MAJOR PROJECT-1

on

Prototype Development of Radio Control Plane

submitted in partial fulfilment for the award of the Degree of

Bachelor of Technology

In

Mechanical Engineering

By

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CERTIFICATE

This is to certify that the Major Project-1 report on "**RC PLANE**" submitted by **K.JAHNAVI (R170037), M.VENKAT SAI (R170123), C.SREE SEVYA (R170245), R.VENKATA KUMAR (R170976), K.SEKHAR NAIDU (R171191),** bonafide record of the work carried out by them is accepted as the Major Project-1 Report submitted in partial fulfilment for the award of the Degree of Bachelor of Technology in Mechanical engineering during 2022-23 at IIIT RK VALLEY, RGUKT-AP.

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DECLARATION

This is to declare that this dissertion entitled **Prototype Development of Radio Control Plane** submitted in partial fulfilment for the award of degree in Mechanical Engineering of the B.tech degree of the RGUKT RK Valley University which is the result of the bonafide. Research work carried out by K JAHNAVI, M VENKATA SAI, C SREE SEVYA, R VENKATA KUMAR, K SEKHAR NAIDU. We found the work is in testing phase, comprehensive and of sufficient high standard to warrant its presentation for the examination. I further declare that the work has been carried out under the proper guidance and has not been submitted earlier to any other university for the Degree of Mechanical Engineering.

ACKNOWLEDGEMENT

We wish to express our heartfelt gratitude to all the people who have played a crucial role in the research for this project, without their active cooperation in the preparation of this project could not have been completed within the specified time limit.

We are thankful to our respected Head of the Department, Mr. G. Naveen Kumar for motivating us to complete this project with complete focus and attention.

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We are also thankful for the lab assistants for providing the necessary tools and making our work to be done with ease and safe.

ABSTRACT

The successful design and operation of the RC aircraft was attempted**.** Various materials and mechanisms are used in the plane. One of them has been tested and another type is under testing phase. The whole equipment and tools which are used are acquired from the university. The plane body parts are assembled in proper manner and necessary electronics are installed to provide motion to the plane. The plane which has been made has a good mobility on the ground and tests on air are still yet to be done for a successful flight.

The first chapter begins with introduction on the planes , aerodynamics and types of air planes that are in real world. In the second chapter literature Survey is given to provide the Evolution, history and Mechanics of a RC-plane. The third chapter consists of the Making of the RC-plane along with the Electronics that are involved. The fourth chapter concludes this report and gives out the current status and scopes of this project.

Table of Contents

Chapter 1

1.1 Introduction

An *airplane* or *aeroplane*(informally *Plane*) is a fixed-wing aircraft that is propelled forward by thrust. Airplanes come in a variety of sizes, shapes and wing-configurations.[1] Airplanes are used by commercial, science and military purposes like transportation and defence. Airplanes can be manually, remotely or computer-controlled. Since the first flight humanity ever made to now, the technology of the aviation as improved and made the aircraft as optimised as possible. There is a scope for research and development in aviation to make aircraft advance. The aerodynamic technology used in the planes also helped to make rockets to explore the space.

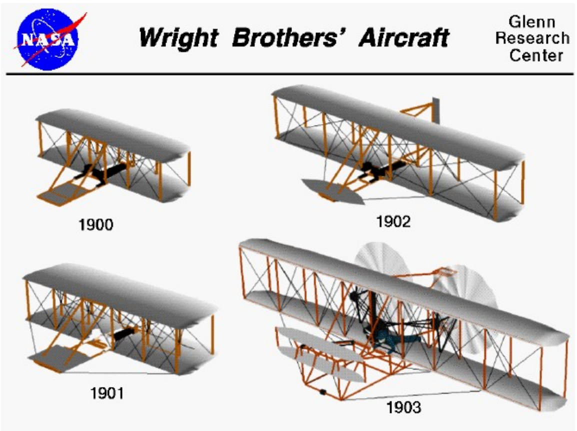

Fig1.1: four types of aircraft's of Wright Brothers' [2]

Fig1.2: Boeing 707 flying in the sky[3]

The *Wright brothers* invented and flew the first airplane in 1903. the first practical jet aircraft was the German *Heinkel He 178*, which was tested in 1939. the *messerschmitt me 262* is the first operational jet fighter. The first *jet airliner,* the *de Havilland Comet,* was introduced in 1952. The *Boeing 707*, the first widely used commercial jet.[4]

1.2 Aerodynamics of a Plane

Aerodynamics is the study of forces and the resulting motion of objects through the air. Studying the motion of air around an object allows us to measure the forces of lift, which allows an aircraft to overcome gravity and drag, which is the resistance an aircraft feels as it moves through the air. Everything that moves through the air is affected by the aerodynamics.[5] As an airplane moves through the air, its wings cause changes in the speed and pressure of the air moving past them. These changes result in the upward force called lift.[6]

A wing is tilted and shaped so the air moving over it moves faster than the air moving under it. As air speeds up, its pressure goes down.[7] The pressure variation across the wing causes a resultant upward force. The Vertical and Horizontal components of this resultant are Lift and Drag respectively. The four forces of flight are lift, weight, thrust and drag. These forces make an object move up and down, and faster or slower. There are many methods to calculate the aerodynamics of a plane, each have their own pros and cons. It is said that to calculate as much as possible remaining are measured.

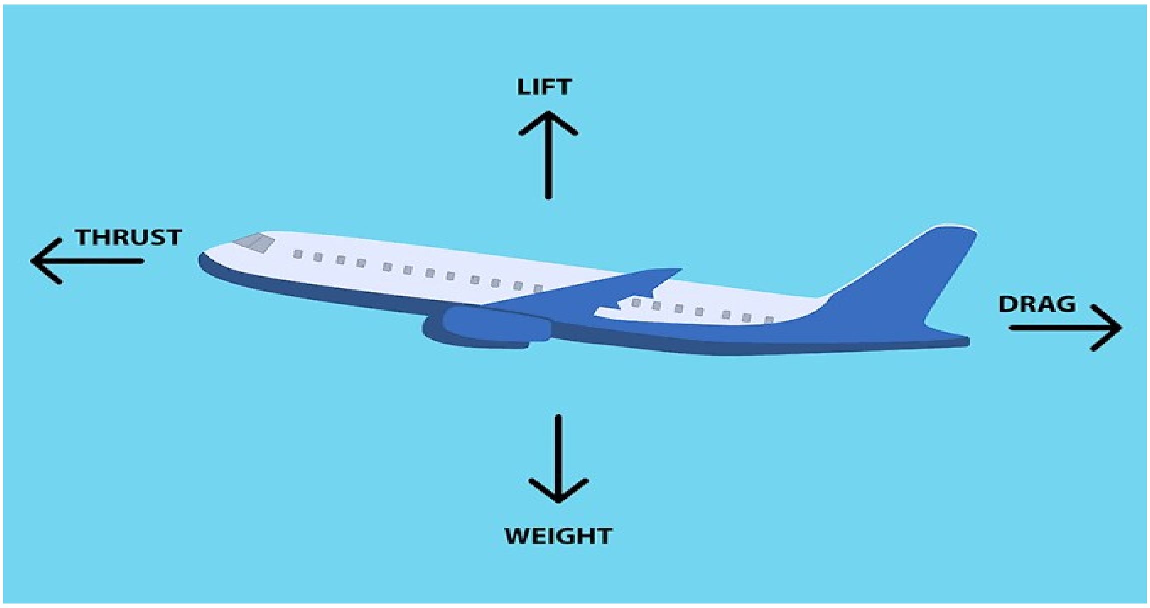

Fig 1.3: Four basic forces of a plane[8]

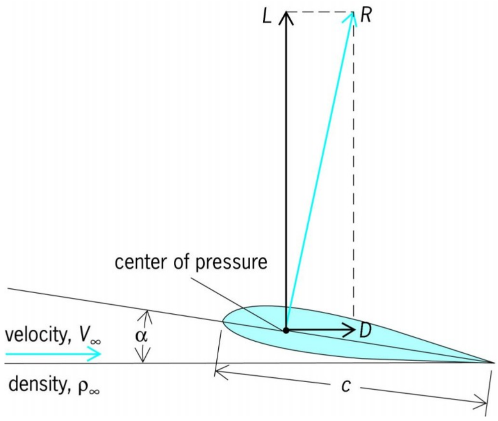

Fig 1.4: Airfoil shape of a plane[9]

1.2.1 Drag Equation

The Drag equation of a plane[10]

$$\mathbf{D = Cd\ \frac{\rho V^2}{2}\ A} \quad \text{...} \ 1$$

where,
D = Drag
Cd = Coefficient
ρ = Density
V =Velocity
A = Reference area

Coefficient Cd contains all the complex dependencies and usually determined experimentally.

Choice of reference A affects the value of Cd.

1.3 Types of RC Planes

Radio controlled planes, shortly rc- planes are a kind of planes. These planes are remotely controlled by radio applications. The range of the plane is limited. Radio Controlled plane has applications in unmanned defensive air crafts, drone, Toy planes, etc. Based on power by motor or engine to weight of the aircraft ratio, there 5 types of model aircrafts.

