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Surveillance using Unmanned Aerial Vehicle

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Abstract: Recently, Unmanned Aerial Vehicle (UAV) have been used as an instrument of research in various fields like Surveillance, Wildlife Monitoring, Package Delivery Systems and many more. Generally, airplanes need a run-up/runway to take-off whereas Drone / Copter is a type of UAV that can take-off without a need of a runway. So, the aim of this project is to provide better Surveillance than the existing kits by making it more cost-effective, energy efficient and lighter in weight as possible as it can be. This project will enable us to aerially survey those parts that are usually much harder to inspect manually and thus make the process easier and much more efficient in terms of time as well as resources required. This project will also have a huge impact on a larger surveying grounds which we will be able to survey easily and quickly.
Keywords: Unnamed Aerial Vehicle (UAV), Quadcopter, Remote Controller, Image Processing, Drone.

I. INTRODUCTION

Aerial Surveillance is gaining a lot of importance these days for a variety of reasons. It is being used in military, smart farming, supervision and other such purposes. Surveillance coverage of larger areas is challenging due to time and resource requirements. We need a system which can be easily adopted for specific requirements, has an open structure and can be built easily using locally available components. Our project tries to address this challenge.
We plan on using hardware that are easily available in market or can be bought online with ease. On software front, we are using Multi-Wii, which is an open-source software that includes codes for many different sensors and is easy to use. We plan hosting this project related documents and code on a GitHub repository so that interested people could easily access project details and can use the same.

The other details of our project are provided below:
1) We would like to create a Level-2 autonomous system which will act as a framework for future development and modifications.
2) Our project will provide help in reducing the resources required by providing a small, light-weight drone which can reach very small, in-accessible areas and perform the required tasks. Because it is small, it will use battery efficiently, delivering good battery life and more air-borne time.
3) Our Drone will be able to record stable video footage and transmit live footage to a screen or a server

II. LITERATURE REVIEW

Prof. A.V.Javir, Ketan Pawar, Santosh Dhudum, et al. , this paper focuses on the aerodynamic effects of a quadcopter and addresses all the aspects of quadcopter ranging from mechanical design to the components used. It provides backup to the selection of different components with the help of various formulas from research papers. It also gives clear results with respect to weight of components and their corresponding costs.
LITERATURE SURVEY ON UNMANNED AERIAL VEHICLE written by SAURAV KUMAR, E. KANNIGA (Senior Research Fellow, Professor), 2018-IEEE have specified in their paper that the UAV is an automatic system and the shrinking size and increasing capabilities microelectronic devices in recent years has opened doors for more real-time UAV applications and also development of auto-pilot project.
Gordon Ononiwu, Arinze Okoye, et al. Sept-2016, this paper presents the design and implementation of an aerial surveillance quadcopter for search and rescue applications. The first phase of the paper considered modeling of the quadcopter while the second phase involved system implementation and simulation. It results in surveillance and reconnaissance quadcopter which can take the photographs from environment captured through the aid of the on board mounted camera while live streaming with the help of laptop during flight.
SURVEYING WITH PHOTOGRAMMATIC UNMANNED AERIAL VEHICLES (UAV), April-2019, IEEE, written by HARIZSHAHRIZUAN, says that the aim of this paper is to compare the possibility of UAV as a photogrammetric tool to replace the total station in regards to survey measurement purposes.

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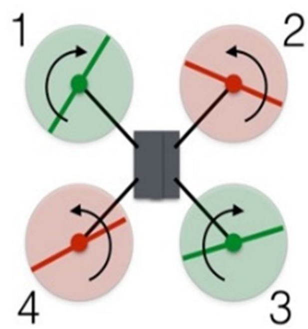
The aspects that shall be compared are the challenges total station surveyors faced compared to UAV surveyor & the accuracy & the precision marginal difference of UAV & total stations. The challenges of the total station surveys against UAV surveys are obtained via the qualitative research method and the site study of the accuracy and precision marginal difference is conducted via the quantitative research method.

