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Design and Development of a Robotic Drone: A Drover.

Dr. Y. S. Ram Mohan[1], Mr. Prashanth U[2], Mr. Vinay K R.[3]
[1]*Professor & HOD, Department of Aerospace engineering, BMS College Of Engineering, Bangalore, Karnataka, INDIA,*
[2]*Department of Aerospace Engineering, BMS college of Engineering, Bangalore, Karnataka. INDIA*
[3]*Department of Aerospace Engineering, BMS college of Engineering, Bangalore, Karnataka. INDIA*

Abstract: ***The main aim of this project is to introduce new way of spying to our Indian armed forces and to improvise the spying techniques in all the required fields. This project helps to work beyond and to learn beyond the limitations. Achievement of this project to overcome the major drawback of the spying techniques which is presently existing, and to develop the strength of our Indian armed forces and to increase the revolution of aeronautical. This project will be mainly used during the surgical strikes to analyse the accurate situation at the location. This project will save many soldiers and help to resolve the strike easily by providing the accurate situation record. This can upgrade the Indian defence sectors.***
Keywords: Hybrid multifunctioning, Surgical strike, spying, CNC turning and milling.

I. INTRODUCTION

Robotic Drone is a machine, which can move on land as well as fly in air. This machine is mainly used for spying purpose. It consists of four propellers with high power brushless motors, 4 track belt driven wheels that is driven using wheels with 2 BO motors either side of front wheel driven and rear wheel driven, high-definition cameras, live video streaming, high range control transmitter and receiver. This machine can easily move on improper surface with the help of wheels. This machine can change from land mode to fly mode in a fraction of seconds. Recently, there has been a lot of interest in UAV technology. One of the IT industries with the quickest growth is this one. In order to expedite remote investigations and provide fast response units, the idea of deploying drones to hover about crime scenes and gather data and evidence is already in use in the United States. Modern drones can mimic the human eye by monitoring their environment from a variety of angles using sensors including laser, infrared, and optical sensors. By utilizing this technology, a drone may navigate by itself to do any mission that was assigned to it. Now that technology has advanced, namely with the development of intelligent systems, drones can be customized and their autonomy can be increased. Drone technology has advanced so much, and the applications that have resulted from this development have opened up new industries. Drones can now be employed in a variety of settings and for a number of reasons. For navigational needs, disabled persons can use drones as a guiding device. In the field of architecture, they are also employed to map buildings and assess their adherence to safety standards.

II. OBJECTIVES

1) Determine the payload for the mission requirement and selection of avionics based on payload obtained.
2) Design of rover using Mastercam and assembly of drone.
3) Development of Rover and Drone controls in 1 transmitter.
4) Establishing the synchronous transmission system for continuous spying.
5) Fabrication of autonomous flight system with thermal camera module to capture the data autonomously.
6) Test flight of the drone and analysis of the data captured.

III. MISSION REQUIREMENTS

Mission requirements of the project specify the main criteria the designed product must fulfil at the end of the project. The following are the specified mission requirements for the designed UAV.

1) Minimum payload carrying capacity = 40gms.
2) Minimum Endurance = 10-15mins
3) Minimum Design safety factor = 2.

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A. Theortical Concept

The first scientist who experimented on multi rotor aircrafts was Etienne Oehmichen. In 1920's, he started designing the multi rotor which includes the four motors and eight propellers. Quadcopter is a helicopter which is propelled by the four motors. Quadcopter has diverse design significance other than the similarity of four propellers. Quadcopter design diverse includes configuration, frame design, electronic components based on the wide range of applications. Quadcopter is classified based on their configuration such as X-configuration, H-configuration and +-configuration. X-configuration is the most commonly used configuration since it is simple construction, ideal placement of camera and it is symmetrical with respect to both axes. To improve mechanical convenience and camera prospective H-configuration is also used.

IV. DESIGN OF DRONE

A. Estimation Of Total Weight

Estimation of weight of the drone is important, in-order determine the minimum thrust required to lift the drone. The weight can be spilt into drive, electronics, body and payload. The drive consists of motor, propeller, ESC and battery. The body and electronics consist of airframe, flight controller, GPS, power distribution board. In our project, the payload includes thermal module, camera controller and a transmitter. Initial estimation of weight can be seen in Table 4.1

Table 4.1 Estimation of Weight

Parts	Weight (Grams)
Airframe	330
Motor	220
Propeller	28
ESC	128
Battery	360
Flight Controller	68
Rover	586
Power Distribution Board	30
Payload	10
Total	1760

After calculating the weight based on the values obtained from the manufacturer details, the total weight including payload obtained was 1760grams. The thrust required to lift depends upon this estimated weight.