5 Types of Model Aircrafts and their Power to weight ratio[11]

a) **Slow airplanes and gliders**

110W/Kg or 50W/Lb

Fig 1.4: Glaser-Dirks DG-808[12]

b) **Slow airplanes and vintage**

110W/Kg - 176W/Kg or 50W/Lb – 80W/Lb

Fig 1.5: Flying Vintage Airplanes[13]

c) **General and sport**

176W/Kg - 264W/Kg or 80w/Lb – 120w/Lb

Fig 1.6: Red Bull Sport Airplane[14]

d) **Aerobatic**

264W/Kg - 396W/Kg or 120W/Lg – 180W/Lb

Fig 1.7:Stampe-Vertongen SV-4[15]

e) Jets and Powerful airplanes

296W/Kg - 440W/Kg or 180W/Lb – 200W/Lb

Fig 1.6:Concorde Jet[16]

Chapter 2

Literature

2.1 History of Rc Plane

The earliest examples of electronically guided model aircraft were hydrogen-filled model airships of the late 19th century. They were flown as a music hall act around theatre auditoriums using a basic form of spark-emitted radio signal. In the 1920s, the Royal Aircraft Establishment of Britain built and tested the pilotless Larynx a monoplane with a 100-mile (160 km) range. The British drone weapons in 1917 and 1918 evolved and their development continued through the work of the Royal Aircraft Establishment resulting in the fleet of over 400 Queen Bee UAV Target Aircraft in the 1930s. Queen Bee is a gunnery target version of the de Havilland Tiger Moth and similar target aircraft. The first truly successful Radio Control Airplane was the Big Guff, built in 1938 by the Good brothers, Walt and Bill.[17]

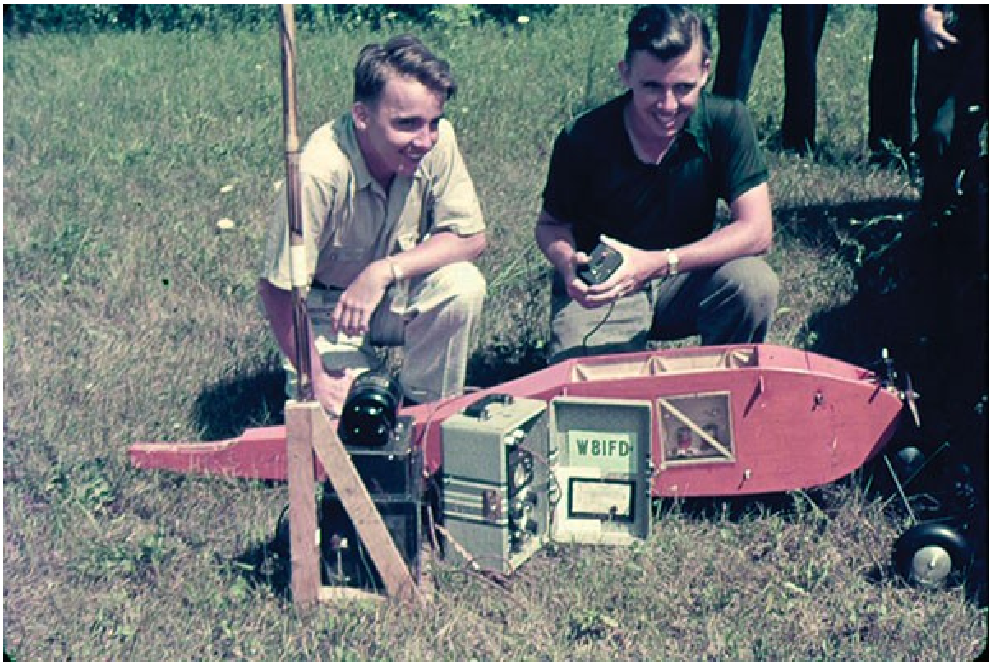

Fig 2.1:First Rc Plane[18]

Radio control systems for model aircraft were developed in the late 1940s and early 1950s by English enthusiasts such as Howard Boys, who patented his 'Galloping Ghost' system of proportional control and became a regular contributor to Aeromodeller on the topic.

In World War II, the U.S. Army and Navy used radio controlled planes called Radio planes as artillery target drones. The earliest model radio-controlled aircraft were constructed of wood covered with paper. Later, plastic film such as Monokote came to be widely used as a covering material. Wood has relatively low cost, high specific Young's modulus (stiffness per unit weight), good workability and strength, and can be assembled with adhesives of various types.

Light-weight strong varieties such as balsa wood are preferred; basswood, pine and spruce are also used. Now Rc Planes are used for various purposes like experimentation, gathering weather readings, aerodynamic modelling and testing. They are much cheaper than drones and can be used in many tough conditions and can be easily disposed.

2.2 Evolution of Rc Plane

Timeline of Radio Control Planes [19]

- 1937: Twins Walt and Bill Good, only age 21, made their first flights at the Kalamazoo MI, airport after adding RC to their 8-foot gas FF model named KG-8.
- 1937: Australian Ross Hull went to Elmira NY, and flew a 13-foot glider with RC.
- 1938: Walt and Bill Good built the first airplane designed for radio control, the Big Guff, and placed first at the AMA Nats.
- 1938: Leo Weiss describes an eight-channel, audio-tone reed system for model airplane radio control he had under development.
- 1938: A new type of tube was introduced for radio control that enabled the development of an ultrasensitive single-tube receiver: the RK-62 by Raytheon.
- 1939: Howard McEntee published twin-frequency transmitter details with schematics.
- 1941: Early multifunction single channel published by Thracy Petrides and Leon Hillman.
- 1940: During WW II, the U.S. Army and Navy used RC airplanes called Radioplanes as artillery target drones.
- 1946: FCC Order 130-C went into effect on March 1, 1946, and created the 6-meter band allocation for the amateur service as 50–54 MHz.
- 1949: First examination-free frequency allowed—465 MHz and 5-watt maximum power.
- 1949: Ed Rockwood's multichannel system was the first commercial venture for an audio-frequency-modulated reed radio.
- 1952: 27.255 MHz available with no test and a 5-watt maximum.
- 1953: Frank Schmidt made and sold a complete, five-channel reed set based on the Rockwood design.
- 1954: Don Brown developed a Galloping Ghost system that might have been the first single-channel multicontrol system called the "crank system."
- 1955: Bramco Inc., in Detroit, entered the RC business with its Blue Chip reed system.
- 1956: Jack Albrecht built what is thought to be the first handheld transmitter.

- 1956: Bob Dunham started Orbit Electronics and produced a popular reed system.
- 1957: Walter Good published his TTPW transmitter for a dual-proportional system.
- 1957: Zel Ritchie built a handheld, solid-state version of Walt Good's TTPW transmitter.
- 1958: FCC granted five additional frequencies at 50 kHz spacing on the 27 MHz band.
- 1959: Ken Willard flew indoor model using an .020 engine weighing only 33/4 oz.
- 1959: Al Doig introduced his Ulti Multi closed-loop, feedback, non-wiggling, multiproportional system.
- 1959: Relayless reed system was flown by Louie Scheel and Ken Oliver.
- 1960: Bramco, Inc. introduced its Control Box Transmitter, which was advertised as the control box for controlling a model with the reflexes and coordination of a real pilot.
- 1960: First commercially available proportional system, Space Control, introduced by Zel Richie. Space Control was engineered by Hershel Toomim and produced by his company, Solidtronic, in Van Nuys CA.
- 1960: Don Baisden submitted a proposed article to Grid Leaks magazine on his single-channel Galloping Ghost pulser and another for his rudder-only pulser, later kitted by Ace R/C.
- 1960: Howard McEntee came up with a simplified version of pulse proportional that used a single tone, and added the feature of being able to vary the pulse rate of the tone as well to get a second function with only one tone.
- 1961: Howard Bonner's relayless servo, the Transmite, became commercially available.
- 1961: First jet model flown with Dyna Pulse Jet and a reed radio system had Jerry Nelson as pilot.
- 1961: The hand-built Quadraplex transmitter and receiver were by Don Brown. Carl Schwab, who designed the electronics, provided advice and assistance by phone.
- 1962: ACL introduced its pioneering feedback proportional system in April 1962, including its incorporation of receiver and servos into an airborne "brick."
- 1962: The first commercial digital RC system flown by Doug Spreng. The radio was named Digicon.
- 1962: First commercially produced four-stick proportional radio, the Astroguide, by Klinetronics.
- 1963: Howard Bonner introduced this eight-channel Digimite system.
- 1964: Howard Bonner introduced the Transmite servo for relayless reed receivers.
- 1965: FCC granted five frequencies on the 72 MHz band with 40 kHz spacing.
- 1966: PCS's revolutionary low price of $299.95 shook the RC world to its foundations and led to the demise of several competing manufacturers.

- 1968: Phil Kraft introduced his “Gold Medal Series” system after winning the gold medal at the Corsica, Italy, World Championship.
- 1968: The first Controlaire three-channel proportional prototypes were built to explore the concept of a more-affordable, three-channel alternative to Controlaire’s full-house proportional system.
- 1968: Bob Elliot designed a servo amplifier that reduced the servo wires from six to three wires.
- 1969: FM and PCM receivers were introduced.
- 1975: Orbit debuted the Elite “super radio” at the March 1975 WRAM Show. It had an LCD display panel.
- 1975: Transmitter features were increased to servo reversing, adjustable travel, and dual rates.
- 1976: Mattel, the toy company, entered the RC hobby with its inexpensive single-channel pulse-proportional system that sold for $29.95.
- 1976: Kraft Systems introduced the first synthesized RC system.
- 1982: The first computer transmitter was introduced by JR Radio.
- 1987: The FCC granted additional channels on the 72 MHz band.
- 1988: The FCC granted additional channels on the 72 MHz band with 20 kHz spacing referred to as narrow band.
- 2004: Paul Beard developed DSM using 2.4 GHz.
- 2011: Futaba introduced FASST.
- 2012: Futaba introduced S.Bus protocol using one cable to control multiple servos.