Controlling Quadcopter Altitude using PID-Control System, December 2019, IEEE- Ayele Terefe Bayisa(Tianjin Key Laboratory of Information sensing and intelligent control School of Automation and Electrical Engineering Tianjin University of Technology and Education)This work presents the stabilization of a quadcopter by using PID controllers to regulate its four basic movements: roll, pitch, yaw angles, and altitude. The quadcopter was originally equipped with sensors and software to estimate and control the quadcopters orientation.

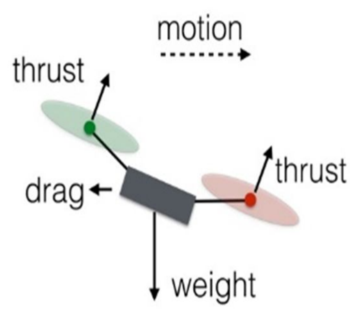
III. WORKING METHODOLOGY

Drones come in different shapes, size and number of motors, but the working of every drone is almost the same. We will be discussing about the Quadcopter (Drone having 4 motors).



In the above figure, as it can be seen diagonally opposite motors rotate in the same direction. Hence, there are 2 set of rotates which rotate in opposite directions so that the angular momentum is zero.

There are 3 types of forces acting on the drone:



1) *Gravity:* It is the gravitational force that acts on the drone and pulls in downwards.
2) *Thrust:* It is the upward force which acts on the drone and it is caused due to the rotation of motors and propellers.
3) *Drag:* It is the force which acts opposite to the motion of drone and caused due to air resistance.

Propellers are fitted on the shaft of the motor, so when the motor rotates, propeller pushes the air down which causes the drone to lift up in the air (thrust is produced) and the upward force should be greater than the weight of the drone. To make the drone hover, the weight of the drone should be equal to the thrust gensserated. To increase or decrease the altitude of drone, changing direction of drone we adjust the speed of motors.

So, for adjusting the speed of motors, the command comes from the transmitter (given by pilot) to the receiver which is connected to the flight controller. As flight controller is the main brain of the drone it executes the command with the help of MOSFET. We can add several other devices and sensors which can constitute to the application of drone.

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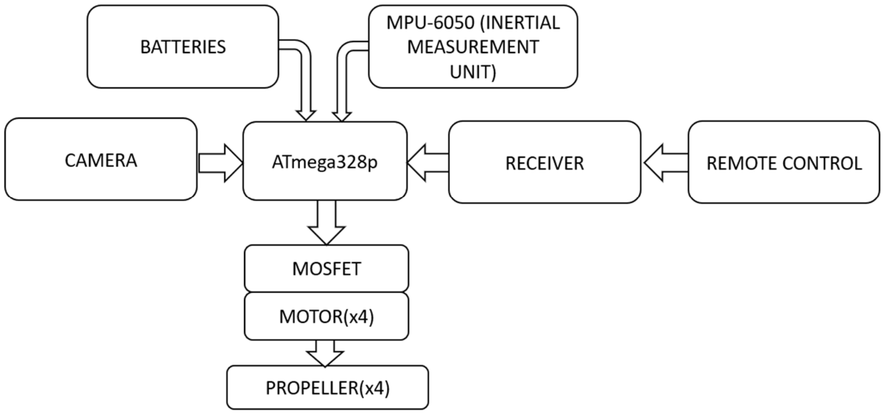
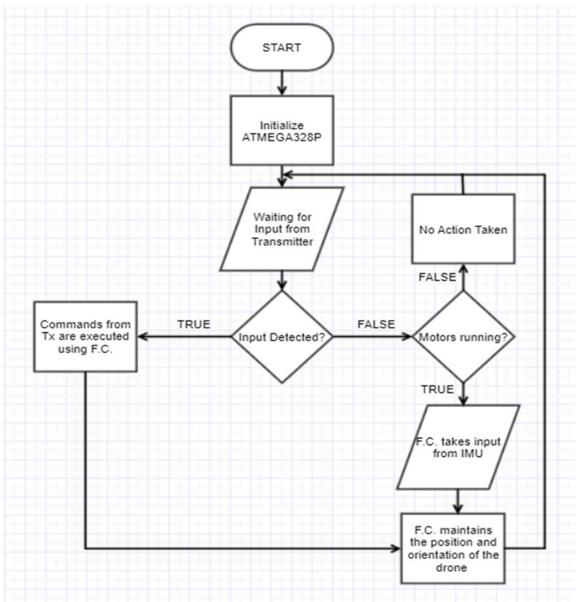
IV. BLOCK DIAGRAM



