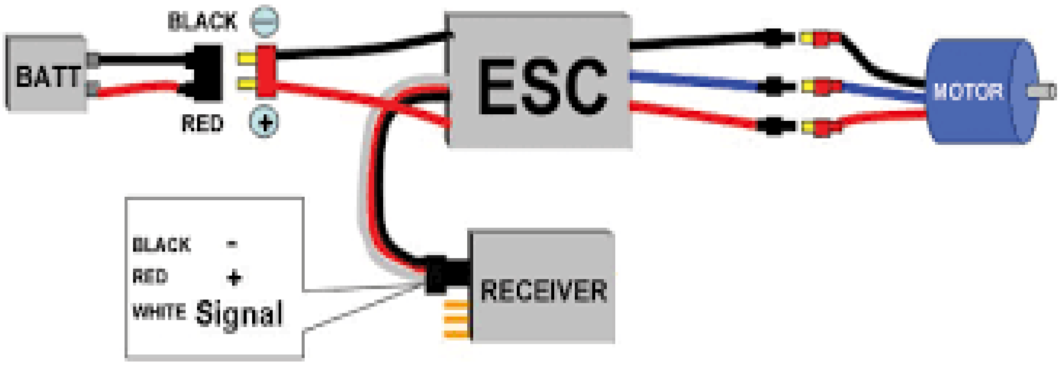


Figure3.6 Overview of an ESC

ESC systems for brushed motors are very different by design; as a result brushed ESC's are not compatible with brushless motors. Brushless ESC systems basically create a tri-phase AC power output of limited voltage from an onboard DC power input, to run brushless motors by sending a sequence of AC signals generated from the ESC's circuitry, employing a very low impedance for rotation. Brushless motors, otherwise called outrunners or inrunners depending on their physical configuration, have become very popular with "electroflight"radio-control aeromodeling hobbyists because of their efficiency, power, longevity and light weight in comparison to traditional brushed motors. However, brushless AC motor controllers are much more complicated than brushed motor controllers.

The correct phase varies with the motor rotation, which is to be taken into account by the ESC: Usually, back EMF from the motor is used to detect this rotation, but variations exist that use magnetic (Hall Effect) or optical detectors.

3.6 PROPELLERS

Quadcopters generally use two pairs of identical fixed pitched propellers; two clockwise (CW) and two counter-clockwise (CCW). These use independent variation of the speed of each rotor to achieve control. By changing the speed of each rotor it is possible to specifically generate a desired total thrust; to locate for the centre of thrust both laterally and longitudinally; and to create a desired total torque, or turning force.Generally, increased propeller pitch and length will draw more current. Also the pitch can be defined as the travel distance of one single prop rotation. In a nutshell, higher pitch means slower rotation, but will increase your vehicle speed which also use more power.

When deciding on length and pitch, you need to find a good balance. Generally a prop with low pitch numbers can generate more torque. The motors don't need to work as hard so it pulls less current with this type of prop. If you want to do acrobatics, you will need torque propellers which provide more acceleration and it puts less pressure on the power system. Lower pitch propellers will also improve stability.

A higher pitch propeller moves greater amount of air, which could create turbulence and cause the aircraft to wobble during hovering. If you notice this with your quadcopter, try to choosing a lower pitched propeller.

When it comes to the length, propeller efficiency is closely related to the contact area of a prop with air, so a small increase in prop length will increase the propeller efficiency. (pretty much like swimmers with larger hands and feet can swim faster, but also more tiring for them)

A smaller prop is easier to stop or speed up while a larger prop takes longer to change speeds (inertia of movement). Smaller prop also means it draws less current, that is why hexacoptors and octocopters tend to use smaller props than quadcopter of similar size.For larger quadcopters that carry payloads, large propellers and low-kv motors tend to work better. These have more rotational momentum, and will more easily maintain your aircraft's stability.

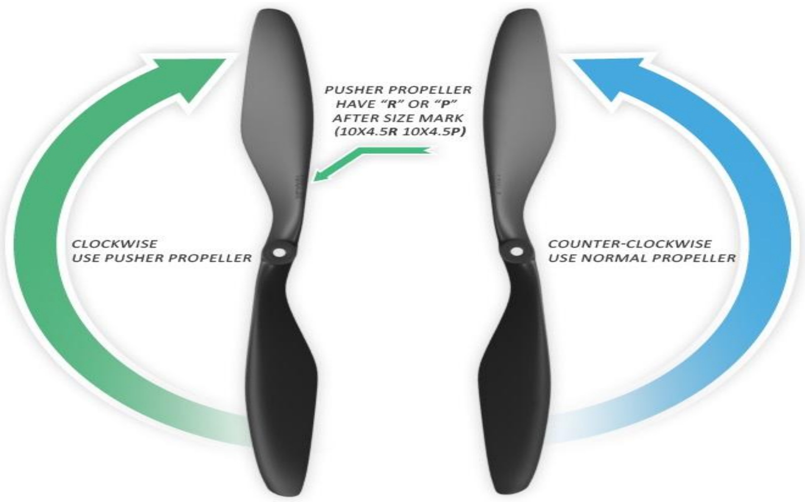


Figure3.7 Overview ofpropeller

3.7 RADIO TRANSMITTER AND RECEIVER

The radio transmitter and receiver allows to control the quadcopter. Four channels for a basic quadcopter is required .Using a radio with 8 channels, so there is more flexibility is recommended. Quadcopters can be programmed and controlled in many different ways but the most common ones are by RC transmitter in either Rate (acrobatic) or Stable mode. The difference is the way the controller board interprets the orientations feedback together with the RC transmitter joysticks. In Rate mode only the Gyroscope values are used to control the quadcopter. The joysticks on the RC transmitter are then used to control and set the desired rotation speed of the 3 axes, though if the joysticks are released, it does not automatically balance again. This is useful when the quadcopter is required to do stunts like tilting it a bit to the right. The speed of the 4 motors will be adjusted automatically and constantly to keep the quadcopter balanced.