2.3 Mechanics of Rc Plane

The mechanism of Rc plane that make the plane fly in the sky[20]

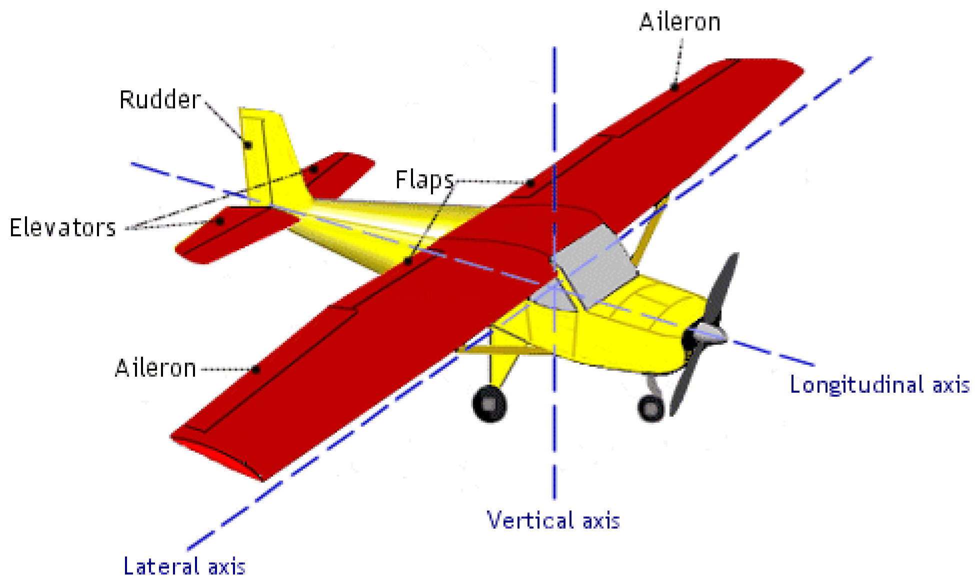

Fig 2.2: Surfaces and Axes of Rc Plane

There are 4 main surfaces that are **ailerons, elevators, rudder** and **flaps.** A basic plane body consist of 3 axis they are longitudinal, lateral and vertical axes. All 3 axis pass through the Centre of Gravity(CG), the airplane's crucial point of balance.

S.No	**Action**	**Axis**	**Controlled by**
1	Roll	Longitudinal	Ailerons
2	Pitch	Lateral	Elevator
3	Yaw	Vertical	Rudder

Table 2.1:Actions when controlled by surfaces through their axis

It's important to understand that all control surfaces work in the same way, in that they alter the camber (airfoil shape) of the complete flying surface. This, in turn, changes the forces acting on the surfaces and so that surface reacts in accordance with the change in force. The force in question is best known to us as *lift*, but this particular force occurs in any direction - not just upwards.

2.3.1 Ailerons

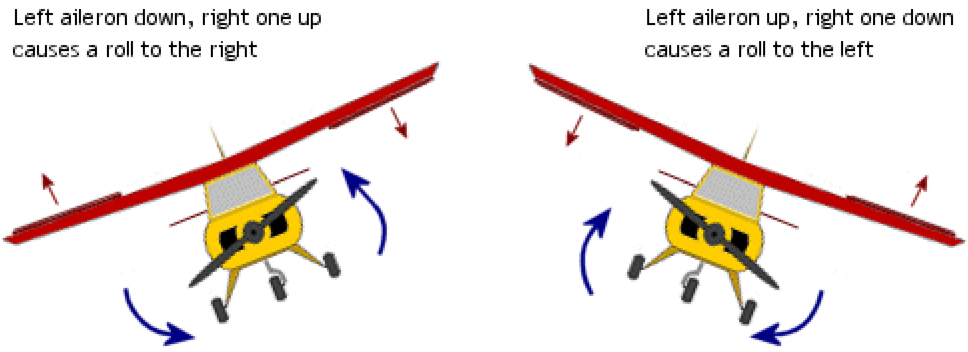

Fig 2.3:Rolling of plane

The ailerons control the airplane’s roll about its longitudinal axis. Each aileron moves at the same time but in the opposite directions i.e. when the left aileron moves up, the right aileron moves down and vice versa.

This movement causes a slight decrease in lift on the wingtip with the upward moving aileron, while the opposite wingtip experiences a slight increase in lift. Because of these subtle changes in lift the airplane is forced to roll in the appropriate direction *i.e.* when the pilot moves the stick left, the left aileron will rise and the airplane will roll left in response to the change in lift on each wing. The ailerons are controlled by a left/right movement of the control stick, or 'yoke'.

2.3.2 Elevator

The elevators are located on the rear half of the tailplane, or horizontal stabiliser. The job of the tailplane is to generate a downward force to counteract the natural nose-diving tendency of planes, which happens as a result of the natural forces that are generated about a plane’s Center of gravity and Centre of Lift.

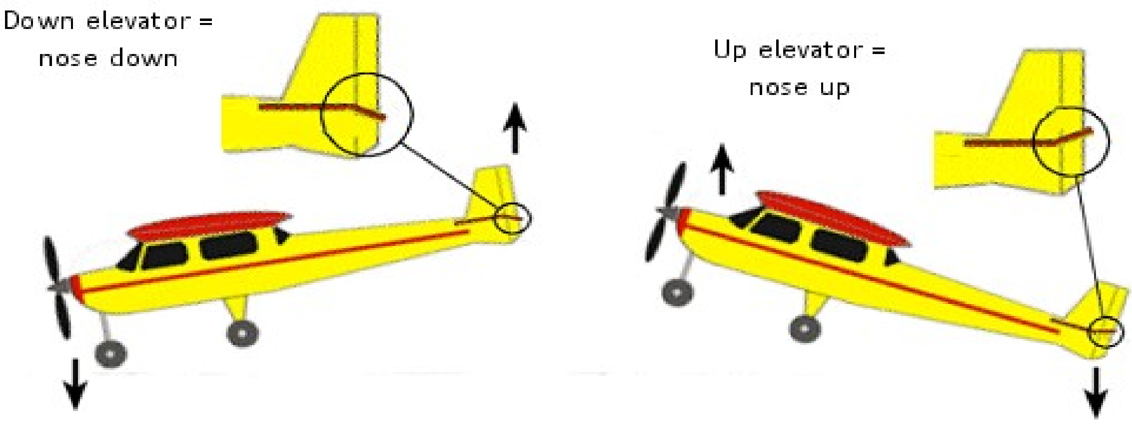

Fig 2.4:Elevator Mechanism of a plane

As the elevators are deflected up or down, so the amount of down force changes and this results in the airplane's nose pitching up or down. Up elevator means more down force, so the plane pitches up, and vice versa.

However, pitching the nose up doesn't necessarily mean the plane will climb. In fact it's quite possible to be flying level, or even descending, with a nose-up attitude. Only when power is added and speed increased, will the plane climb with up elevator.

Elevators are the single most important control surface of a plane, and they effect the airplane's airspeed more than the need to climb or dive.

2.3.4 Rudder

The rudder makes up the rear portion of the vertical stabiliser, or fin, and is controlled by 2 pedals at the pilot's feet. When the pilot pushes the left pedal the rudder moves to the left, while depressing the right pedal deflects the rudder to the right. The rudder works in the same way as ailerons and elevators, in that it changes the airflow over the fin. Essentially, you can think of a fin as a vertical wing. The air flowing over the fin and rudder acts in exactly the same way as it does flowing over a wing and aileron - except the forces are horizontal and not vertical.

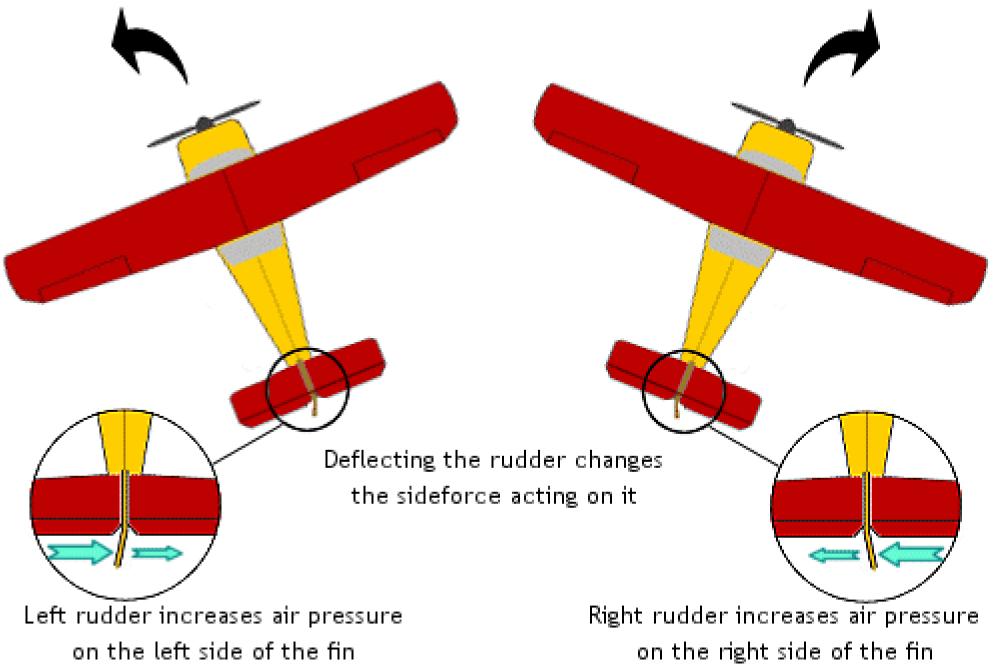

Fig 2.5: Yaw of a plane at the tail of plane

Deflecting the rudder to the left increases the air pressure on the left side of the fin and rudder, and so the whole back end of the plane is pushed across to the right, thus yawing the nose to the left.

