Design and development of a tri-pro UN manned Arial vehicle Concept for commercial application

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Abstract:
Purpose – This paper aims to present the results of aerodynamic calculation of the aircraft in tricopter with 2 fixed brushless and a servo attached motor at the rear side. A presented unmannedaerial vehicle is one of two types of tricopter UAVs, but presented and analyzed in basic level. The aircraft is equipped with a pair of fixed rotors mounted on the tips of the front and a servo attached rotor to the rear wings/arms. The main goal of the presented research was to research, design and analyze a rarer kind of the aircraft. Moreover, the studied model or design is also supposed to be manufactured later.
Methodology/approach – The Solid Works was used to design and assemble the parts/components of the UAV. Detailed study of tricopter types and components along with mathematical logic was conducted by the team in order to learn about the tri rotor UAVs. Findings – The result obtained from the study includes the functioning along with the given components. Not only that, it covers the mechanical forces that are acting on our UAV. The influence of the angle of attack, sideslip angle and the change of angle of servo motor was briefly investigated. New design of tricopter is also provided.
Practical implications – Presented results could be very useful in the computation of dynamic stability of unconventional aircraft. Moreover, results could be slightly helpful during designing the aircraft in the tandem wing configuration.

Index Terms **- UAV, Tri Prop, Dynamic Pressure, Design Of aircraft, Drons**

1. INTRODUCTION

Unmanned aerial vehicles (UAVs) are rapidly becoming one of the most advanced technologies in different countries. An UAV is an aircraft that can be operated remotely by a pilot and raises itself using wind energy and aerodynamics. UAVs come in a variety of sizes, with fixed or rotary wings, and are used in a variety of applications. Because of the ease of construction and control, there is a surge in interest in rotary UAVs, especially multirotor.

In recent decades, multi-purpose, compact unmanned aerial vehicles have developed remarkable capabilities. They are significant because of their ability to replace manned aircraft in a variety of routine and hazardous missions, as well as their ability to reduce the cost of many aerial operations. These aerial robots can be used for a wide range of civilian missions, including disaster surveillance, traffic monitoring, law enforcement, and power line maintenance. Military applications such as intelligence, surveillance, target acquisition, reconnaissance, and aerial attacks have already benefited from them.

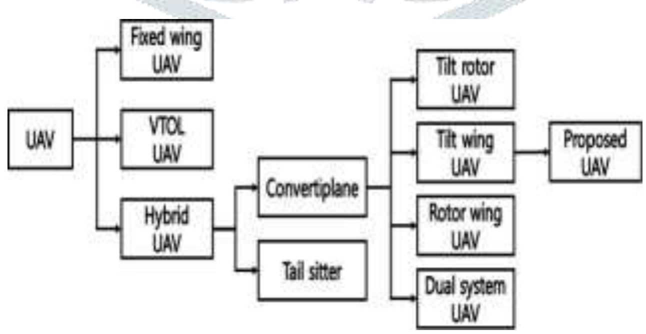


Fig 1: Classification of UAVs

The VTOL aircraft was created at the Warsaw University of Technology (WUT) by the Aircraft Design department team of the Faculty of the Power and Aeronautical Engineering.

This paper describes the aerodynamic and mechanical design, prototyping, and flight control system design of a newly designed unmanned aerial vehicle that can take off and land vertically like a quad-rotor helicopter while still flying horizontally like an aircraft.

1.1 Tricopter/ Tri-rotor UAVs

Tri-rotor VTOL UAVs are divided into two groups. UAVs are fitted with three coaxial rotors in the first. To cancel the yaw moment produced by each motor within the coaxial rotor assembly, each motor in each coaxial rotor in this configuration rotates in the opposite direction of the other. UAVs in the other category have three single rotors, one of which is controlled by a single servo motor. One of the three single rotors has its lifting angle changed by a servo motor. The yaw of the car can be changed by turning the motor clockwise or counterclockwise through the control loop. The main objective in both configurations is to keep the vehicle's yaw moment stable.

Only the rotational speeds of the propellers at each rotor are manipulated in the control strategy. Two of the rotors spin in the same direction, while the third spins in the opposite. In comparison to other systems that require coaxial rotors or an extra servo motor to control the yaw of the UAV, the control technique is novel.

The rear pair of rotors can be tilted more effectively than the front ones. Although the lift force increment produced by the rear rotors is less than that generated by the front rotors, it has no negative impact on the aircraft's stability.

The change in the tilt angle of the rear rotor was subjected to the same analysis. The results obtained for the front pair of rotors are different. The stability of angle attack equal to 0° is improved by changing the tilt angle of the rear rotors. Furthermore, as the angle of attack increases, the neutral point moves forward, reducing stability. When the tilt angle is greater than 30 degrees, the rotors' effect changes dramatically.

Recently, several researchers have worked on design and control of tri-rotor UAVs using the previously mentioned two configuration approaches (Salazar-Cruz et al., 2008; Yoo et al., 2010; Chiou et al., 2013;Kulhare et al., 2012; Papachristos and Tzes, 2012; Mohamed and Lanzon, 2012; Escareo et al., 2008). For instance, Salazar-Cruz et al. (2008) presented a T-shape configuration of a tri-rotor UAV.

2. NONLE TRICOPTER

Drone is the generic term for a rotating wing unmanned aerial vehicle. The energy management of 4 propelled quadcopters and other multi-propelled multicopters is inefficient, 2 propelled bicopters are less maneuverable, and the tricopter is more beneficial than the others. Because of the servo mechanism used in the tail motor, tricopters have better maneuverability than other rotary wing aircraft. The endurance, ease of control, and ease of to-downstream of the tricopter's fixed body (moment arm of the rotor) keep the air vibrations constant and, like many other features, provide stable flight. The moment arm of the rotors is provided with variability using an innovative tricopter aerodynamic mechanism, and performance/stability parameters are intended to be stabilized and maintained in the air for a long time.