Figure3.8. 6 channel receiver

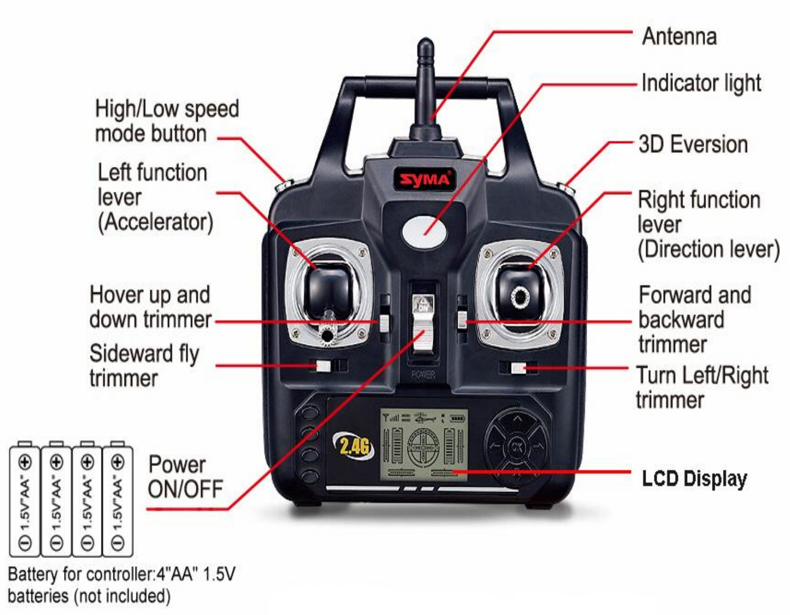


Figure3.8 6 channel transmitter

3.8 FLIGHT CONTROLLER

The flight control board is regarded as the „brain‟ of the quadcopter. It houses the sensors such as the gyroscopes and accelerometers that determine how fast each of the quadcopter‟s motors spin. Flight control boards range from simple tohighly complex. An affordable, easy to set up, having a strong functionality controller is always recommended. Such controllers can handle about any type of multirotor aircraft so if even we want to upgrade to a hexacopter or experiment with a tricopter, we need not purchase another board

CHAPTER 4:IMPLEMENTATION

4.1 DESIGN OVERVIEW

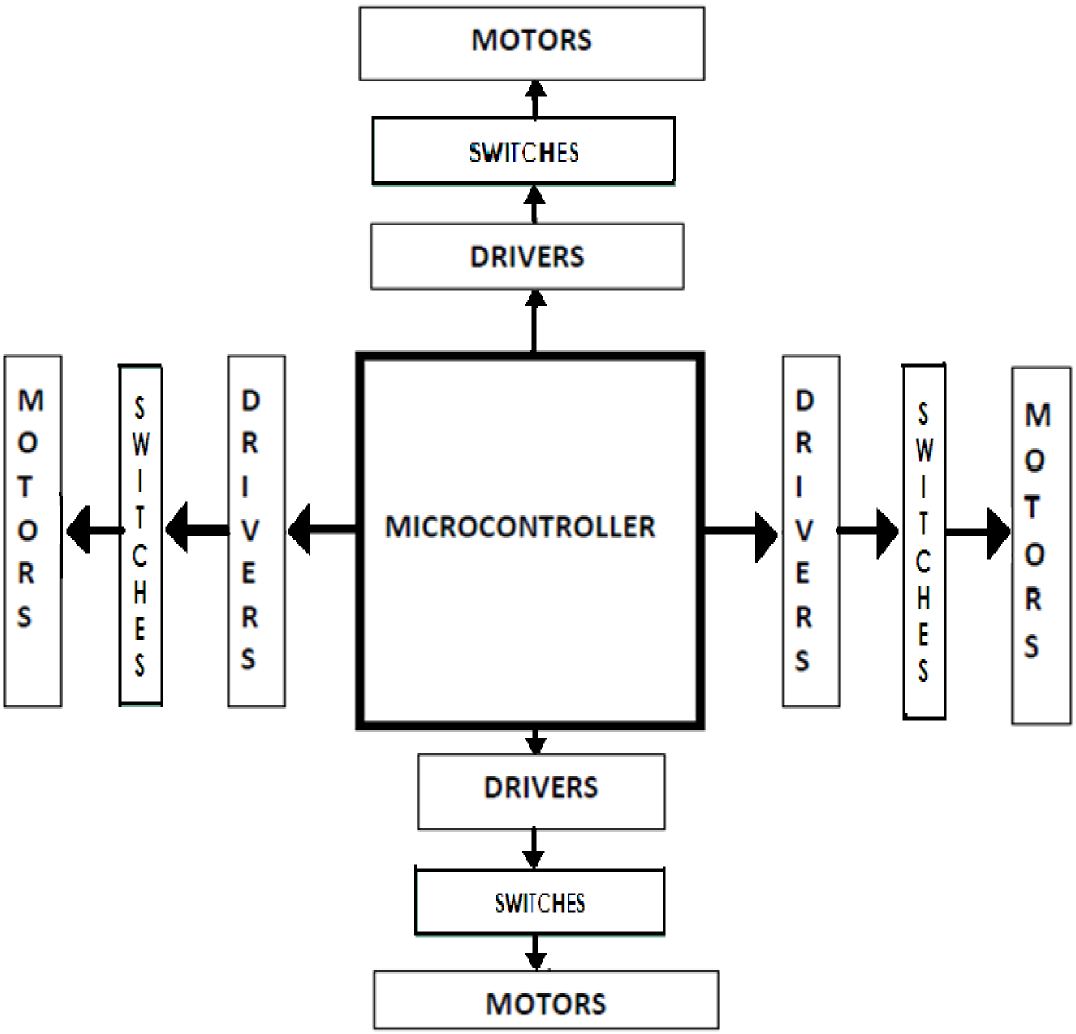


Figure 4.1 Design overview

4.2WORKING PRINCIPLE

4.2.1 INERTIAL AND BODY FRAME

The inertial frame is defined with respect to the ground, with gravity pointing in the negative Z-axis. (Fig. 4.3) The body frame is defined by the orientation of the quadcopter, with the rotor pointing in the positive Z-axis and the armextensions pointing in the positive/negative X and Y axes. (Fig. 4.2) All metrics with respect to either the inertial or body frame are implied in braces.