2.3.5 Flaps

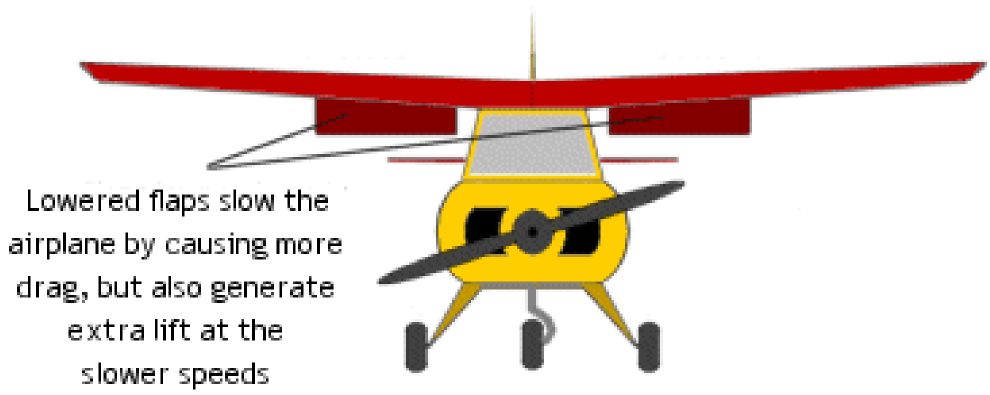

Fig 2.6:Flaps Mechanism of a plane

Flaps are located on the trailing edge of each wing, usually between the fuselage and the ailerons. They extend downward (and often outward) from the wing when put into use.

The purpose of the flaps is to generate more lift at lower airspeeds, which enables the airplane to fly at a greatly reduced speed with a lower risk of stalling. When extended further flaps also generate more drag which slows the airplane down much faster than just reducing throttle. There many kind of configurations in the arrangement and design of flaps.

2.4 The Airfoil

The cross-section of the wing is in the shape of airfoil. This is considered as the sophisticated shape for the wings to get an optimised performance.[21]

- Leading Edge
- Trailing Edge
- Camber
- Chord
- Angle of Attack
- Angle of Incidence
- Centre of Pressure

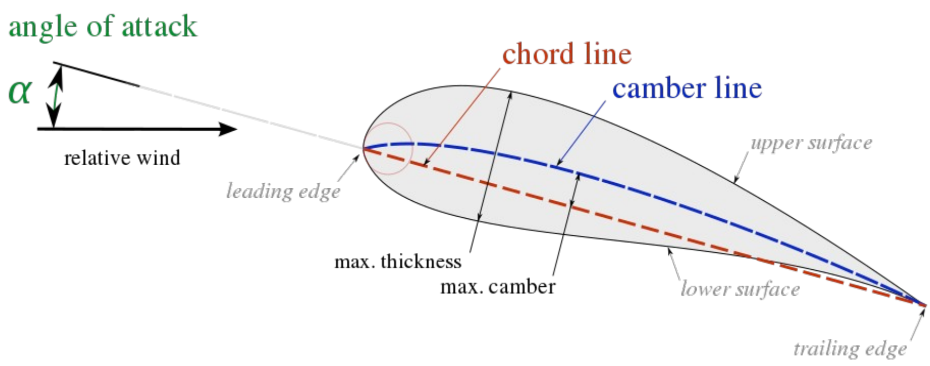

Fig 2.7: The Airfoil Shape[22]

➔ Centre of Pressure[23]

- Point on wing chord where the lift force is centred.
  - may change when angle of attack increases or decreases
- Location of the centre of pressure affects aerodynamics balance and controllability.

➔ Three axes of Flight and Stability[24]

1. Longitudinal axis (Nose to tail)
2. Lateral axis (wingtip to wingtip)
3. Vertical axis (top to bottom)

➔ Longitudinal Stability

- Stability about the lateral axis (pitch axis)
- Depends on location of Centre of Gravity
  - when CG is ahead of NP (neutral point) the weight tends to correct the upset. This is known as Stable condition
  - when CG is behind NP, the weight will worsens the upset. This is known as unstable condition.

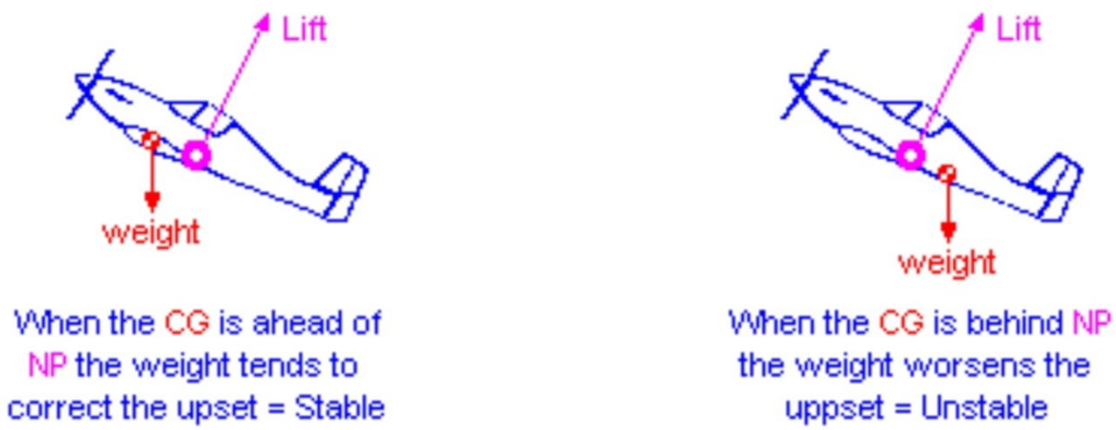

Fig 2.8:Relation between centre of gravity and the neutral point[25]

2.5 Drag

- Parasitic Drag[26]
  - It is produced by aircraft as it moves through the air
  - It increases with square of the airspeed with respect to the wing.
- Induced Drag
  - Drag created by lift
  - Increase at high angle of attack/ lower Airspeed
  - Highest at slow speed while in landing configurations

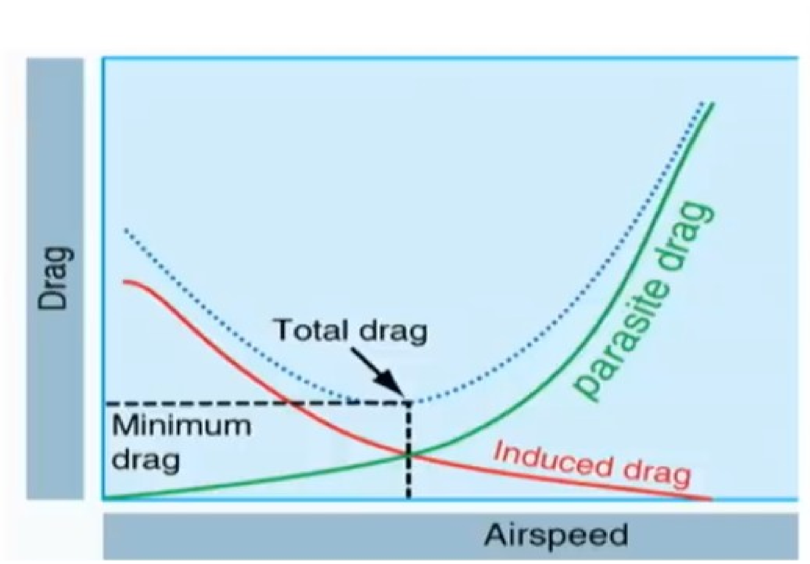

Fig 2.9: Drag vs Airspeed[27]

2.6 Left turning tendencies of a plane

There are some constructional and functional aspects of a plane that causes plane to turn to leftward. These left turning tendencies should be countered using the airplane controls system.[28]

Some of the left tendencies are

- Torque
- p- factor
- Spiraling/Slip stream/ Corkscrew Effect
- Gyroscopic Precession (this is not always left turning tendency)

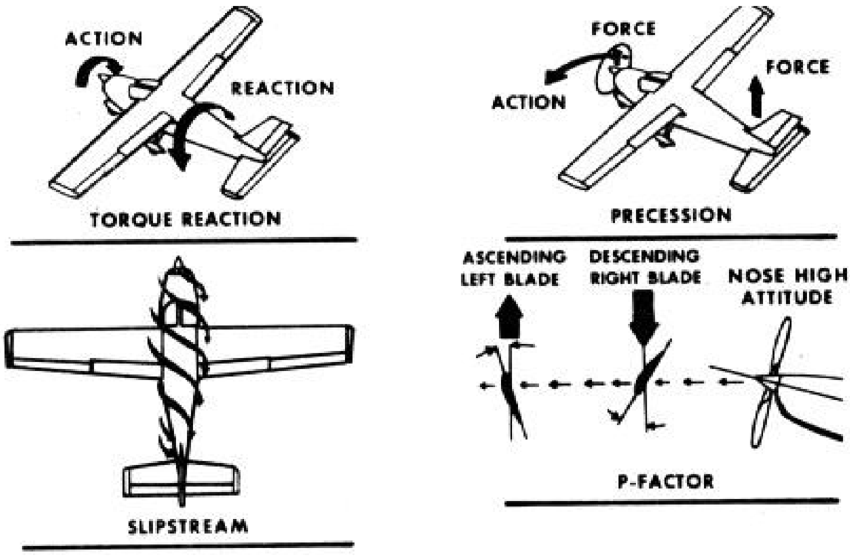

Fig 2.10: Left turning tendency of a plane[29]