Total weight	1.5 kg.
Useful load	0.5 kg.
Passive morphose	Used
Active morphose	Used
Range	10 km.
Flying time	30 min.
Max. Altitude	3000 m.
Transparent body	Used
Autonomus flying	Used
Airfoil	Used
Energy source	Electric battery

Fig 2: General Characteristics of Noble Tricopter

2.1 Components of Tricopter

2.1.1 Propeller

Propeller selection is one of the most important aspects of designing the thrust system for the novel tricopter. The propellers use cyclic motion to move the air, similar to how engines do. The surface must be smooth in order for the propeller to work effectively. The propeller chosen has an impact on the entire thrust system. The diameter and pitch of the propeller are useful factors to consider when choosing one. The propeller should be smaller in diameter than the distance between the engines. The distance between the two ends of the propeller is indicated by the diameter of the propeller. The propeller is designed to move air and is inclined to do so. The propeller pitch is the distance traveled during a rotation of the propeller. The CW and CCW propellers are the final factors to consider when choosing a propeller. While the tricopter is in its formal configuration, some propellers turn clockwise (CW) and others turn counter-clockwise (CCW).

According to the results of the experiments, when the propeller diameter increases while the propeller pitch remains constant, the static thrust increases while the maximum speed remains constant. To produce more thrust, the propeller diameter and pitch must be large enough. More thrust means more load can be carried. However, if all components of the thrust system are inadequate, the system will cause significant damage. Other components, such as the engine, ESC, and battery, must be compatible for the system to produce enough power.

Fig3: Solid Model Drawing of the Propeller Used in Tricopter Fig4: Solid Model of Brushless Motor Used in Tricopter

2.1.2 Motor

The motor is the most critical component of the thrust system. The engines and motor drivers used in the production and maintenance of the tricopter must be identical. Electric motors must be used because it has been decided to use electricity as the tricopter's power source. Brushed and brushless motors are the two types of electric motors. The torque and RPM values of brushed engines are low, despite their ease of use. Brush engines are therefore suitable for use in small unmanned aerial vehicles. The motor KV value should be carefully chosen when selecting a motor. When a 1V voltage is applied to the motor, the cyclic speed is measured in KV. When a 750 kV engine is powered by 10 volts, it will spin at 7500 RPM. 7500 RPM is the number of times the motor shaft rotates in a minute. When the motor is under load or accelerating, it uses a lot of current. At the same time, the maximum current value affects ESC selection. Overheating and fire will occur if a thrust system is built without these values in mind.

2.1.3 ESC (Electronic Speed Controller)

Following the engine selection, the next step is to pick the ESC. Brushless DC motors have the disadvantage of requiring a controller to operate. The ESC is a component of the thrust system that regulates the motor's speed and adjusts the voltage supplied to it. The ESC is a component of the thrust system that aids in controlling the motor's speed. When using ESC, you must select a 30 percent increase in the motor's maximum current value, or at least 10A more. For example, in a motor with a maximum current of 30A, it is recommended to use a 40A ESC. The ESC has the ability to brake the engine.

Brushless ESCs operate on three-phase AC power. In brushless motor ESCs, there are three types of wires. The first is the battery voltage cable, which is made up of two wires. This cable is connected to the battery directly. The ESC would also be compatible with the battery. The third is a control cable made up of three thin wires. The control cable is connected to the control board and receives information about the motor's rotation speed. The engine is connected to the last cable. The three cable is used to connect the motor. If the motor's rotational direction differs from the intended direction, one or both of the motor connection cables should be replaced.

If the propeller dimensions are changed, the motor may overheat or suffer permanent damage if the ESCmin values that determine the motor's power are exceeded.

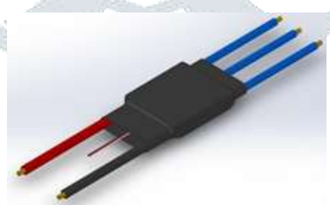


Fig5: Solid Model Drawing of ESC Used in Tricopter

2.1.4 Battery

Because lithium-polymer (Li-Po) batteries can produce a high current, they are preferred for unmanned aerial vehicles that use electricity as a power source. Because of their high power, light weight, and long life, lipo batteries are the most common source of energy in UAVs. Lipo batteries have some drawbacks as well as benefits. The following are the advantages and disadvantages of lipo batteries when compared to rechargeable batteries such as ni-mh and ni-cd:

Advantage:

(1) Lipo batteries are lighter.

(2) Lipo batteries have high capacities.

(3) They may allow high discharge currents.

Disadvantage:

(1) Lipo batteries have less life.

(2) The sensitive chemical structures of lipo batteries are available to burn.

There are 3 basic units to consider when choosing a Lipo battery. These units are number of cells, electric capacity and discharge current.

In electric air vehicles, the discharge rate is a crucial parameter. The unit "C" is the unit of this parameter that can be used to calculate the maximum current intensity that the battery can provide. Multiplying the amper/hour (Ah) by the discharge rate yields the current that the battery can safely produce (C). For example, a 3000mAh or 3Ah battery with a discharge rate of 50C would deliver a maximum of 50X3 = 150A.

2.2 Avionics System of Tricopter

2.2.1 <u>Remote Control System</u>

Receiver and transmitter modules make up the control systems. The control system's transmitter module is located in the ground station, and the pilot's commands are relayed to the UAV. A receiver module that operates at the same frequency as the transmitter module is required in the control system. The radio signals generated by transmitter control movements are converted into electrical power by the receiver module. The tricopter's performance is influenced by the channel bandwidth that receiver and transmitter modules use to operate on the same radio frequency. The control distance is an important parameter of the control system. Control range and range of aircraft; the communication receiver and transmitter modules without disconnect the work area. The air vehicle's environment has an impact on control distance.