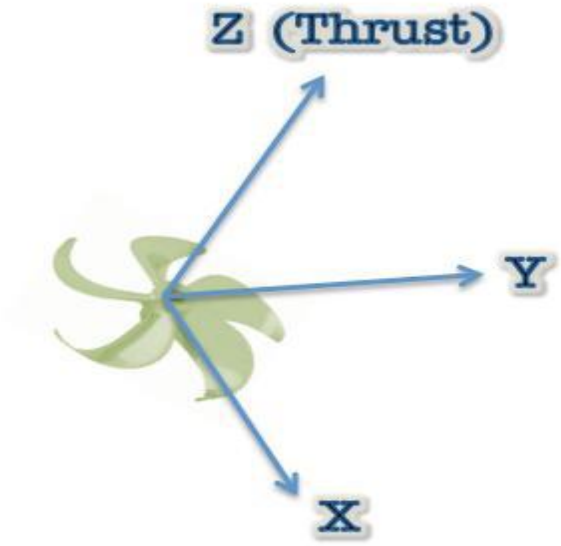


Figure.4.2. Body frame

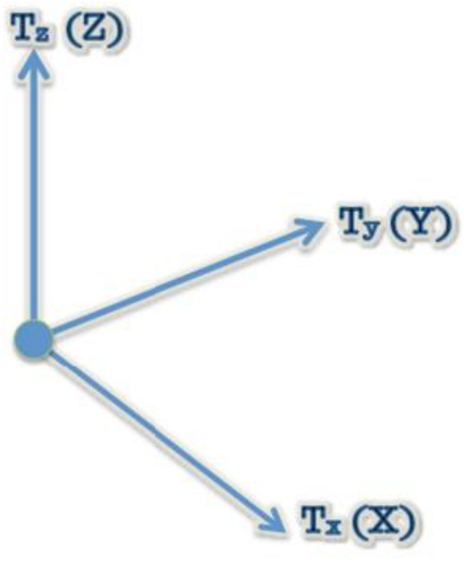


Fig.4.3 . Inertial frame

4.3 THRUST AND STANDARD FLIGHT OPERATIONS

4.3.1THRUST

Thrust is the force that is orthogonal to the propeller. It is generated by rotor spin at a certain velocity (Eq. 1). Moreover, it accelerates the body in the direction of its force. In all the equations henceforth ‘i‘ refers to the particular rotor in figure shown below:

$$\left|\overrightarrow{T_i}\right| = \rho A {v_i}^2$$

(Eq. 1)

In eq. 1, T is determined using the parameters v (velocity), ! (air-density) and A (cross-sectional area) of the propeller. A real-time air-density reading is necessary because the density of air is correlated to external environmental factors that are not always constant. As a result, the velocity of rotors required for the quadcopter to climb up or down, or hover a fixed altitude is also variable at external conditions. So, a constant air-density reading would dramatically compromise the performance of the rotors and therefore, the overall total thrust of the quadcopter. For the latter parameter, the crosssectional areas of all the propellers are constant during anystate of the flight. However, the area of the propellers could also contribute to the amount of total thrust generated.

4.3.2 TAKE-OFF AND LAND

In takeoff mode all the four rotors spin in CW direction. The CW direction contributes positive net thrust {Z-axis Body frame} on the quadcopter body, thereby enabling translational motion about positive Z-axis {Inertial frame}. In landing mode all the four rotors spin in CCW direction. The CCW direction contributes negative net thrust {Z-axis Body frame} on the quadcopter body, thereby enabling translational motion about the negative Z-axis {Inertial frame}. Provided all the rotors are spinning in the same direction and velocity, Eq. 2 gives the net thrust on the body.

$$net\ T = \rho A \sum_{i=1}^{4} [v_i]^2$$

(Eq.2)

4.3.3 HOVER

When the net thrust of all the rotors is equal to 0, the quadcopter maintains a state of constant altitude also known as hovering. The direction of rotation of a pair of rotors at each axis is always the same. For net thrust to equal 0, the spin direction of both rotors in X-axis {Body frame} must be opposite to the spin direction of rotors in Y-axis {Body frame}. (Fig. 4.4)
The speed of all four rotors during hovering is equal regardless of the propellers' direction of rotation.
Eq. 3 shows the net thrust from the four rotors. The arrows indicate the direction of thrust in the Z-axis {Body frame}.

$$net\ T = \rho A \sum_{\uparrow i=1}^{2} [v_i]^2 - \rho A \sum_{\downarrow i=3}^{4} [v_i]^2 = 0$$

(Eq.3)