B. Estimation Of Thrust

Based on the estimated weight of the drone, thrust required is evaluated.
For the drone to hover at 50% throttle, T/W ratio value should be 2.
$TR = 2 \times W$
$TR = 3520 grams$
The minimum thrust required for hover at 50% throttle was 2220 grams. Adding 180 grams of extra thrust to the TR to give some extra headroom. The final thrust required summed up to 3600gms.
The thrust needed to be produced is split up between 4 BLDC motors, hence each motor requiring to produce 900 grams of thrust.

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V. DESIGN AND ITS CHALLENGES

To address an issue, engineers must go through a number of steps in the engineering design process. The methods include approaches to problem-solving include deciding your goals and constraints, prototyping, testing, and evaluation. Once you have chosen the fundamental layout of your device, you must perform the necessary calculations to ensure that it will serve its purpose. These calculations include determining how much force is needed, what size pieces are required, and other factors. Design challenges are

1) Low weight (accurate wait was 1873 grams).
2) Q450 is the quad frame.
3) Analysis on a economy material satisfying the required parameter of our vehicle.
4) Having a long working tenure without any structural deformation.
5) Designing the rover in order to adapt to the drone frame was the major challenge.
6) Location of the camera.
7) Maintaining the Centre of gravity.

VI. DEVELOPMENT AND ASSEMBLY

A. Parts of Drone

1) Q450 Quad copter Frame

The Q450 Quad copter Frame is very popular and mostly used Multicopter Frame by hobbyists!!! This is 3rd version of the Q450 Quad copter Frame that comes with stronger material over v1 and v2, so no more arm breakage at the motor mounts on a hard landing. This Q450 Quad copter Frame is made from Glass-fiber which makes it tough and durable. They have the arms of ultra-durable Polyamide-Nylon which are the stronger molded arms having a very good thickness so no more arm breakage at the motor mounts on a hard landing. The arms have support ridges on them, which improves stability and provides faster forward flight.

*2) 10*4.5 Propellers*

This is 1045(10×4.5) SF Propellers Black. They are for lower RPM motor and slow flying drone models. They have wide and thin blades in their size category which makes them much flexible in crash conditions where they do not break easily. 1045(10×4.5) SF Propellers Black especially draws larger currents and in results will give you a considerable amount of thrust.
1045(10×4.5) SF Props have high-quality propellers specially designed for multi-copters. 1045(10×4.5) SF Props has 15° angle design in the end of the propeller to avoid whirlpool multi-copter flying.

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3) KK 2.1.5 Multi-Rotor LCD Flight Control Board

The original KK gyro system has been updated to the incredibly sensitive 6050 MPU system making this the most stable KK board ever and adds the addition of an auto-level function. At the heart of the KK2.1 is the ATMEL Mega 644PA 8-bit AVR RISC-based microcontroller with 64k of memory.

An additional header has been added for voltage detection, so now there is no need for onboard soldering. A handy piezo buzzer is also included with the board for audio warning when activating and deactivating the board, which can be supplemented with an LED for visual signalling.

4) 11.1 V 5200Mah battery

Orange 5200mAh 2S 35C Lithium polymer battery Pack (LiPo) batteries are equipped with heavy-duty discharge leads to minimize resistance and sustain high current loads. Orange batteries stand up to the punishing extremes of aerobatic flight and RC vehicles. Each pack is equipped with gold plated connectors and JST-XH style balance connectors. All Orange Lithium Polymer batteries packs are assembled using IR matched cells.