Fig6: Transmitter and Receiver Used in Tricopter

Fig7: Flight Control Card used in Tricopter

2.2.2<u>Flight Control Card</u>

A flight control card processes signals from the control system. Due to a number of sensors and software installed in advance, this flight control card allows for autonomous flight. The control card is configured to work with the flight control card manufacturer's computer software. This program is linked to the flight control card, and adjustments can be made. The flight control card has the following sensors:

-Accelerometer / gyroscope

-Magnetometer (magnetic compass)

-Barometric pressure sensor

- GPS Connection

2.3 Specification of different components

The specification assigned to the components that will be used while manufacturing, prototyping and designing are all systematically enlisted below:

SL. NO.	COMPONENTS	SPECIFICATIONS
1	PDB	Mateksys PDB –XT60 I/P voltage :9 to 18 V O/P voltage :5V Burst current: 25A to 12V
2	ESC	SIMONK 30A Dimension :32*24*7 Weight :15gm
3	BLDC MOTOR	RS 2205/2300 KV MOTOR Shaft diameter :5mm Weight :30gm Thrust :1024gm
4	PROPELLER	Size :8*45 Dimension :5
5	FLIGHT CONTROLLER	KK2.1.5 I/P voltage :4.8V to 6.0V Sensors :6050 MCU Weight :26gm
6	SERVO MOTOR	MG 995 servo motor Dimension :40.5*20*44 Weight :55gm
7	TRANSMITTER AND RECEIVER	FLYSKY FS-i6 Weight :392gm, Power :6V
8	BATTERY	Li- Po battery :3000mah , Weight :292gm O/P voltage :14.8V, Dimension :135*25*45

3. DESIGN PRINCIPLE

The basic design of a tricopter consists of three arms: two in front and one at the back. We first draw a circle with one arm length and 16cm circumference. Make another arm at a 120-degree angle from one shoulder, then draw a circle, rear arm, and end tail. We must draw a line through the intersection of the two circles, and we obtain the dimension of three arms with the C.G point in the center of the circle. The size of a tricopter (UAV) is determined by its surroundings and the impact it has. For the construction of the tricopter, 6 degree of freedom nonlinear equations are used to explain the dynamic variables and their effects on the tricopter.

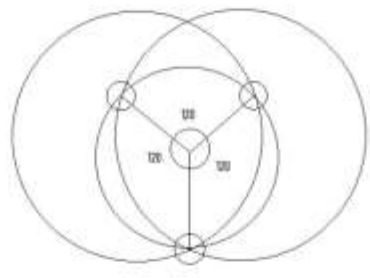


Fig8: Dimension of tricopter (16cm arm)

2.1 Design Procedure

The procedure begins with a rough estimate of the tricopter's weight. The estimated weight is then used to determine which main components, such as engines, propellers, and other electrical components, will be used. Weight, strength, and cost are all factors to consider when choosing a material. A prototype is built to test the tricopter's performance after a conceptual design and materials are collected. The prototype is to be created with a focus on the tricopter's functionality, with further research and development in mind.

4. DYNAMIC MODELLING

The suggested dynamic model for the tri-rotor in this paper is based on Newton-Euler 6-DOF mathematical formulas for rigid body multi-rotor UAVs emerging in 3D space (Castillo et al., 2004; Padfield, 2007; Dorf and Bishop, 2010). During the development of the mathematical model of the tri-rotor UAV presented in this paper, the following assumptions are taken into account:

[1] the body structure is rigid
[2] the center of gravity and the body fixed frame coincide
[3] the propellers are rigid
[4] thrust and drag are proportional to the square of propellers' speed
[5] the drag factor of the rear rotor equals the summation of the drag factor of the front two rotors.

5. CONTROL ALGORITHMS

To control the hover altitude of the tricopter as well as quadcopters, the PID (Proportional-Integral-Derivative) control algorithm has been considered and introduced in the literature. In the robotics and automation industry, PID control is a type of linear control that is widely used. The PID algorithm is popularly used mainly because:

· It has a simple structure.
· It provides good performance.
· It can be tuned even if the specific model of the controlled plant or system is not available.

The error, or difference between a measured output and a desired setpoint, is computed by a PID controller, which then adjusts the system control inputs to minimize the calculated error. P – Proportional, I – Integral, and D – Derivative are the three control parameters that make up the PID algorithm. The discrete-time PID algorithm's mathematical expression is given below. P determines the reaction to the current error; I determines the reaction based on a sum of recent errors; and D responds to the rate of change of the error;

$$J = \sum_{k=0}^{N} (x_k^T Q x_k + u_k^T R u_k)$$

MATHEMATICAL MODEL

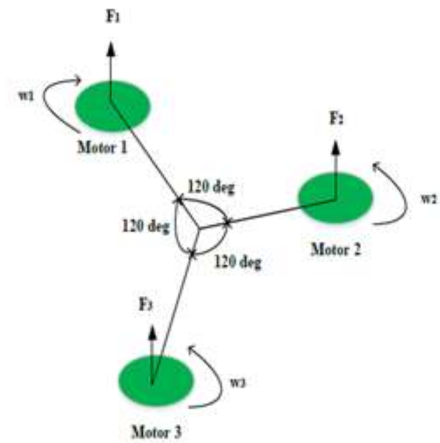


Fig9: Three Rotor Rotorcraft Scheme

The dynamic equation of the tricopter is illustrated in the diagram above. That is because in yaw control, RC servomotor drives the tail axis to change the declination angle of the tail axis.