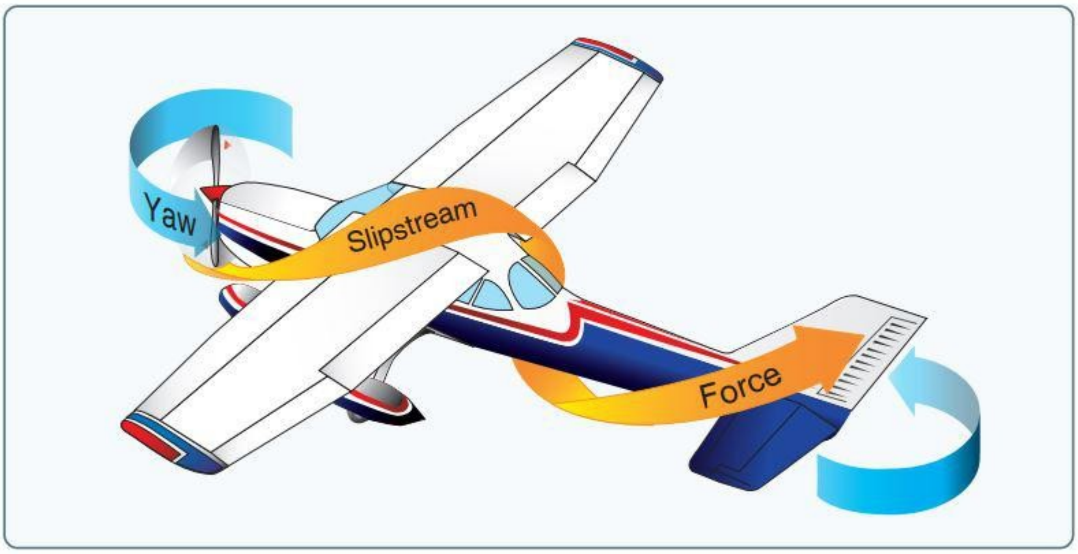

Fig 2.11: Crockskew Effect[30]

2.7 Thrust to Weight Ratio

Power exerted by the motor/engine in terms of load is Called as Thrust

- **F/W =a/g** ....2[31]

  - High excess thrust results in a high rate of climb
  - if F/W >1 and drag is small, the aircraft can accelerate straight up like a rocket.
- Wing loading is a measurement that relates the mass of an aircraft or bird to the total wing area.
- In Gliders, the wing loading is less than in aerobatic aircraft because of high wing area in gliders.[32]

2.8 Angle of attack

- The angle between the air velocity to the chord of wing is known as Angle of attack.
- The Critical Angle of Attack does not change for a given wing.
- When the Angle of Attack exceeds more than critical point. The plane will Stall.
- Uncordinated stalls will results in Spinning of the plane. The aircraft will follow a rotating helical downward path. It is Hazardous near the ground. Stalls can be avoided by inducing Right rudder in most of the cases.

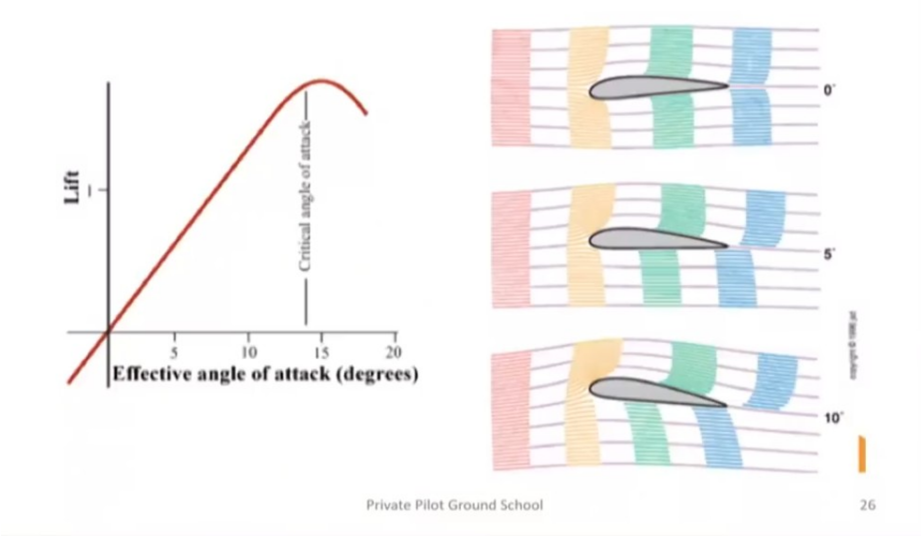

Fig 2.12: Lift vs Angle of attack[33]

2.9 Thumb Rules for Rc Plane design

The nominal size of a conventional Rc airplane should follow this rule for good stable flight (Flying wings and other designs do not follow this rule.

All the size ratio start with the wingspan. Determine the wingspan and start calculating the other sizes as follows[56]

- The fuselage length should be 70% - 75% of the wingspan.
- The ratio of the wing span to wing root chord should be 5 or 6.

  Example 2.1: If the wing is 36" long then the wing root chord should be 6"
- The wing thickness should be 12% - 14% of the wing root chord.

  Example 2.2:If the wing root chord is 6" the the widest part of the wing should be 3/4" thick.

  Note :Foam profile planes do not follow this rule of thumb but still fly.
- The aileron surface are should be 10% - 12% of half of the wing surfaces.

Example 2.3: If half wing is 6" x 8" then the ing surface is 108 sq inches. The aileron shape should equal 11 - 13 square inches of surface area.

- The distance from the leading edge of the wing to the back of the prop should be 15% of the wingspan.

  Example 2.4: If the wingspan is 36" then the distance from the back of the prop to the leading edge of the wing should be 5.4".

- The leading edge of the wing to the stabilizer should be 3 times the wing root chord.

  Example 2.5: If the wing chord is 6" then leading edge of the wing to the stabilizer should be 18".

- The horizontal stabilizer should be 25% of the wing area.

  Example 2.6:If the wing is a rectangle, 36"L x 6"W, it has a wing area of 216 sq inches. 25% of 216 = 54sq inches. The shape of your horizontal stabilizer should equal 54 sq inches.

- The elevator (attached to the horizontal stabilizer) should be 25% of the horizontal stabilizer surface area.

  Example 2.7: If the Horizontal Stabilizer is 54 sq inches then the elevator surface area should equal 13.5 sq inches.

- The vertical stabilizer should be 110% of the wing area.

  Example 2.8: If the wing is a rectangular 36" x 6" shape it has a surface area of 216 sq inches. 10% of 216= 21.6 sq inches. The shape of your horizontal stabilizer should equal 21.6 sq inches of surface.

- The rudder (attached to the vertical stabilizer) should be 25% of the vertical stabilizer surface area.

  Example 2.9: If the vertical stabilizer is 21.6 sq inches then the rudder surface area should equal 5.4 sq inches.

- The plane should balance at 25% -33% of the wing root chord.

  Example 2.10: If the wing root chord is 6" from the leading edge to the trailing edge of the wing then the Center of Gravity (COG) should be located 1.5" - 2" from the leading edge of the wing.

Chapter 3

Electronics

3.1 Circuit Diagram

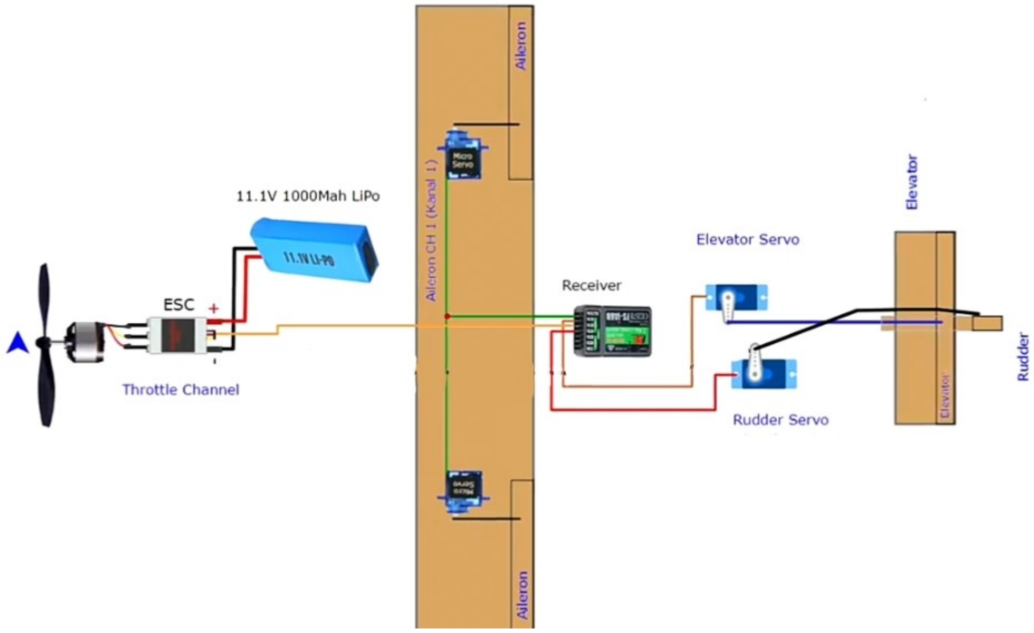

Fig 3.1: Circuit diagram of Rc Plane[34]

The circuit diagram of the Rc Plane looks like the above figure.
It consists of -

1. Motor
2. Electronic Speed Controller(ESC)
3. LiPo battery
4. Servos
5. Channel Receiver and
6. Transmitter

3.1.1 Motor[35]

Motors are used to convert electric signals into mechanical energy. There are 2 types of motors-

1. DC Motor.
2. AC Motor

AC Motors are dived into 2 types-

1. Induction Motor(IM)
2. Synchronous Motor(PM)

DC Motors are dived into 3 types-

1. Brushed DC Motor
2. Brushless DC Motor(BLDC)
3. Stepper Motor(STP)

We use Brushless DC Motor in the RC-Plane. Brushless DC Motor do not have brushes and there is very little friction and are more efficient. In-runner Brushless DC Motor is fast and out-runner motor have more torque.