5) 920 Kv Brushless Motors

a) This Motors are less noise and stable.
b) With 3.5mm bullet connectors, save welding trouble.
c) Fit for F330 F450 F550 S500 S550 Quad copter.
d) Due to different people use different frames and it requires screw sizes are also different, so it didn't come with screws.
e) Suggest to use our 1045 propellers, ASIN: B0823NNTKD

6) 30Amps ESC

The DYS blue series speed controllers have been developed and setup specifically for multirotor use, so no programming required. Unlike generic helicopter / aero plane ESCs, the DYS speed controllers come preloaded with multirotor specific firmware preinstalled. Best still, it's not just any old firmware; it's the highly regarded Simonk firmware, which is optimized for multirotor applications.

a) Developed specifically for multi rotor use
b) Smooth, linear and precise throttle response
c) Extreme low output resistance, super current endurance
d) Supports high RPM motors
e) Safe start, motor will not run until ESC is armed correctly
f) Includes 5V 2amp BEC

7) Fly sky FS-i6 2.5G 6CH(Transmitter)

The Fly Sky FS-i6 2.4G 6CH PPM RC Transmitter with FS-iA6B Receiver. It is a great entry-level radio for those just starting in the field of drones flying.

Above all, you get a slim, modern radio transmitter that fits nicely in your hands and weighs just under 400 gm. It won't test your arm stamina on those long flights. This radio is also really practical with a 3-position switch. It has two adjustable knobs for flight modes/ multiple flap positions.

You will get the new FS-iA6B receiver with this kit. This is a compact 6-channel receiver with a range exceeding 500m in addition. It comes with a dual antenna for excellent reception and interference rejection capabilities.

Each transmitter has a unique ID and so when binding; the receiver remembers this ID and accepts data from that transmitter only. This avoids picking up other transmitter signals and dramatically decreases inference and increases safety.

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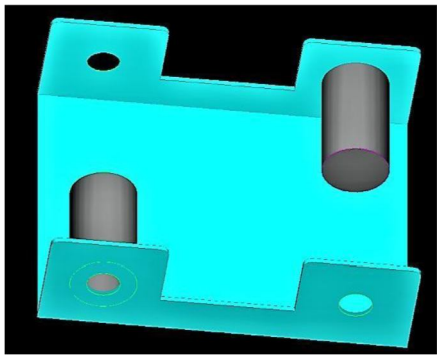
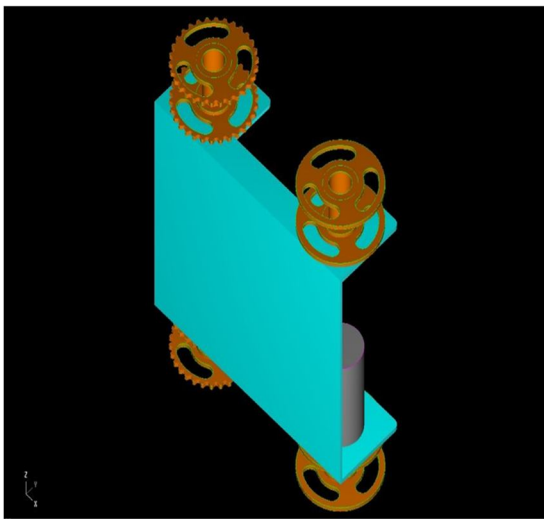
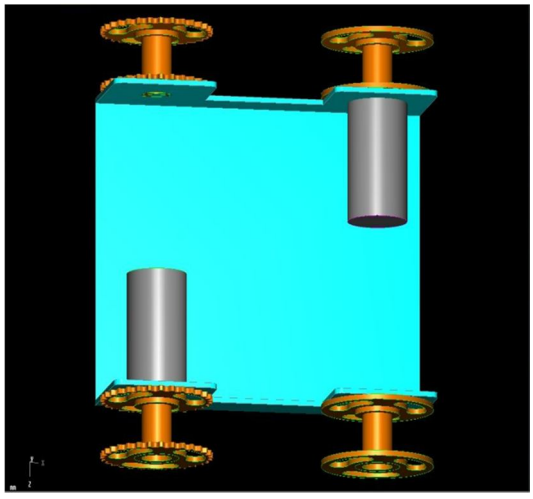
VII. FABRICATION AND ASSEMBLY

A. Parts of Rover

1) Chassis







Chassis of the ROVER is designed using Master cam x5 software in such a way that it has to be adaptable by the Q450 Quad frame used for the Drone.

This chassis was made up of 2mm Sheet Metal by Bending and welding process. Powder coating for surface finish.