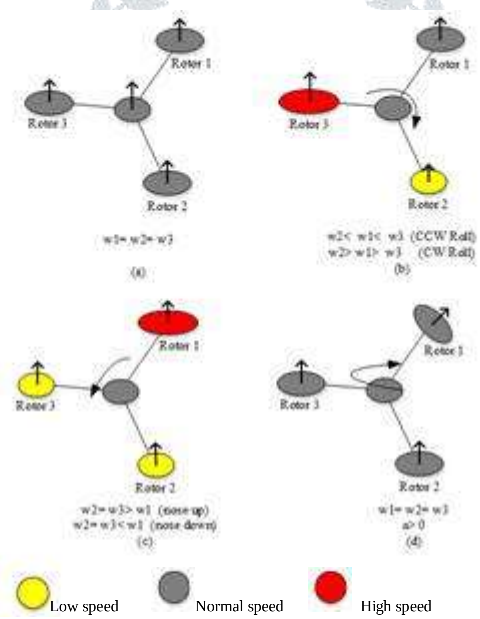


Fig10: Control strategies for tri-rotors, (a) altitude, (b) roll, (c) pitch, (d) yaw

The motion control of the tri-rotor can be broken down into altitude, roll, pitch, and yaw. Figure depicts the control strategies for tri-rotors. The altitude control is shown in Fig. (a), with increasing the speed of each rotor increasing the altitude and vice versa. The approach to roll control is that given the same rotor-1 speed, varying the rotor speeds of the two front rotors will produce roll control (see Fig. (b)). Figure (c) depicts pitch control; given the same angular velocities for the front two rotors, pitch control is achieved by varying the rotor speed of rotor 1. Yaw control can be successfully produced by using the natural yawing moment from the reaction torque as well as the tilt angle. When confronted with a sudden risk of collision, the tilt angle is extremely useful because it allows for quick turning control.

6.1 Mathematical Expression

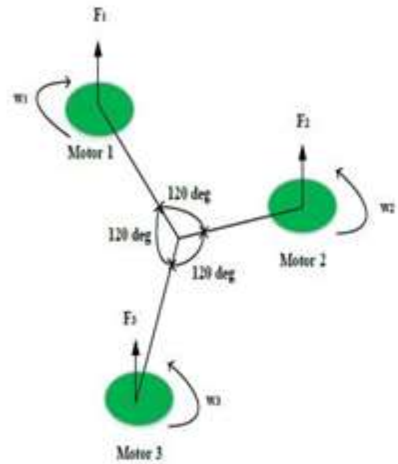


Fig11: Angle and rotation of tricopter

It consists of three rotors which are order in a "T" and sometimes in "Y" shape usually 120 degree aside.

<u>Force equation:</u>

$a=zb-yc-g\sin\theta+F1/m$

$b=za-xc-g\sin\phi.\cos\theta+F2/m$

$c=ya-xb-g\cos\phi.\cos\theta+F3/m$

Where,

F1, F2, F3= external forces.
a,b,c =translational velocities.
x,y,z = rotational velocities.
M= Moment of force
θ- Angle of inclination

When tricopter flies there are some forces acting on it, these are:

- Drag force [D]
- Thrust force[T]
- Lift force[L]
- Weight force[W]

Due to this force tricopter can be balanced.

$\Sigma Fy=0$
$\Sigma Fx=0$
F= ma [Newton 2nd law] (eq.1)
a = 0 [for constant velocity]
So, F = 0

So, the balancing force on the horizontal direction.

Thrust force-Drag force =0
So, T-D=0
T=D (eq.2)

In this way horizontal direction.

Lift force-Weight force=0
L-W=0
L=W (eq.3)

To maintain the equilibrium of flight at the certain height the thrust force must equal to the drag force and the lift force must equal the weight of the tricopter. In order to gain altitude, the force of lift must be greater than the force due to gravity. Similarly, in order to accelerate the vehicle, the force of thrust must be greater than the force of drag.

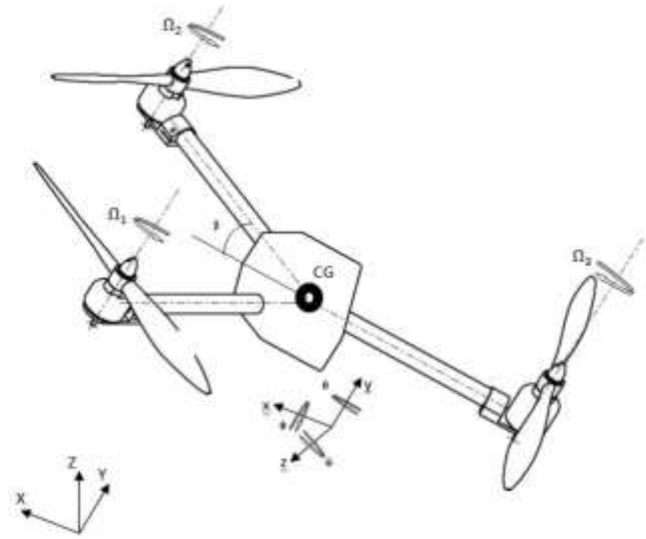


Fig12: Tri-rotor UAV rigid body configuration with earth and body frames

Fig illustrates the subject tri-rotor UAV configuration with reference frames. The 6-DOF rigid body motion equations are expressed as follows:

Kinematic equations:

$$\varphi = p + \tan\theta\,(q\sin\varphi + r\cos\varphi);\ \theta = q\cos\varphi - r\sin\varphi,$$

$$\psi = (q\sin\varphi + r\cos\varphi)\sec\theta\ ,$$

Tri-rotor moment inputs:

$$U_x = b_1(\Omega_1^2 - \Omega^2{}_2)l,$$

$$U_T = b_1(\Omega_1^2 + \Omega^2{}_2) + b_2\Omega_3^2\ ,$$

$$U_y = b_1(\Omega_1^2 + \Omega^2{}_2)l\cos\beta - b_2\Omega_3^2 l,\ U_z = ld_1(\Omega_1^2 + \Omega^2{}_2) - ld_2\Omega_3^2\ ,$$

U_T, U_x, U_y, U_z are the total thrust, rolling moment, pitching moment and yawing moment, respectively, and b, d are the thrust factor and the drag factor, respectively.