Fig 3.2: Brushless Dc motor[36]

Parts of BLDC Motor:

- The rotating part is called the **Rotor** and stationary part is called the **Stator** in most cases outer is called the rotor and the inner part is called the stator.
- Rotor and Stator have holes in ti that work as the vent to release heat.
- BLDC Motor have 3 wires to represent 3 phases.
- There are 3 sets of coils in the motor and each set of coil is connected to a different phase.
- The magnets are attached to the rotor with alternating poles.

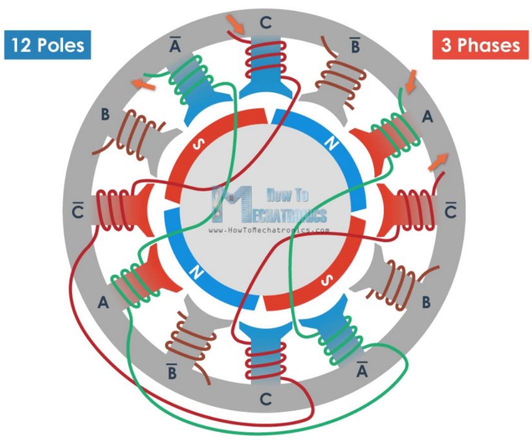

Fig 3.3:Internal view of brushless Dc motor[37]

How BLDC Motor works:

- Bldc motor has 3 wires which are connected to Electronic Speed Controller(ESC) with sends a pulse width modulation signal(PWM signal) which is used to controll the speed of the motor.
- The esc is connected to a battery.
- When the electricity is passed through the coils it will generate Electromagnetic Field which will rotate the motor.
- **RPM= KV x Voltage applied**

3.1.2 Electronic speed controller[38]

The electronic speed controller (ESC) is an essential part of an electric propulsion system's hardware. It acts like the brain of the system by telling the motor how fast to go based on data signals it receives from the throttle controller

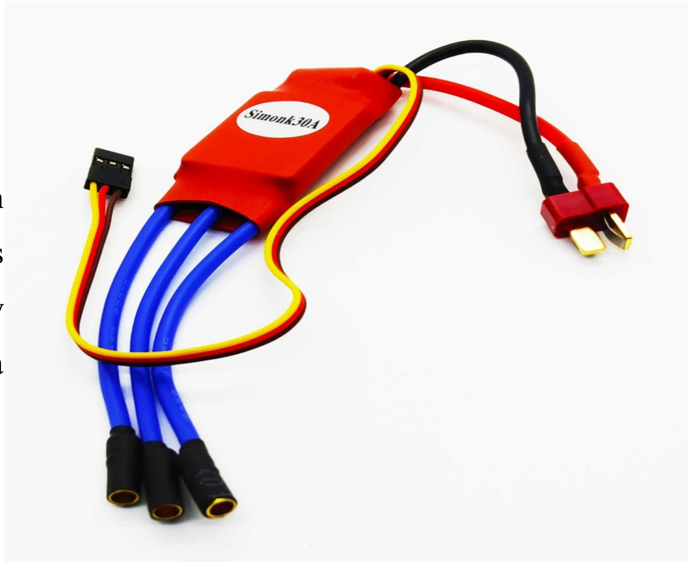

Fig 3.4: Electronic Speed Controller[39]

How does an ESC works:

The role of the ESC is to act as the regulating middleman between the battery and the electric motor. It controls the rotation of the motor by delivering timed electric signals that are translated into changes in speed. It uses the direct current from the battery coupled with a switch system to achieve an alternating three-phase current that is sent to the motor.

3.1.3 LiPo Battery[40]

Fig 3.5: Orange Lithium-polymer battery[41]

LiPo stands for Lithium-polymer battery. LiPo battery has 2 connectors one is used to charge called balance connector and another connector is used to connect to ESC and some other.

'S' on the battery represents the number of cells present in the battery, the cells are connected in the series so that they are called as 1s, 2s, 3s etc. Single cell can provide a voltage of 3.7 volts.

'C-Rating' on the battery represents the Maximum safe continuous discharge rate.

C rating x **number of amps=total number of amps that can be drawn safely from the battery**

'mah' battery represents the capacity if the battery i.e, how much power is there in the battery.

Mah= **how long the battery will last in the air**

3.1.4 Servo Motors[42]

Servo motors convert electrical energy into mechanical energy. There are 2 types of servo motors-

1. Closed loop (180 degree rotation)
2. Open loop (360 degree rotation)

Fig 3.6: Servo Motor[43]

They will rotate on the basis of signals sent to them. The higher the voltage the faster the motor rotates. Generally servo motors are used to apply torque. On the side of the servo motor it is mention that how much torque it can apply.

Components of Servo Motor:

Servo motor mainly consist of a DC motor, gears and a circuit board. One side of the gears is called input and the other side is called the output. Dc motor is connected to the input gears. This gear setup is called as the compound gear train. At the input the motor has high speed and low torque and this compound gear train slows down the speed and increases the torque.

One side of the circuit board is connected to the output shaft and the other side is connected to the potentiometer. Changes in the pulse sent to the servo changes the direction of rotation and if the pulse is stable the servo will be in rest position. The signals will be sent to the servo board which is connected to the motor.

Fig 3.7:Internal parts of servo motor [44]

3.1.5 Receiver and Transmitter[45]

The receiver is what goes into your aircraft and controls the servos and motor(s). You can see from this receiver that it is a 6 channel receiver. The BAT slot is not considered a channel. The receiver shown above was only 10 dollars as opposed to around 20.

The receiver above connects wirelessly to the the transmitter using a 2.4Ghz frequency. 2.4Ghz frequency is the standard frequency for RC planes.

Fig 3.8: Receiver and its binding wire[46]

The receiver runs off of 5v, and sends signals the the servos to turn them. It also sends a signal to the ESC to tell it how fast the run the motor. The receiver gets it's 5 volts from the ESC's.

There are a total of 6 channels in the above receiver that means it can be used to control 6 components and it requires a bind wire to pair with the transmitter so that we can control using the transmitter and the receiver does the rest.

Transmitters allow the pilot(controller) control the plane movement and orientation. The above transmitter consists of 6 channels. Channels are the amount of things you can control. These channels are used to controll the motor, elevator, rudder, ailerons, aux1 and aux2. So basically each channel controls a different motor. Aux1 and aux2 are auxiliaries that are used as an extra switches or knobs on the transmitter.

The above transmitter require 8 AA batteries to function and should be bind with the receiver. This transmitter offers 2.4GHz readability.

Fig 3.9: Transmitter and its parts[47]

3.2 Making of Rc-Plane

- Take a cardboard sheet of thickness 5mm.
- Cut the cardboard sheet 58 cm x 8 cm to make the side of the fuselage, make two sides using the below dimensions.

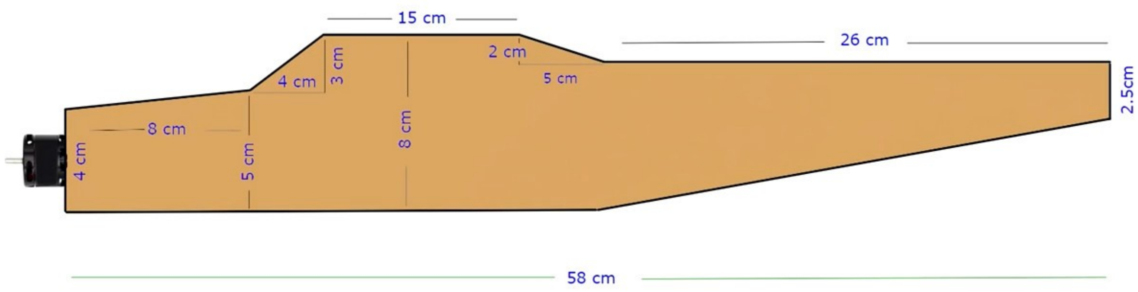

Fig 3.10: Side view of the Fuselage dimensions[48]

- Take the cardboard of 58cm x 5cm for the bottom of the fuselage.

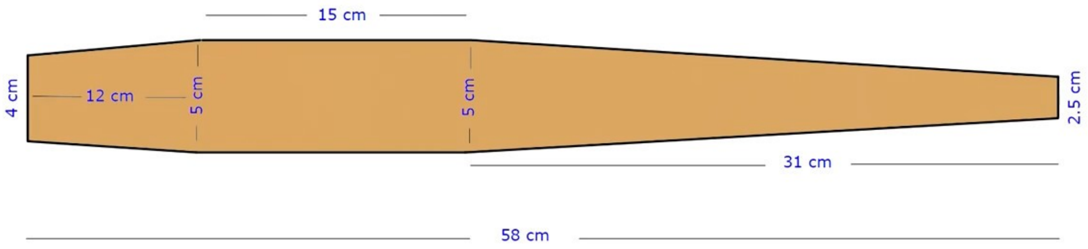

Fig 3.11: Bottom view of fuselage dimensions[49]

- Now attach the fuselage sides and the fuselage bottom together so it will look like the figure below

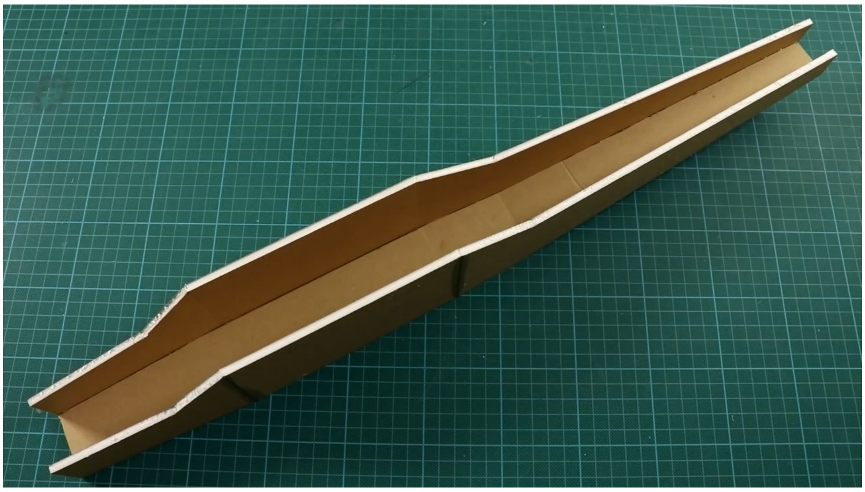

Fig 3.12: Fuselage[50]

- Make the elevator of the plane using the below dimensions.