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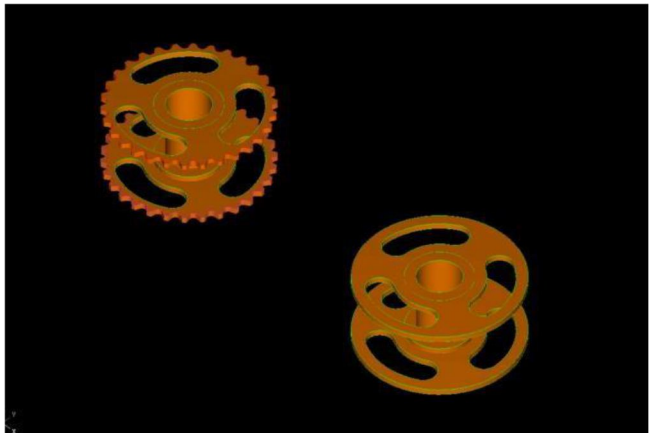
2) Track Belt

Rubber track can be a tank or track car, such as tile to rely on crawler transmission robot. This product is only track, no wheels, can make their own, according to their own model needs, find a round metal sheet, plastic sheet, wood chips, processed out of certain teeth to match the track.
[Narrow strip]: width of 1.6 cm, with a length of 21 cm (double after the length of the fold), the circumference of about 42 cm
[Broadband]: width of 2 cm, with a length of 18.5 cm (double after the length of the fold), the circumference of about 37 cm
[With the surface of the convex distance]: 0.5 cm
[Weight]: each pair of 23 grams (width and width of the same weight)
【Material】: environmentally friendly rubber.

3) Track Belt Driven Wheels



Wheels for the selected track belt are designed by us using Master cam x5 software. These wheels will be made of aluminum 7075 and manufactured using CNC Turning.

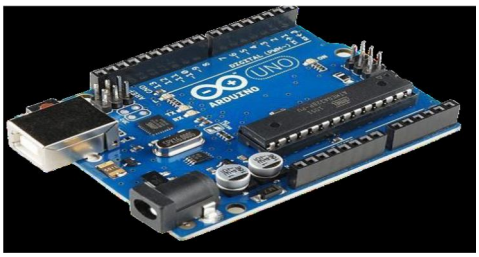
4) Brushed Motor

The motor which is used to power the rover, brushed motor; it is 12 volts dc with 350 rpm. Drover consists of two of these motors, one for the front wheel of the left side (considered from the forward motion direction) and the other one at the rear wheel of the right side (considered from the forward motion direction). Both the motors are placed according to perfect motion and center of gravity is considered.

5) Arduino Board

UNO R3 SMD is the open-source Embedded Development board based on Atmega328 SMD Package Microcontroller. Because Atmel is moving more and more of their production capacity to surface mount ICs, the DIP packaged AT mega is becoming more and more difficult to get. To keep up with demand, we now offer the Uno R3 with an SMD AT mega. The board is identical to the PTH version of the Uno, but you won't be able to remove the AT mega without some hot-air. This change shouldn't affect most users

a) Microcontroller: ATmega328 SMD.
b) Operating Voltage: 5V.
c) Supply Voltage recommended: 7-12V DC.
d) Digital I/O Pins: 14 (of which 6 provide PWM output).
e) Analog Input Pins : 6.
f) DC Current per I/O Pin: 40 mA.
g) DC Current for 3.3V Pin:50mA.



6) Video Transmission System

48 channels choice to get the best transmitting quality. compatible with almost all 5.8g frequency smaller size with lighter weight. 32 ch compatible with all fpv 5.8g receivers. 5.8g 600mw 32 channels av wireless fpv transmitter super small 200ma current for 600mw wireless transmitter power. 600mw transmitter power ensures 5 km distance in open area, 5-8 km is available if working with the bigger gain antenna.

Drover is installed with a basic VGA vision quality FPV camera. This camera has a servo motor connected to it which is used to control the angle of the camera view.

VIII. ASSEMBLY OF DRONE PARTS

A. UAV Airframe Assembly

In any UAV configurations, the airframe is one of the principal components of the whole structure. Apart from housing all the electronics and relevant sensors, the airframe also plays a role in the structural integrity and aerodynamics of the UAV.