Equations of motion:

$$I_{xx}\varphi = \theta\,\psi\,(I_{yy} - I_{zz}) + J_r\,\theta\Omega_r + U_x,$$

$$I_{yy}\theta = \theta\,\psi(I_{zz} - I_{xx}) - J_r\,\varphi\Omega_r + U_y,$$

$$I_{zz}\psi = \theta\varphi\,(I_{xx} - I_{yy}) + J_r\,\Omega_r + U_z,$$

$$m_z = mg - (\cos\psi\cos\varphi)U_T\ ,$$

$$m_x = (\sin\psi\sin\varphi + \cos\psi\sin\theta\cos\varphi)U_T\ ,$$

$$m_y = (-\cos\psi\sin\varphi + \sin\psi\sin\theta\cos\varphi)U_T\ ,$$

7. DESIGN

7.1 Base of tri-copter

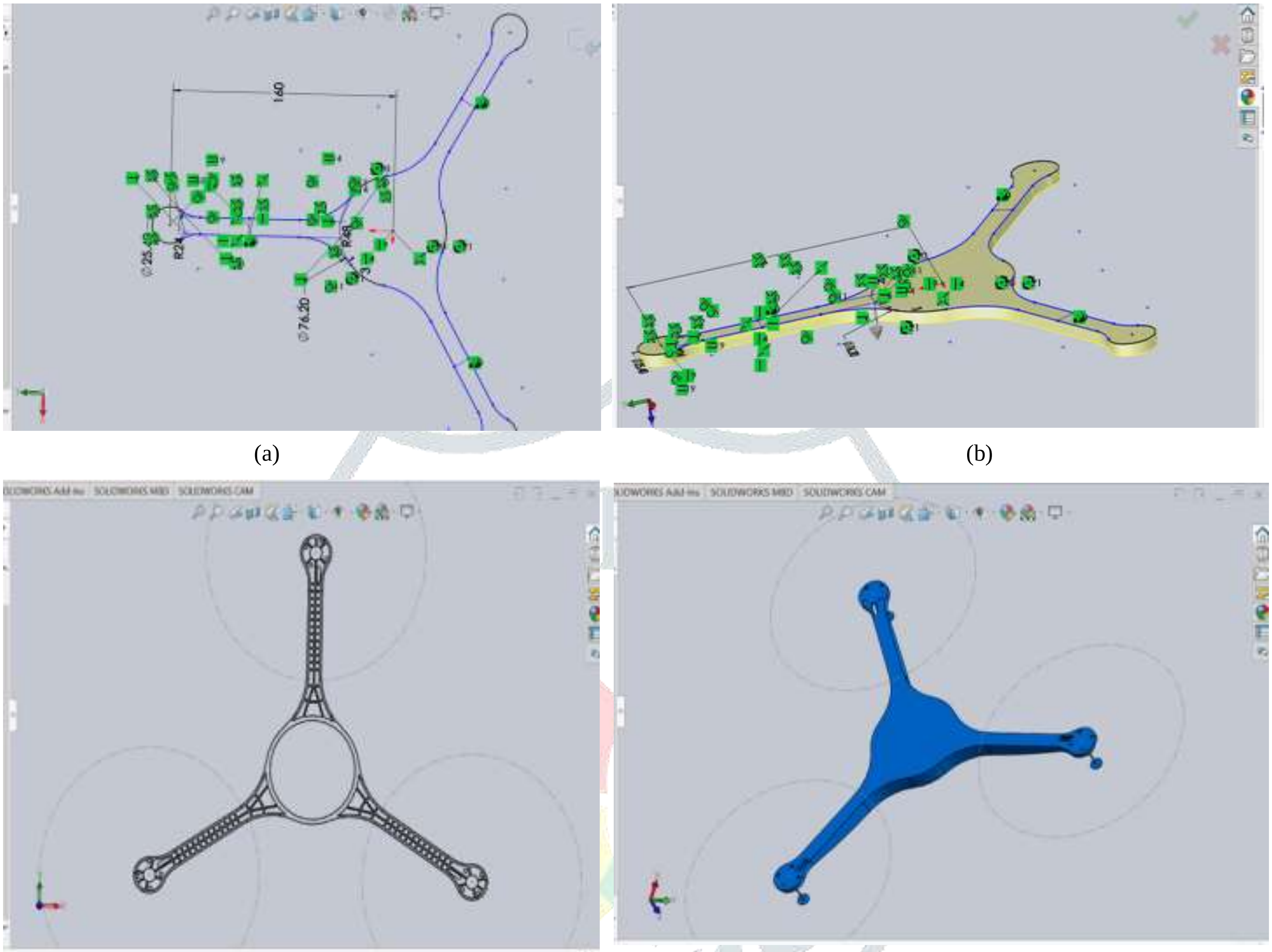


Fig 13: Frame of the tricopter design (a)Frame sketch with parameter (in mm), (b)Base while extruding, (c)Top view of frame, (d)Final frame work of base

Tricopter design basically, consists of three arms that are front two arms and tail rear arm. We take first one arm length and we have also taken 16cm length and draw a circle. Then from one arm make another arm at 120-degree angle then draw a circle and rear arm and end tail. We must draw a line at which the two circles are intersecting and we got the dimension of 3 arms with C.G point at the Centre of circle. The size of tricopter (UAV) depends onto the surroundings and the impact act on the tricopter.
Each arm having same distance from the center of the circle and length of each arm was 160mm and also each arm adding additional weight of motor and propellers of the tri-copter, And also ESC and battery also additional weight on the center of the circle.