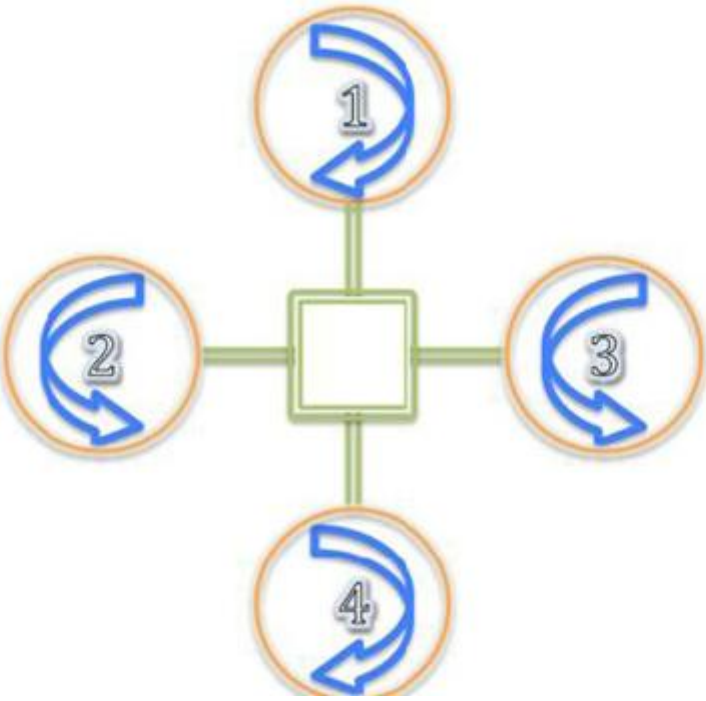


Figure.4.4 Rotational Direction of Propellers

4.3.4ORIENTATION

Adjusting the angular orientation enables the user to maneuver the quadcopter. Angular orientation is stated in terms of pitch and roll. (fig. 4.5) Pitch is the angle measured with respect to the rotation through y-axis {body frame}. Roll is the angle measured with respect to the rotation through x-axis {body frame}.

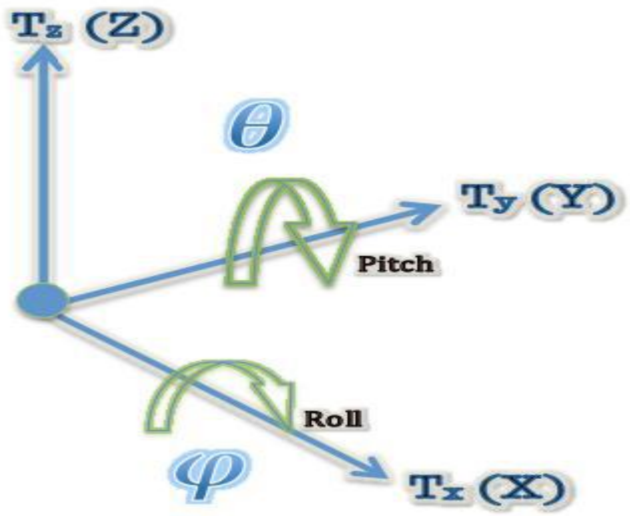


Fig. 4.5. Pitch and Roll angles

Orientation	**θ**	**ϕ**	**X**	**Y**	**Z**
*Hovering	θ=0˚	ϕ=0˚	0	0	$\pm T_z$
*Forward	0˚< θ<90˚	ϕ=0˚	T_x	0	$\pm T_z$
Backward	-90˚< θ<0˚	ϕ=0˚	$-T_x$	0	$\pm T_z$
*Left	θ=0˚	0˚<ϕ<90˚	0	T	$\pm T_z$
Right *Pitch + Roll	θ=0˚ 0˚< θ<90˚	-90˚<ϕ<0˚ 0˚<ϕ<90˚	0 T_x	$-T_y$ T_y	$\pm T_z$ $\pm T_z$
Pitch + Roll	-90˚< θ<0˚	-90˚<ϕ<0˚	$-T_x$	$-T_y$	$\pm T$

Table4.1 Shows how the different orientations of the quadcopter are related to the range of angles

4.4FLIGHT CONTROL

The flight control in quadcopters work is based on the principle that each rotor produces thrust and torque about its center of rotation, as well as a drag opposite to the vehicle's direction of flight. If all rotors spin at the same angular velocity, with rotors marked 1
and 3 rotating clockwise and rotors marked 2 and 4 counterclockwise, the netaerodynamic torque, and subsequently the angular acceleration about the yaw axis, is exactly zero, which implies that the yaw stabilizing rotor of conventional helicopters is not needed. Yaw is induced by mismatching the balance in aerodynamic torques (i.e., by offsetting the cumulative thrust commands between the counter-rotating blade pairs).
The 4 rotors aligned take the shape of a square, two on opposite sides of the square rotate in clockwise direction and the other two rotate in the opposite direction. If all rotors turn in the same direction, the craft would spin just like the regular helicopter without the tail rotor. Yaw is induced by unbalanced aerodynamic torques. The aerodynamic torque of the first rotors‟ pair cancelled out with the torque created by the second pair which rotates in the opposite direction. Hence if all four rotors apply equal thrust the quadcopter will stay in the same direction.

For balance, the quadcopter should continuously take the required measurements from the sensors, and make alterations to the speed of each rotor to maintain the body level. These adjustments usually are done automatically by a sophisticated control system on the quadcopter in order to stay perfectly balanced. A quadcopter has four controllable degrees of freedom, namely: Yaw, Roll, Pitch, and Altitude. Each degree of freedom can be controlled by adjusting the thrusts of each rotor.