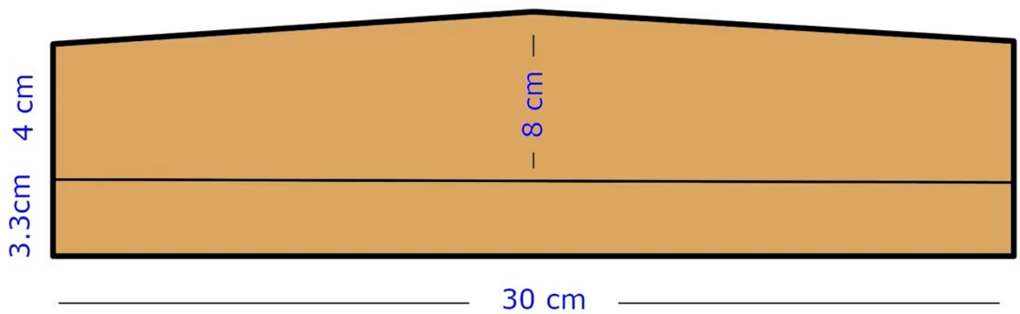

Fig 3.13:Elevator dimensions[51]

- After elevator make the rudder with required measurements.

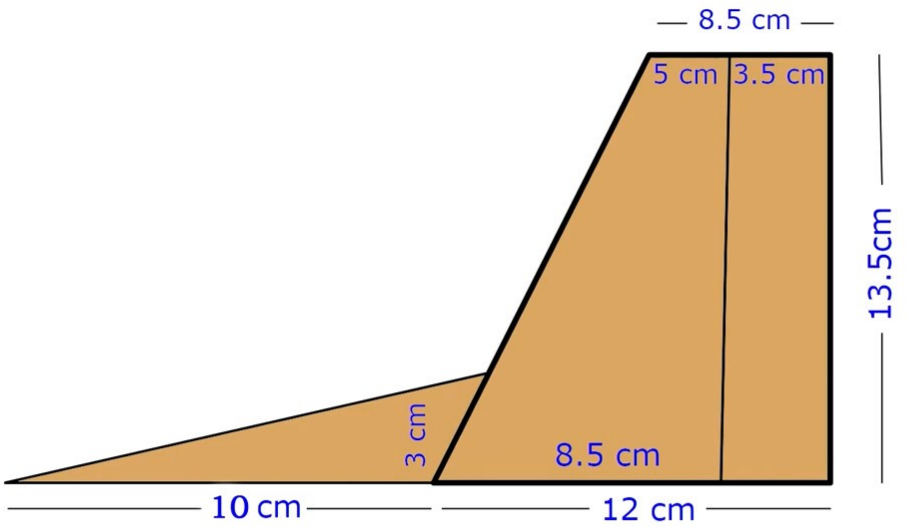

Fig 1.14: Rudder dimensions[52]

- The fuselage of the plane, the elevator and the rudder are completed, now we should make the wings of the plane.

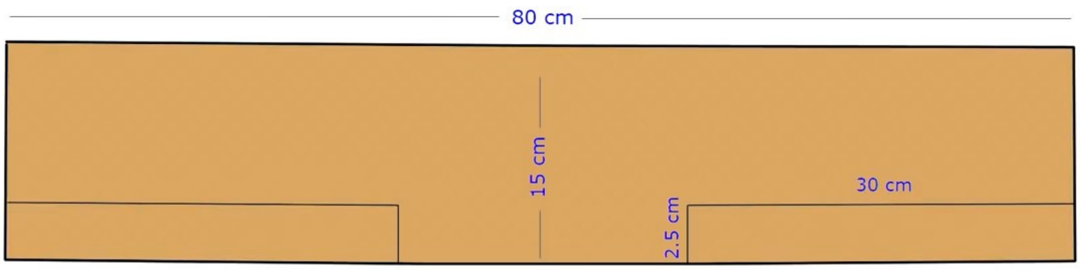

Fig 1.15: Single Wing bottom dimensions[53]

- The total wing will look like the one in the above figure,we will make the wing in two halves.

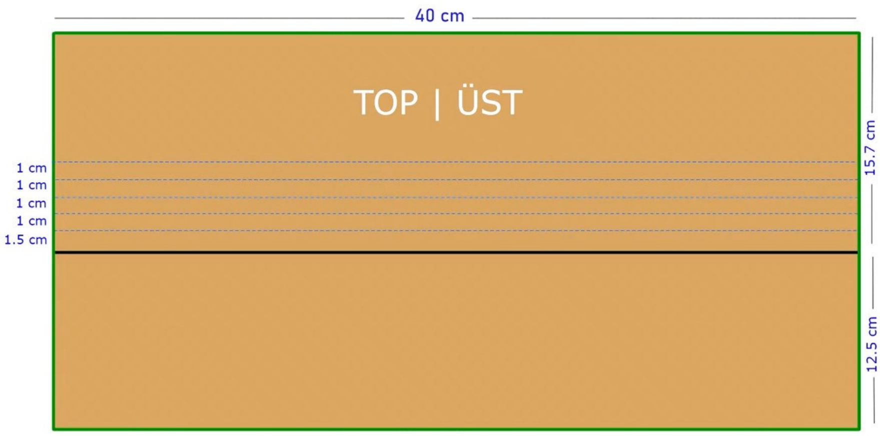

Fig 1.16:Dimensions for the top part of the wing[54]

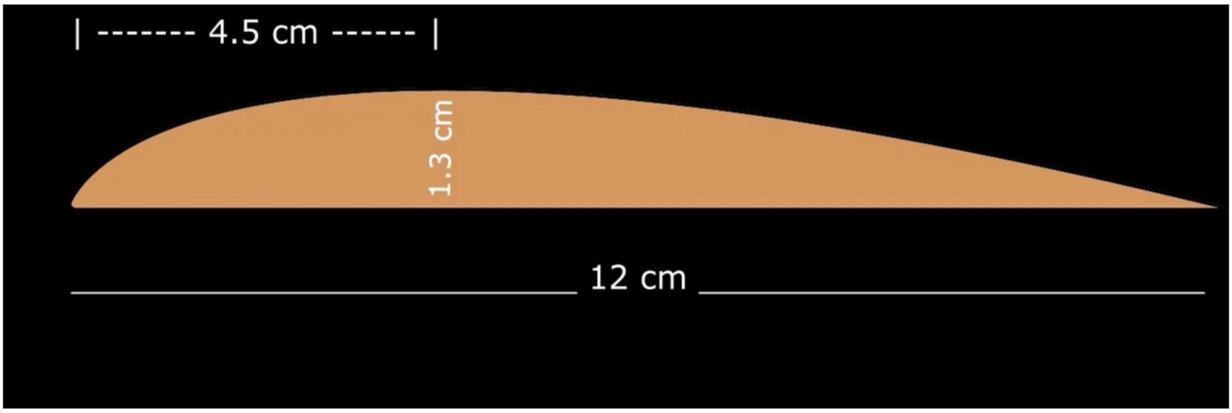

Fig 1.17: Wing rip dimensions[55]