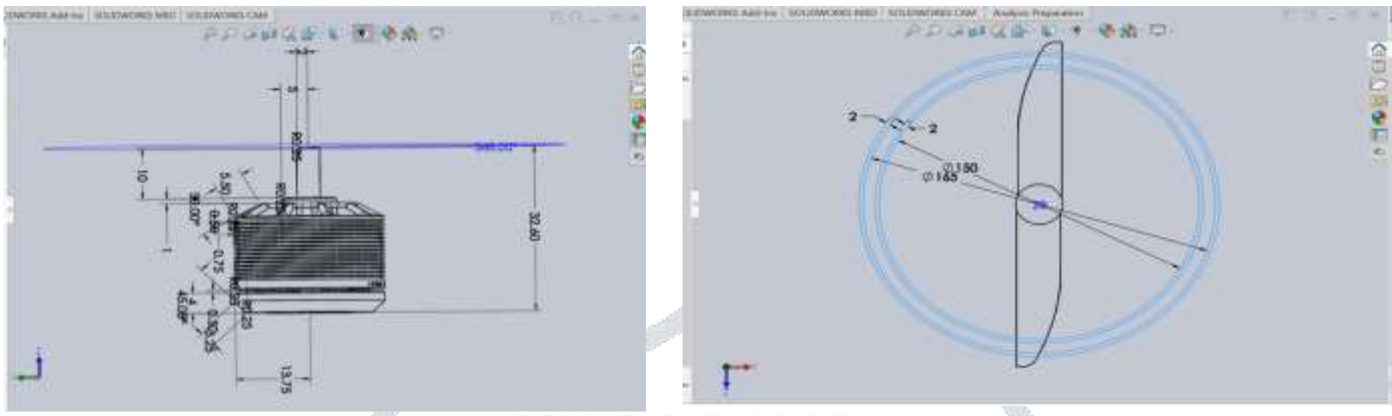
7.2 Motor

The motor is the most critical component of the thrust system. The engines and motor drivers used in the production and maintenance of the tricopter must be identical. Electric motors must be used because it has been decided to use electricity as the tricopter power source. Brushed and brushless motors are the two types of electric motors. The torque and RPM values of brushed engines are low, despite their ease of use. Brush engines are therefore suitable for use in small unmanned aerial vehicles.

7.3 Propeller

Propeller selection is one of the most important aspects of designing the thrust system for the tricopter. The propellers use cyclic motion to move the air, similar to how engines do. The surface must be smooth in order for the propeller to work effectively. The propeller chosen has an impact on the entire thrust system. The diameter and pitch of the propeller are useful factors to consider when choosing one. The propeller should be smaller in diameter than the distance between the engines. The distance between the two ends of the propeller is indicated by the diameter of the propeller. The propeller is designed to move air and is inclined to do so. The propeller pitch is the distance travelled during a rotation of the propeller. The CW and CCW propellers are the final factors to consider when choosing a propeller. While the tricopter is in its formal configuration, some propellers turn clockwise (CW) and others turn counter-clockwise (CCW).

Propeller having their own lengths but we take the propeller length as 170mm and also, we have taken the diameter of propeller was complete circle diameter was 20mm, thickness of the circle was 2mm, and also length of the one single propeller was 85mm and also weight of the propellers are 55grams, In this tri-copter we are used two propellers because of weight loss of the tricopter.



(a) (b)

Fig 14: Design of components (a)Motor design(x3), (b)Two blade propeller(x3)

7.1 Assembly of All Parts of Tri-Copter

7.1.1 <u>Insert Components</u>

You can add components to new or existing assemblies from the Property Manager. And also add new or old parts in same area, you can add a single component, multiple components in sequence, or multiple components at a time at a single location.

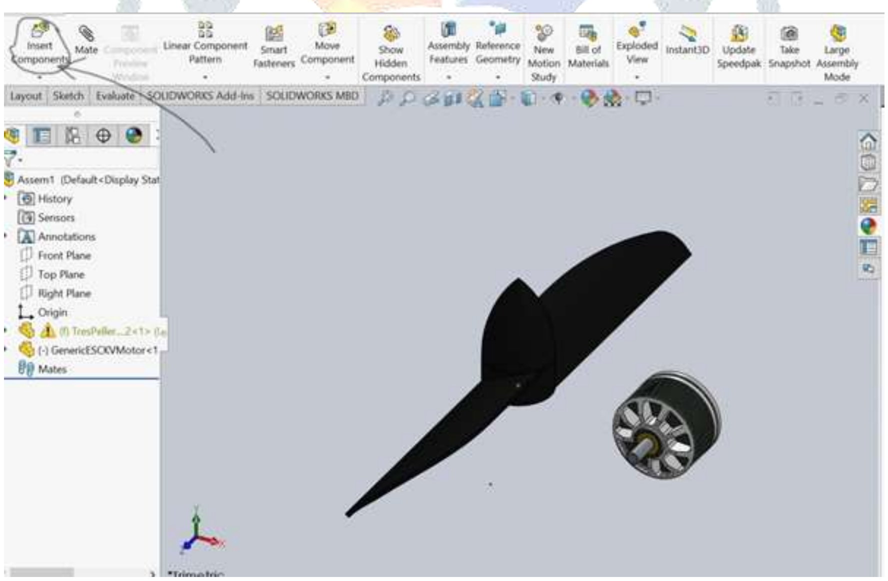


Fig 15: Motor-propeller (side by side before insertion)

7.1.2 <u>Mate</u>

Mate was used for surface to surface and also axis, A coincident mate forces two planar faces to become coplanar. The faces can move along one another, but cannot be pulled apart. A concentric mate forces two cylindrical faces to become concentric. The faces can move along the common axis, but cannot be moved away from this axis.

We have taken mate option and one tab on the upper surface of motor and inner surface of the propellers, to coincides each other to take same axis or same plane.

Mates create geometric relationships between assembly components. As you add mates, you define the allowable directions of linear or rotational motion of the components.

You can move a component within its degrees of freedom, visualizing the assembly's behavior.