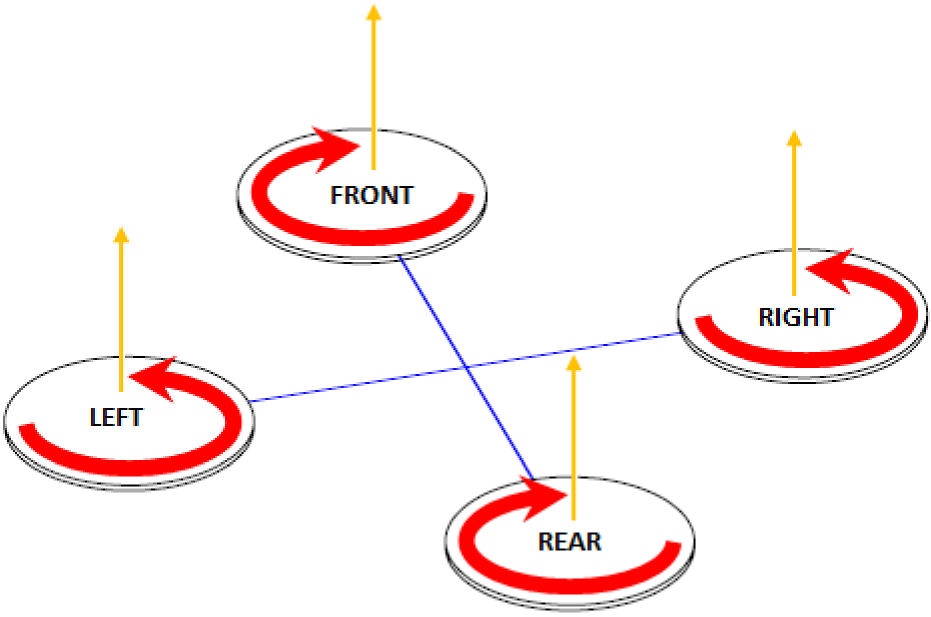
The movements of a quadcopter contain- roll, yaw and pitch.

- Roll (tilting left and right) - Controlled by increasing speed of one motor and lowering the opposite one.
- Pitch (moving up and down) - Same way as roll, but second pair of motors are used.
- Yaw (turning left and right) - Controlled by turning up the speed of the regular rotating motors and taking away power from the counter rotating.

For rolling or pitching, one rotor‟s thrust should decrease and the opposite rotor‟s thrust should increase by the same amount, which causes the quadcopter to tilt. When it tilts, the force vector is split into the horizontal and the vertical component. Due to this, firstly, the quadcopter begins to travel opposite to the direction of the newly created horizontal component. Secondly, because the force vector has been split, the vertical component will be smaller, causing the quadcopter beginning to fall. In order to keep the quadcopter stable, the thrust of each rotor should then be increased in order for compensation.

4.4.1TAKE-OFF AND LANDING MOTION MECHANISM

Take-off is movement of Quadcopter that lift up from ground to hover position and landing position is versa of take-off position. Take-off (landing) motion is control by increasing (decreasing) speed of four rotors simultaneously which means changing the vertical motion. Figure given below illustrated the take-off and landing motion of Quadcopter respectively.



Figure

4.6. Take off Motion of Quadcopter

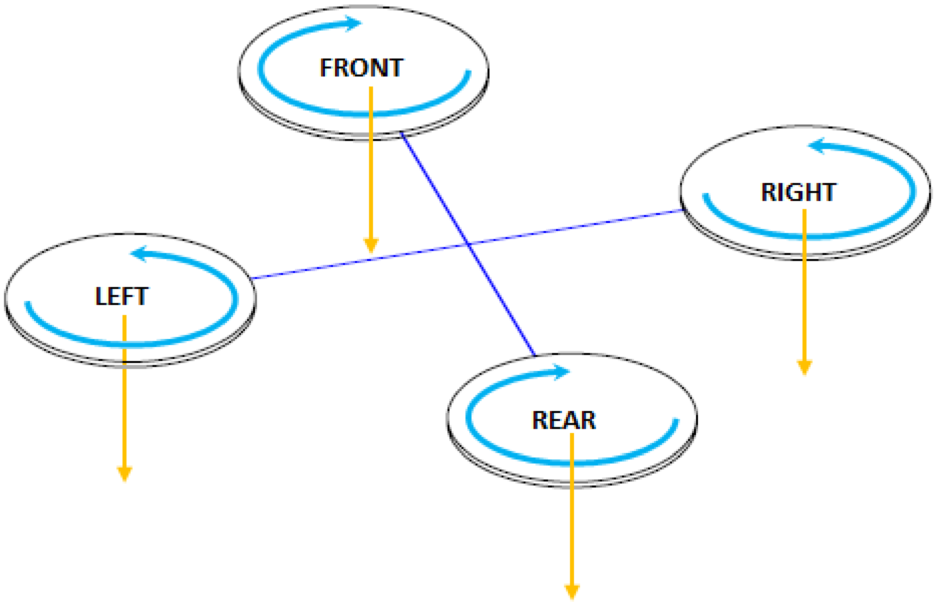


Figure 4.7. Landing Motion of Quadcopter

4.4.2 FORWARD AND BACKWARD MOTION

Forward (backward) motion is control by increasing (decreasing) speed of rear (front) rotor. Decreasing (increasing) rear (front) rotor speed simultaneously will affect the pitch angle of the Quadcopter. The forward and backward motions of Quadcopter are represented in figure given below:

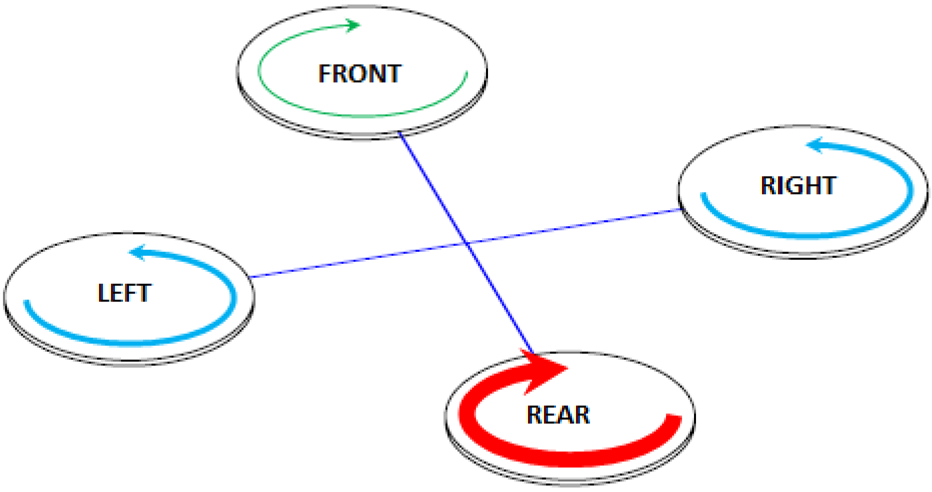


Figure 4.8. Foraward Motion of Quadcopter

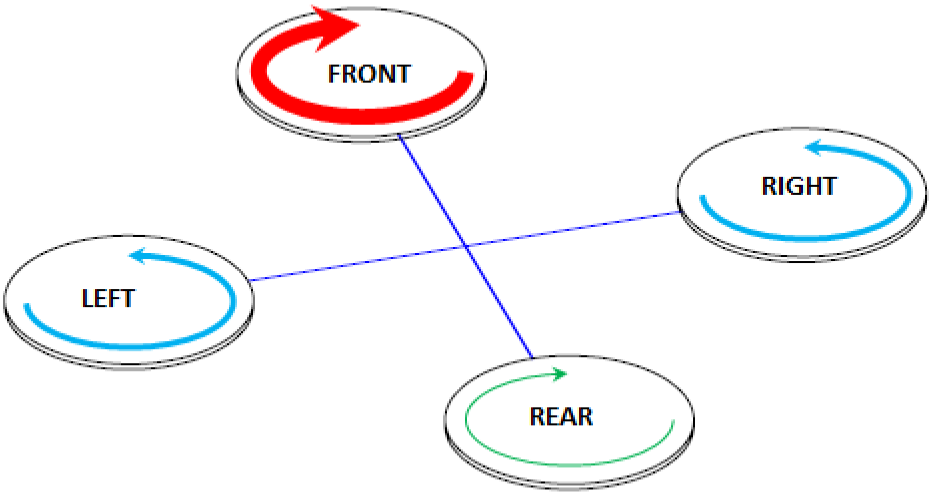


Figure 4.9. Backward Motion of Quadcopter

4.4.3 LEFT AND RIGHT MOTION

For left and right motion, it can control by changing the yaw angle of Quadcopter. Yaw angle can control by increasing (decreasing) counter-clockwise rotors speed while decreasing (increasing) clockwise rotor speed. Figure given below show the right and left motion of Quadcopter.

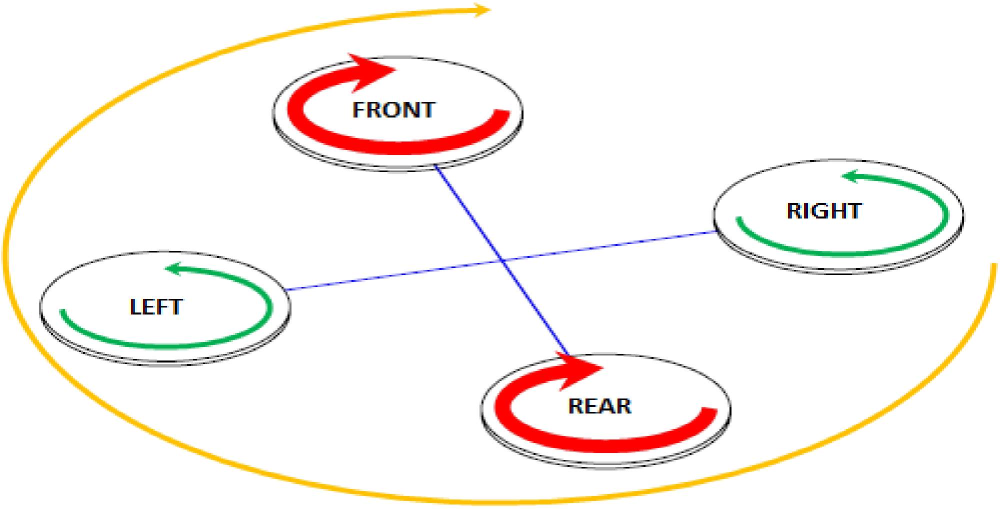


Figure 4.10. Right Motion of Quadcopter

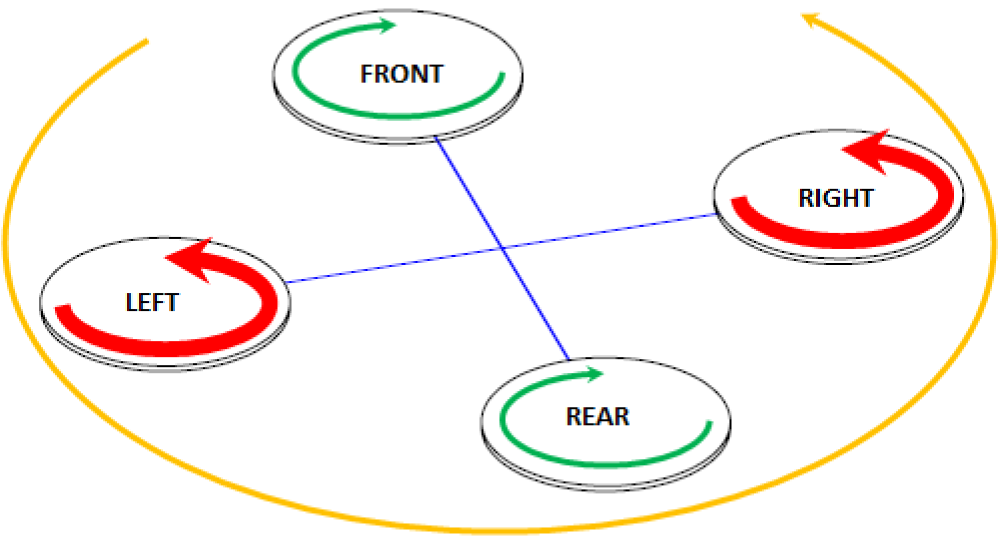


Figure 4.11. Left Motion of Quadcopter

TABULAR FORM:

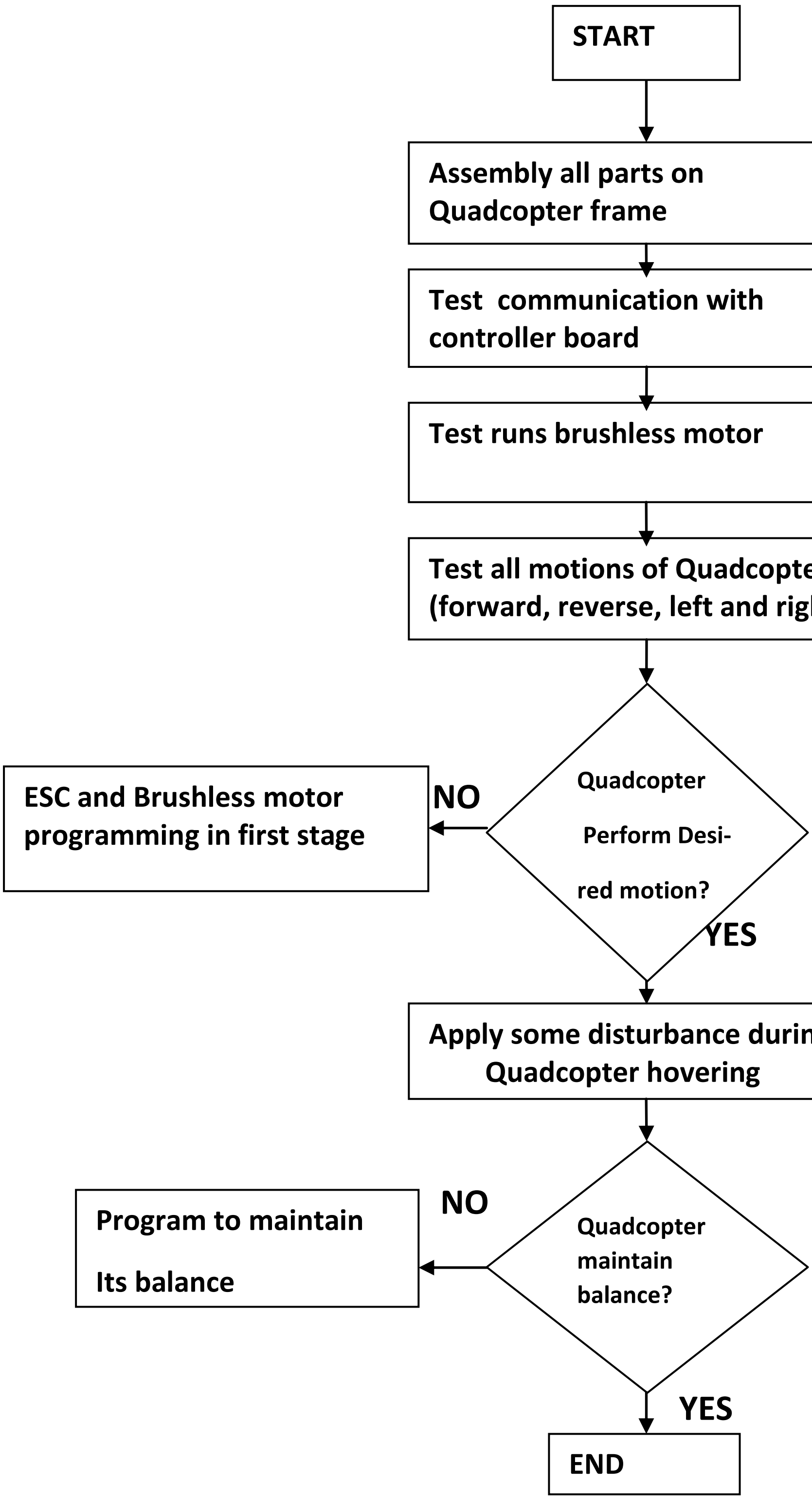
	TAKE-OFF	LANDING	FORWARD	BACKWARD	RIGHT	LEFT
On Y-axis (1)	High Speed (C)	Low Speed (C)	Medium Speed (C)	High Speed (C)	High Speed (C)	Medium Speed (C)
On Y-axis (2)	High Speed (C)	Low Speed (C)	High Speed (C)	Medium Speed (C)	High Speed (C)	Medium Speed (C)
On X-axis (1)	High Speed (AntiC)	Low Speed (AntiC)	Medium Speed (AntiC)	Medium Speed (AntiC)	Medium Speed (AntiC)	High Speed (AntiC)
On X-axis (2)	High Speed (AntiC)	Low Speed (AntiC)	Medium Speed (AntiC)	Medium Speed (AntiC)	Medium Speed (AntiC)	High Speed (AntiC)

Table 4.2. Tabular Form of all the Motion of Quadcopter

CHAPTER 5: SOFTWARE DESCRIPTION

5.1 FLOW CHART

Designs of Quadcopter are divided into two stages that is part design in first stage and full interface at second stage. Flow chart of Quadcopter design is described in Figure below:



5.2 EMBEDDED C

Embedded C is language for programming the microcontroller for embedded applications. There is a large and growing international demand for programmers with embedded skills and many desktop developers are starting to move in this developed area.

The reasons for writing programs in C are

- It is easier and less time consuming to write in C than assembly.
- C is easier to modify and update.
- We can use code available in function libraries.
- C is portable to other microcontrollers also.