- Wing rip is used to make the curved shape of the wing

- By following the above given dimensions the final model which we made is-

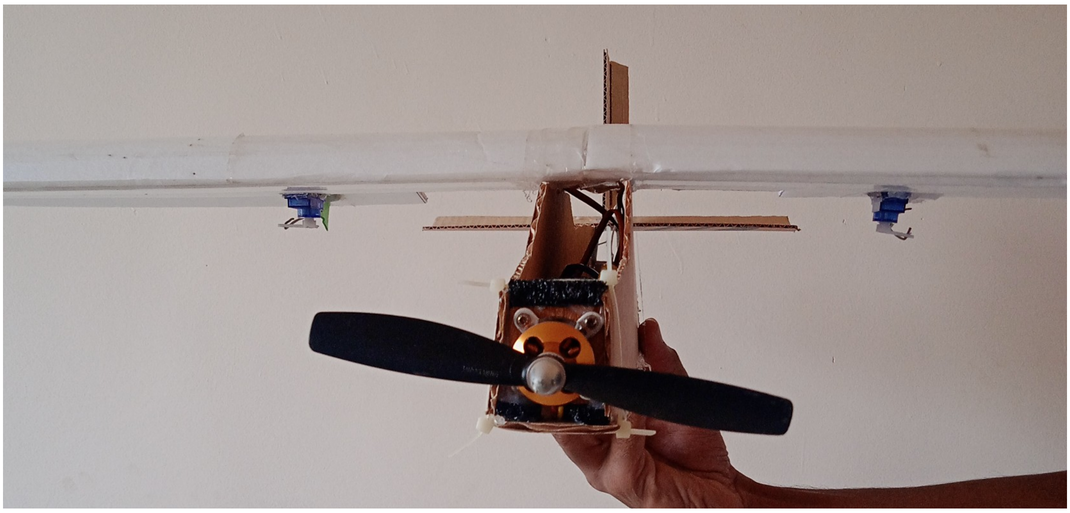

Fig 1.18: Front view of the plane

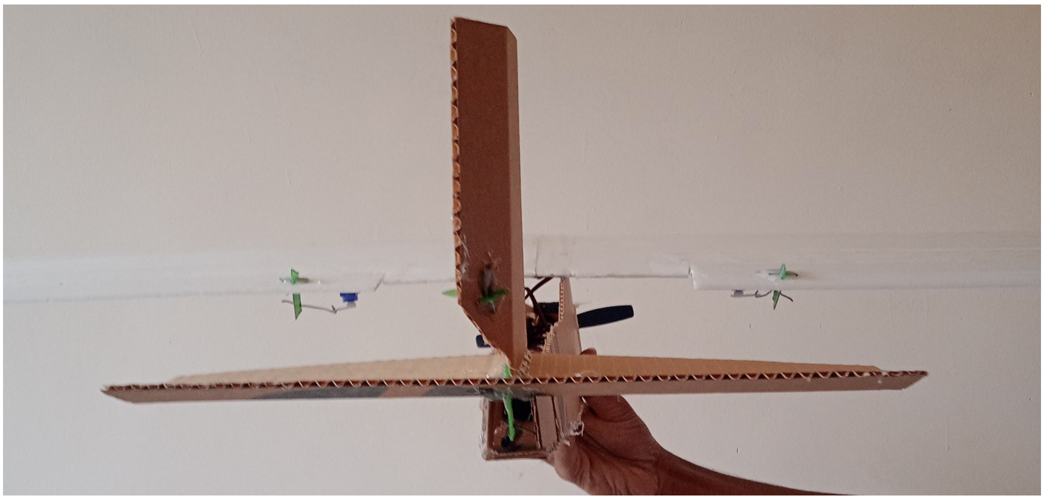
Fig 1.19:Back view of the plane

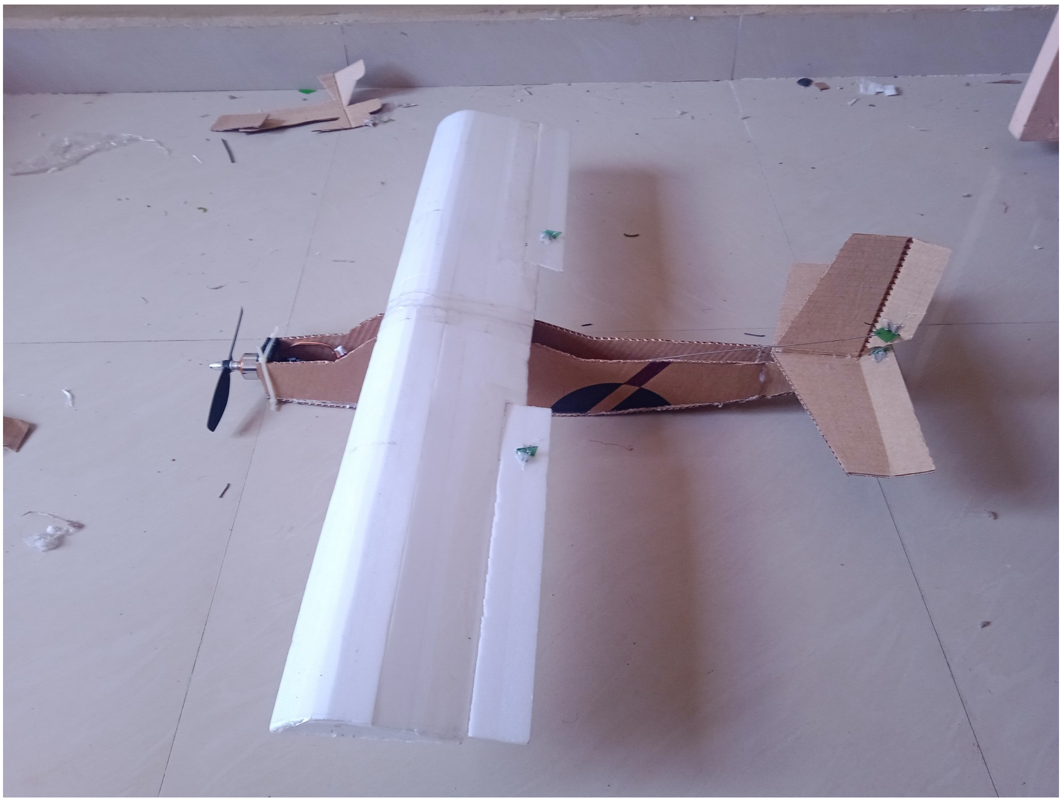
Fig 1.20:Total assembled Prototype of the Plane

Chapter 4

Result and Observation

The first prototype has been successfully made with foam-board. The plane has shown good mobility on land by wheels but significantly failed to take off. Due to the crashes while testing, we observed that the impact of the crash is largely on plane’s fuselage. We believed that miscalculations on centre of gravity and poor skill of operating remote control, lead to several crashes. After few tests, we changed the material of the plane’s fuselage from foam-board to cardboard. We also removed the wheels to compensate with increased weight. The second prototype is under testing phase.

References

1. https://en.wikipedia.org/wiki/Airplane Dated 04-02-2023

2. https://www.google.com/url?www.grc.nasa.gov Dated 04-02-2023

3. https://en.wikipedia.org/wiki/File:Boeing_707 Dated 04-02-2023

4. https://en.wikipedia.org/wiki/Airplane Dated 04-02-2023

5. https://howthingsfly.si.edu/aerodynamics Dated 04-02-2023

6. https://howthingsfly.si.edu/aerodynamics Dated 04-02-2023

7. https://howthingsfly.si.edu/aerodynamics Dated 04-02-2023

8. https://www.google.com/the+four+forces Dated 04-02-2023

9. https://www.google.com/resultant Dated 04-02-2023

10. https://www.grc.nasa.gov Dated 04-02-2023

11. https://joyplanes.com/en/power-to-weight-ratio-rc-aircraft/ Dated 04-02-2023

12. https://en.wikipedia.org/wiki/Glider Dated 04-02-2023

13. https://en.wikipedia.org/vintage_aircraft Dated 04-02-2023

14.https://www.google.com/Sport_airplane Dated 04-02-2023

15. https://en.wikipedia.org/wikiareobatic_airplane Dated 04-02-2023

16. https://en.wikipedia.org/wiki/Jet_aircraft Dated 04-02-2023

17. https://military-history.fandom.com/wiki/RC-Planes Dated 04-02-2023

18.https://www.modelaviation.com/legendary-life Dated 04-02-2023

19. https://www.modelaviation.com/history-of-rc Dated 04-02-2023

20. https://www.rc-airplane-world.com Dated 04-02-2023

21. https://youtu.be/edLnZgF9mUg?t=2107 Dated 04-02-2023

22. https://commons.wikimedia.org/wiki/File:Wing_profile Dated 04-02-2023

23. https://youtu.be/edLnZgF9mUg?t=2449 Dated 04-02-2023

24.https://youtu.be/edLnZgF9mUg?t=2803 Dated 04-02-2023

25. https://youtu.be/edLnZgF9mUg?t=3061 Dated 04-02-2023

26. https://youtu.be/edLnZgF9mUg?t=2626 Dated 04-02-2023

27. https://youtu.be/edLnZgF9mUg?t=2623 Dated 04-02-2023

28. https://youtu.be/edLnZgF9mUg?t=3387 Dated 04-02-2023

29. https://youtu.be/edLnZgF9mUg?t=3420 Dated 04-02-2023

30. https://youtu.be/edLnZgF9mUg?t=3577 Dated 04-02-2023

31. https://www1.grc.nasa.gov/beginners-guide-to-aeronautics Dated 04-02-2023

32. https://www.sciencelearn.org.nz/resources/ Dated 04-02-2023

33. https://youtu.be/edLnZgF9mUg?t=2334 Dated 04-02-2023

34. https://youtu.be/LzZ4Oqk_J1Y?t=692 Dated 04-02-2023

35. https://youtu.be/yiD5nCfmbV0?t=54 Dated 05-02-2023

36. https://circuitdigest.com/microcontroller-projects Dated 05-02-2023

37. https://www.pinterest.com/pin/648096202616162209/ Dated 05-02-2023

38. https://www.tytorobotics.com/blogs/articles/esc Dated 05-02-2023

39. https://dsmonline.in/product/SimonK-30A Dated 05-02-2023

40. https://youtu.be/eKLHD7_zzCE Dated 05-02-2023

41. https://www.techtonics.in/lipo Dated 05-02-2023

42. https://youtu.be/1WnGv-DPexc Dated 05-02-2023

43. https://www.amazon.in/Solnoi-Electronics-Servo-Motor-Micro/ Dated 05-02-2023

44. http://www.robotiksistem.com/servo_motor Dated 05-02-2023

45. https://www.instructables.com/Beginners-Guide Dated 05-02-2023

46. https://www.electronicscomp.com/fs-r6b-flysky Dated 05-02-2023

47. https://www.techtonics.in/flysky-transmitter Dated 05-02-2023

48. https://youtu.be/LzZ4Oqk_J1Y?t=242 Dated 05-02-2023

49. https://youtu.be/LzZ4Oqk_J1Y?t=250 Dated 05-02-2023

50. https://youtu.be/LzZ4Oqk_J1Y?t=305 Dated 05-02-2023

51. https://youtu.be/LzZ4Oqk_J1Y?t=308 Dated 05-02-2023

52. https://youtu.be/LzZ4Oqk_J1Y?t=373 Dated 05-02-2023

53. https://youtu.be/LzZ4Oqk_J1Y?t=21 Dated 05-02-2023

54. https://youtu.be/LzZ4Oqk_J1Y?t=26 Dated 05-02-2023

55. https://youtu.be/LzZ4Oqk_J1Y?t=26 Dated 05-02-2023

56. https://modelairplanelibrary.blogspot.com/p/thumb-rule-for-rc-plane Dated 05-02-2023