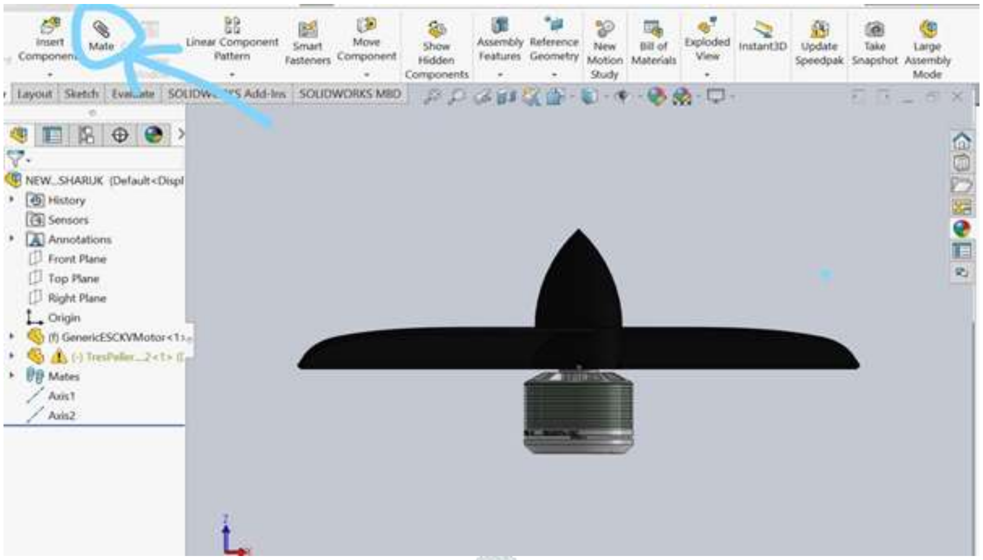


Fig 16: Assembly of motor-propeller

Same process to assemble the all parts we need to use (insert component) and add what we need to assemble the parts same like assemble all parts we need a mate tool is the tool that will assemble all parts of the tri-copter and the final design of our tri-copter was created.

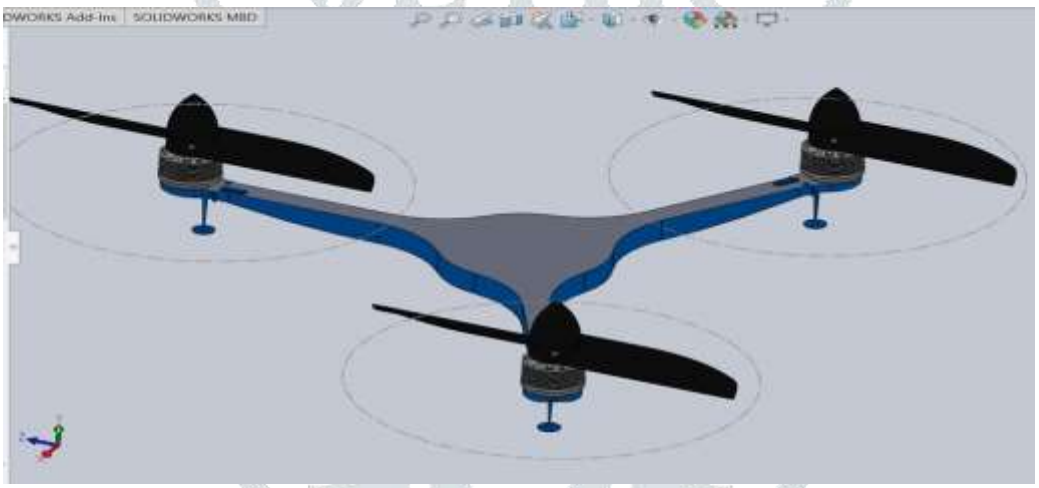


Fig 17: Final design of our tricopter model

8. STABILITY CONTROL The avionics control system of the tri-rotor UAV is shown in the figure below. The four PID controllers and the three motor order mixers make up the system's key components. Roll, pitch, yaw, and altitude controllers are the four PID controllers. The front right, front left, and rear motors all have command mixing blocks. The gyros, accelerometers, ultrasonic, and pressure sensors, if any are used, provide feedback states. The attitude and altitude of the UAV are described as these. The desired pitch, roll, and yaw angles, as well as the desired height, are all commands sent from the ground station or remote pilot.Each PID controller attempts to eliminate error by calculating the difference between the input and the reference. Each controller's output is combined in three mixing blocks to produce the desired pulse width modulation (PWM) signals, which are then sent to the motor controllers to achieve the desired motor speed for each motor.

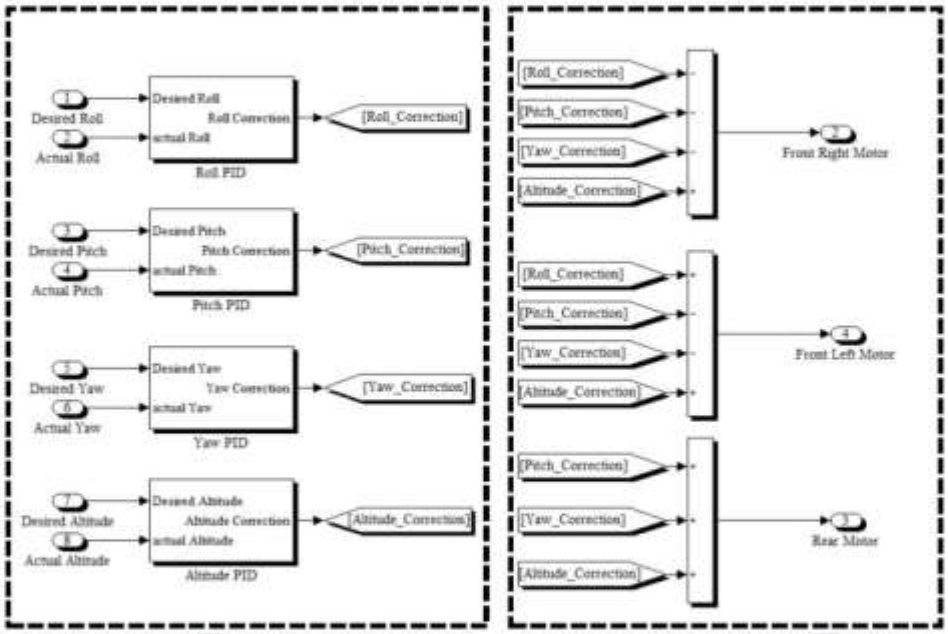


Fig 18: Tri-rotor UAV avionics control system

9. CONTROL SYSTEM BLOCK DIAGRAM

The proposed system's block diagram is shown in Figure. It demonstrates how the controllers are decoupled, as well as which controllers' interface with which inputs and outputs. Gain Scheduling is also noticeable, which divides the positive and negative error values into two linear regions.