5.3 CODEVISION AVR

Integrated Development Environment for the 8-bit Atmel AVR and XMEGA Microcontrollers. This is the software where we will write our C code. It provides us with lots of features, some of them include :

• Application that runs under Windows® XP, Vista, Windows 7, Windows 8 and Windows 10, 32-bit and 64-bit
• Easy to use Integrated Development Environment and ANSI C compatible Compiler
• Editor with auto indentation, syntax highlighting for both C and AVR assembler, function parameters and structure/union members autocomplete

5.4 PROTEUS

Proteus is a Virtual System Modelling and circuit simulation application. The suite combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. Proteus also has the ability to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it. It simulates Input / Output ports, interrupts, timers, USARTs and all other peripherals present on each supported processor.

CHAPTER 6: RESULTS & FUTURE SCOPE

6.1 RESULT

We have successfully implementedall the quadcopter operations by burning our code on ARDUINO UNO microcontroller.

6.2 FUTURE SCOPE

The use of drones has tremendously grown in a short span of time owing to the long flying time in contrast to the manned aircrafts. Without a human pilot, drones can operate for significantly longer without fatigue than airplanes. Moreover, drone operators can easily hand off controls of a drone without any operational downtime. They are remote controlled, so no danger will be there to the crew. They contain a whole lot of widespread applications, in day to day lives, domestic purposes and national to international purposes. Some more of their advantages include:

- Does not require mechanical linkages to change the pitch angle at the blade as it spins.
- Four small rotors have smaller diameter than one large helicopter rotor.
- Takes less damage to rotors.
- No need for a tail rotor which generates no lift.
- Easier to build four small blades compared to large one.
- Due to ease in construction and control, they are used in amateur model aircrafts project. They can traverse through difficult terrains because of their small size and there is less risk of damage too.
- They can save lives.They greatly reduce putting military manpower in combat (in harm).
- They are significantly cheaper and the cost in fuel and maintenance is way lower than regular airplanes.
- Quadcopters are smaller and are able to fly lower than traditional airplanes and the risk level to military hardware is comparatively low.
- Drones increase surveillance, reconnaissance, and general military intelligence.
- Since the advantages of quadcopter technology are more than its demerits (are very well rectifiable), then according to drone experts, drones will be “in trend” within next 10 to 20 years. There is a wide scope that with its extending use in almost every field and with greater powerful components, drones will surely come into full time existence. Hence quadcopters will very soon start taking over larger roles in a variety of jobs.

CONCLUSION

Quadcopters or drones first came to application as small toys, or school/university projects and then no sooner began to garner widespread attention- used in big-budget movies, photography of high profile sports, agricultural use to rectify lands and detect levels of pesticides as well as other components like nitrogen in plants, search and rescue, land mapping, military.etc. The commercial as well as private use of drones is enlarging. The main point is that with growing progress in technology, drones too are coming in different shapes, sizes and configuration (quadcopters, hexacopters, etc.) for better load and yaw stability. Moreover, extended components like camera, water- resistant components or GPS tracker make it easy in missions of combating, surveillance and especially search and rescue. After 10 years, the market for commercial drones will reach $1.7 billion. Each year, $6.4 billion is being spent developing drone technology. The drones are even providing new job opportunities. 70,000 new drone-related jobs are projected within the next three years in USA alone. 100,000 new jobs are expected till 10 years. Moreover, schools are offering drone degrees & programs in order to provide a trained workforce capable of meeting this demand. This may also prove that there is no need for people to fear about losing their jobs because of replacement by robots or drones. But there are also some concerns like all the new leading technologies. It is important to plan appropriately to achieve a productive outcome. Privacy among being the major concern in warfares, could be used as a means of spying which is mere exploitation and negative use of quadcopter technology.

The core intention of our project is to familiarizeourselves with the complete design process from engineering requirement to finished product. We aim at making a robust design of a quadcopter which can be used in the market for both military and commercial use.With the aid of our faculty advisor we have the resources and technical knowledge to successfully complete this project. We chose the quadcopter for our UAV design since it has interesting design elements and potential for marketable gains. At this point the project could go in avariety of directions since the platform seems to be as flexible. This flexibility allows changing the functions it performs and also allows integration of any technology that would prove to be useful. This project will clearly demonstrated the goals of proving that small scale UAVs are useful across a broad range of applications.

REFERENCES

[1] http://copter.ardupilot.com/wiki/advanced-multicopter-design/

[2] http://blog.oscarliang.net/build-a-quadcopter-beginners-tutorial-1/

[3] http://andrew.gibiansky.com/downloads/pdf/Quadcopter%20Dynamics,%20Simulation,%20and%20Control.pdf

[4] http://sal.aalto.fi/publications/pdf-files/eluu11_public.pdf

[5] http://www.es.ele.tue.nl/education/5HC99/wiki/images/a/af/Quadcopters.pdf

[6] http://www.hobbyking.com/hobbyking/store/uploads/780101971X7478X58.pdf

[7] https://canberrauav.readthedocs.io/en/latest/_downloads/MHV-Quadcopter-Workshop-v3.pdf

[8] http://projects-web.engr.colostate.edu/ece-sr-design/AY11/quadcopter/documents/ECE401final%20paper.pdf

[9] https://www.parallax.com/sites/default/files/downloads/80000-ELEV-8-Quadcopter-Info-Assembly-Guide-v1.1_0.pdf

[10] http://web.uvic.ca/~barryjin/Quadcopter.pdf

[11] http://www.ijstr.org/final-print/aug2014/Quadcopter-Flight-Dynamics.pdf

[12] http://www.swann.com/us/downloads/dl/file/id/1494/MATOMQC090514E.pdf

[13] https://en.wikipedia.org/wiki/Quadcopter