B. Installation Of Electronics

After the airframe is assembled motor, ESC, Vibration pad, APM are installed as shown in the figure below, Battery is connected to power modulator. SC are connected to the output of APM. ESCs are soldered to the power distribution board. Output pins have 3 pins in each row. Right most all pins are ground. All center pins are Vcc (5 volt). And all firsts' pins are signals. Connect all the four ESCs wire to the first four output pins of KK2.1.5 board.

C. KK2.1.5 Setup

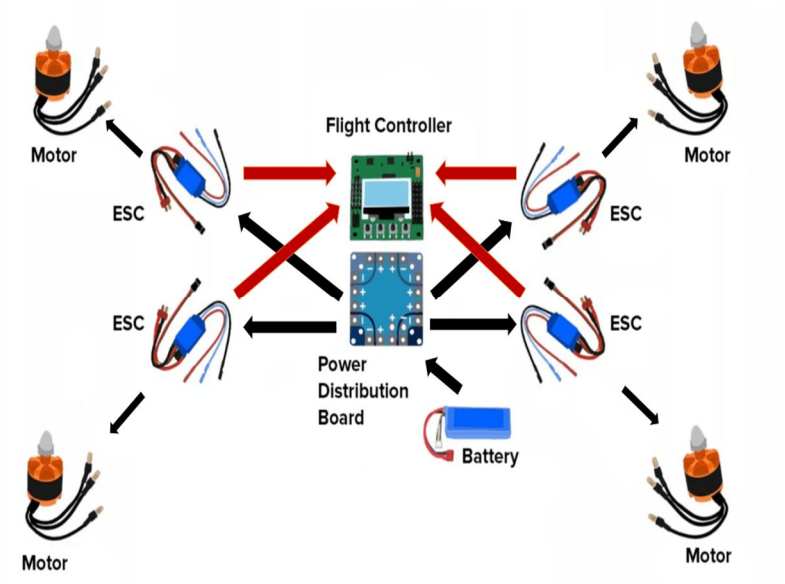
For setting up KK2.1.5 board, first keep the transmitter on and ensure that the receiver is bound to transmitter. There are four buttons at the bottom of the KK2.1.5 board S1, S2, S3 and S4.

Using these buttons, we will interact with LCD display.

Step-1 First go to menu by pressing S4 then go to load motor layout then select quad copter X mode and setup quad Copter at X – mode. Check all the motor directions here.

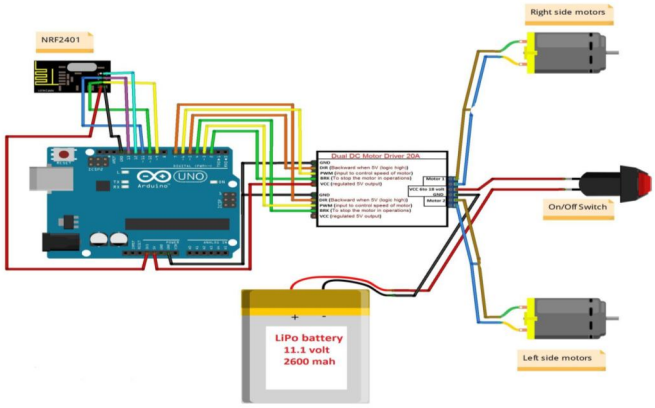
Step-2 Next is ACC calibration, for which we have to place quad copter on the plane level surface and select the Accelerometer Calibration that is to calibrate accelerometer. Click on S4, this is auto calibration. As soon as Accelerometer calibration over, we can pull out the power and provide the power again. It will be showing safe on LCD display which means, it has changed from error to safe.

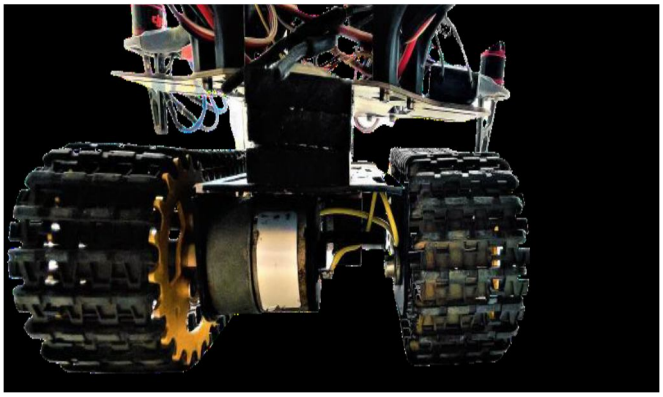
Step-3 Now, go to the PI editor. Here, we have to set P (gain / limit) and I (gain / limit) of aileron (Roll), elevator (Pitch) and rudder (Yaw). P gain is proportionality gain that represents sensitivity and responsibility. Higher P means sharper control and lower P means softer one.