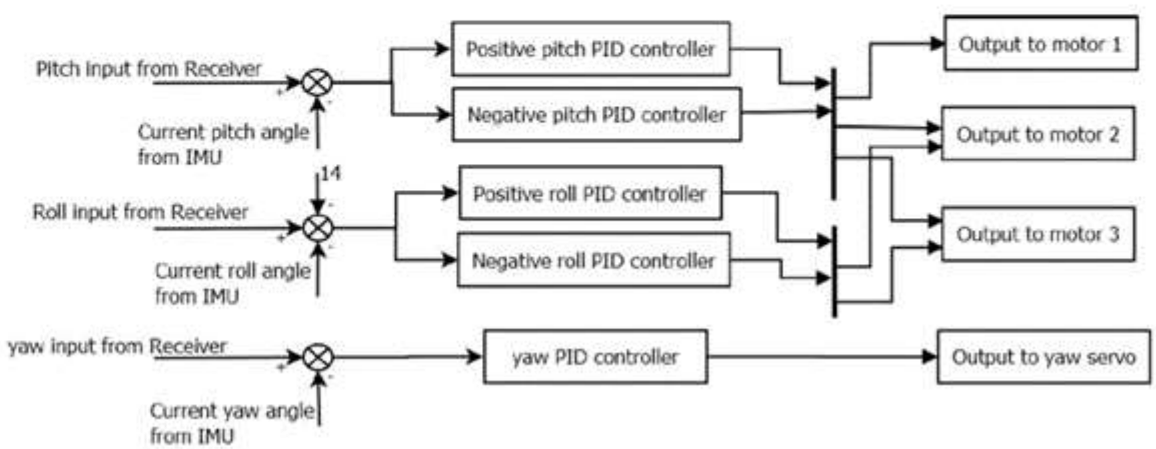


Fig19: Block diagram overview of the control system

10. SOFTWARE SYSTEM ARCHITECTURE

Figure depicts a high-level view of the software architecture. Timing is accomplished through the use of timer interrupts, which cause an interrupt vector to be generated. One iteration of the control loop will be triggered as a result of this. A low battery feature is also included in the software. Because lithium batteries are used, safety is a major consideration, and overcharging the batteries to a voltage of less than 3V per cell is discouraged because it reduces the battery's life and performance. When the system detects a low battery, the user input throttle value is gradually reduced until it reaches zero. When the user loses power, the result is a tricopter that is easy to lower.

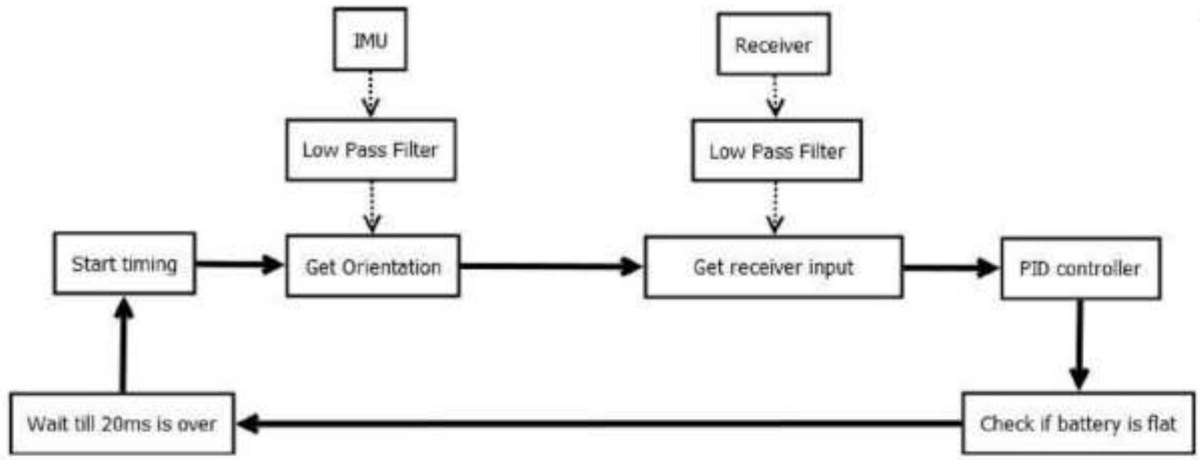


Fig20: Overview of the software architecture of the system

CONCLUSION:

As we all know that while taking in consideration about the UAVs, we rarely find or know the concept towards the Tri-copter. So, the concepts behind the rarely used tri-copter was studied. This paper has presentedour own complete and calculated designof a tricopter. The components which are used in building a tri copter are easily available in the market (i.e., 3 pieces of brushless motor (2205/2300kv), 3 pieces of brushless esc, 1 piece of servo motor (55gm), 3 pieces of propeller (8*5), 1 piece 6-ch transmitter and receiver, 1 piece of flight controller (KK2.1.1 26 gm), 1 piece of li-po battery (3000mh), 1 piece of base frame with arm 16 cm, with some battery connector and some connecting wires). This paper also gives complete study about the principle behind the design and related theories with control systems, stability controls and others. The design started off with simple compass sketch in the paper which is also provided above. The dimension was taken as 16cm arm length with 5mm wide. The angles between each arm were 120 degree and circular base plate was taken as 5 cm diameter.

Future work - After designing a unique tricopter structure and checking the outcome of design, their performances will be tested out both virtually and manually with the help of prototype. Along with that, the design will have to be developed and programmed manually which will be published in next part of journal. This project will be limited up to the manufacturing of prototype of the design.

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