D. Assembly of Rover

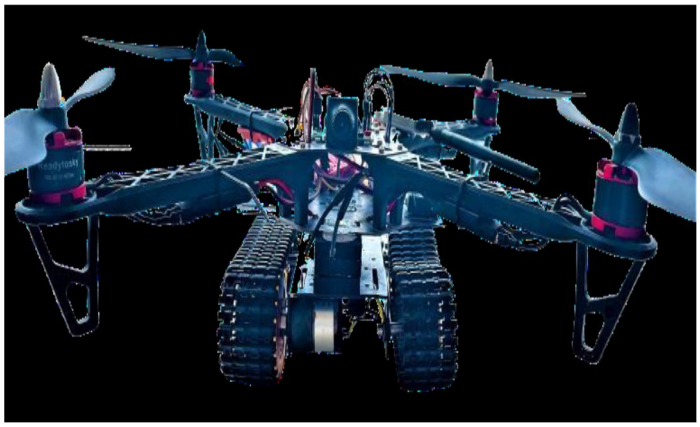
Current paradigms for planetary exploration are strongly dependent on the use of small, capable mobile robots ("rovers") to seek out and retrieve scientific information. The recent Pathfinder mission is a successful example of the capabilities of such systems. However, the scope of the Pathfinder mission was limited to short traverses under relatively close human supervision. In future mission's rovers will be required to negotiate more challenging terrains, with limited human supervision. Alleging terrains, with limited human supervision. In a representative future mission command cycle, a rover might be expected to obtain midrange terrain data via a mast mounted ranging system, identify a scientific "goal" or traversal waypoint, and autonomously plan and negotiate a path through challenging terrain. In this paper, the problem of autonomous rover rough-terrain path planning is addressed. A rapid path-planning technique which considers uncertainty sources relevant to the rough-terrain planning problem is presented. Rover which is also called as UGV (Unmanned ground Vehicle) is used to augment the human capabilities in both civil and military activities in open terrain. It can be used as a human replacement in several dangerous military activities such as frontline reconnaissance.





E. Final Assembly

Final Assembly of Quadcopter with all the equipment's installed in the frame and connected to appropriate parts of the Quadcopter. Camera is mounted in the cam mount which is designed and fabricated using 3D printing and landing gear uses carbon fibre rods.



F. Applications

1) It can be used during surgical strikes for finding the victims. • It can be used to survey the condition during emergency situation.
2) It can be used in dense forest for surveillance.
3) It can be used for surveillance on terrain surfaces.
4) It can be used for videography.
5) It can be used in tall buildings for surveillance.
6) Night vision surveillance.

This project will be mainly used during the surgical strikes to analyse the accurate situation at the location. This project will save many soldiers and help to resolve the strike easily by providing the accurate situation record. This can upgrade the Indian defence sectors.

G. Advantages

1) This can move on land as well as fly in air.
2) It consist of FPV wireless cam
3) Live video can be transmitted and recorded.
4) The land and air mode can be changed simultaneously

H. Limitations

1) It can only move on land and air. It is not specified for the water operations.
2) It cannot withstand heavy winds during flight.
3) It has approximate working temperature, which is 10degree Celsius to 50degree Celsius.
4) It cannot be used in rain.

IX. SCOPE OF THE PROJECT

Main reason for selecting this project is because of its hybrid multi functioning properties. This can be used for rescue operation, military applications, and many more. By modifying the designing and choosing better flight controller, we can have better performance and power output, applications, etc.

X. FUTURE SCOPES

With further developments, the applications of the ROBOTIC DRONE can be improved like:

1) Upgrade with latest quad specifications for an accurate flying.
2) 360degree cameras and night vision for spying during night
3) Water proof body and water landing skids for water functioning.
4) Illumination for night vision.
5) Failsafe modes: high wind, Battery, GPS, Link loss tolerance etc.

XI. CONCLUSION

We conclude that the project we took up has undergone fabrication and basic configuration. During the course of this project we faced lots of challenges because the centre of gravity is the main concern and also the attachment of the rover and drone assembly. So selecting the material with proper strength to weight ratio and proper placement of the objects played a vital role. With the advancement in our project, we can upgrade our Robotic Drone with all the advanced features and specifications, resulting in more safety and reliable.

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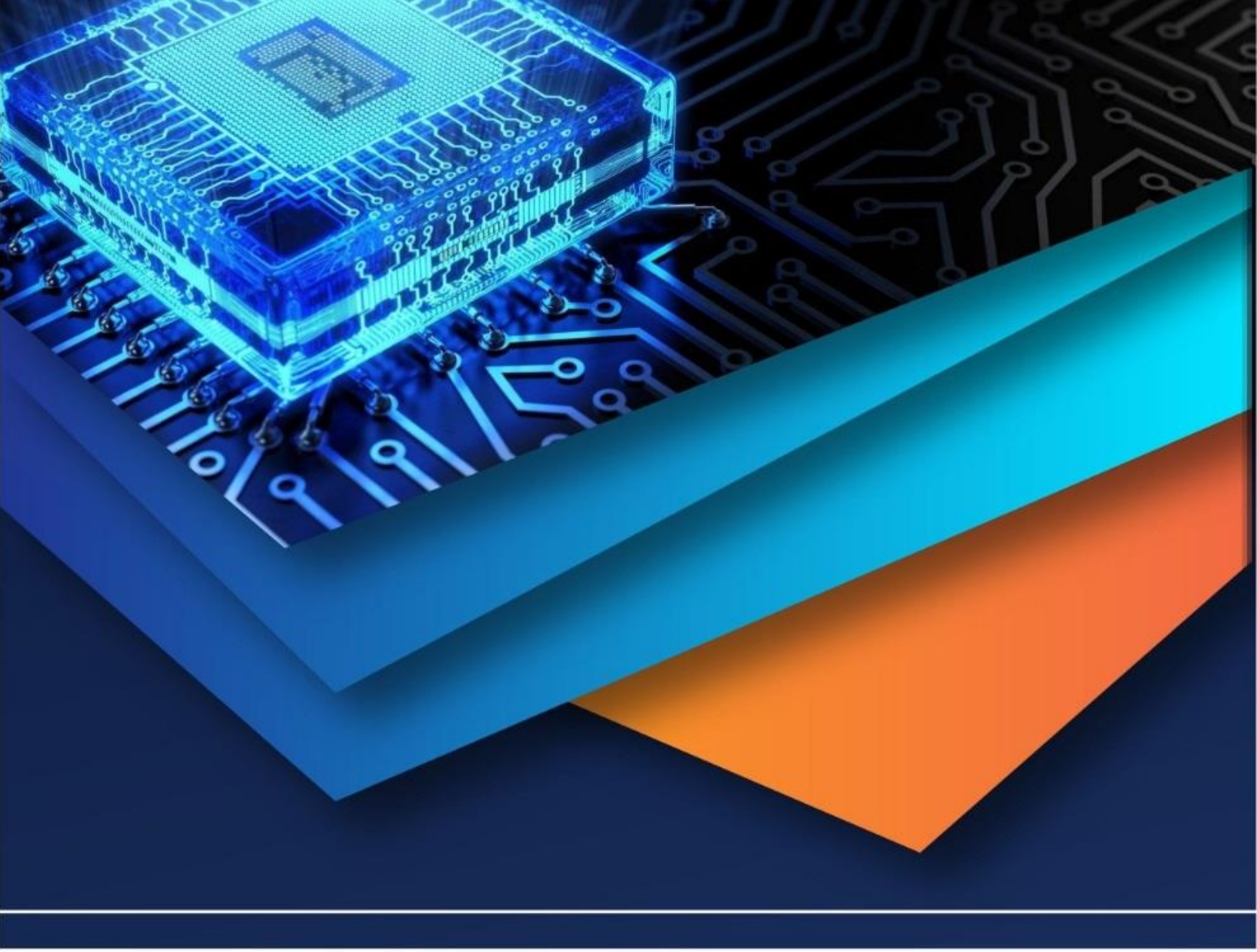

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