V. ALGORITHM

A. When we power on the flight controller (ATmega328P), it initializes the MPU-6050 which takes some initial readings to calculate its offset.
B. When we send any instruction from the transmitter, it gets coded into a PPM signal and at the receiver's end it gets decoded by the flight controller which then executes the instruction.
C. Flight controller then adjusts the current given to MOSFET which is responsible for adjusting the speed of motor.
D. MPU-6050 is continuously giving its readings to the flight controller so that it can perform PID control which helps in stabilizing the drone.
E. Flight controller also sends some telemetry data like battery voltage through the receiver to the transmitter.
F. We use VTX for transmitting the real-time video onto the required device using the camera.

VI. FLOW-CHART



VII. COMPONENTS USED

A. Frame
1) Provides the basic structure for the drone.
2) We are using Q100 frame which has a wheelbase of 100mm.
3) Components should be placed on the frame in such a way that weight is distributed uniformly.

B. Motor

1) Responsible for spinning the propeller which makes the drone fly.
2) Better the motor design, longer will be flight time of drone. Hence, efficient output is achieved
3) We will be using 8520 coreless motor in this project.
4) Different parameter needs to be check for selecting motor: Thrust and RPM of motor, voltage and current drawn, etc.

C. Propeller

1) They are the most fundamental component for lifting the drones in air by transforming the rotary motion into linear thrust.
2) They do this by creating a pressure difference between the top and bottom surface of the propeller. When the propeller spins, air flows over the top and creates low pressure whereas high pressure is created underneath the propeller which pushes the drone upwards.
3) We are using 65mm propellers in this project
4) Different parameters for choosing the propeller: Size, Pitch, Blade Configuration, Material used and Design of the propeller.

D. MOSFET

1) They interpret the signals coming from the flight controller and translates those signals into pulses which then determines the speed of the motor.
2) We will be using SI2302-TP, which is an N-Channel MOSFET for this project.
3) While selecting the appropriate MOSFET some points are: V_{DS} should be at least 20% greater than the supply voltage, MOSFET’s current rating should be high enough to provide peak current to the motor, Gate drive current and also the rise/fall time of the MOSFET.

E. Flight Controller

1) It is the main brain of the drone. We are using ATmega328P as the flight controller.
2) It is used to interpret the data coming from the different sensors and receiver and take appropriate steps according to the commands and algorithm.
3) Parameters for choosing appropriate flight controller: Processing speed, power consumption and internal memory.

F. MPU-6050

1) It is the Inertial Measurement Unit which is responsible for giving the accelerometer and gyroscope readings.
2) It plays an important role in PID control and also in understanding the position of drone.

G. Transmitter and Receiver

1) To control a drone, 2 elements are needed. Transmitter (hand-held device operated by pilot) and receiver (present on the drone).
2) Transmitter reads the stick movement and then transmits the information to the receiver using the air as a medium in real-time. As soon as the receiver receives the information, it directs it to the flight controller which then processes it and takes the appropriate step.
3) We are using FS-i6X as the transmitter and FS-iA10B as the receiver.
4) Parameters for choosing an appropriate transmitter and receiver: Number of Channels, Type of Gimbal used in transmitter, frequency used, protocol used for communication and what type of telemetry data is available.

H. Batteries

1) Without battery, the drone won’t get any power and hence won’t be able to fly.
2) We mostly prefer using LiPo battery for powering the drone.

I. Camera

1) It is responsible for capturing the video which will be used for surveillance.
2) We are using 600TVL 170-degree Mini FPV camera for our project.
3) Parameters for selecting an appropriate camera: Camera resolution, Sensor size, aperture and focal length of the drone.

VIII. RESULT

A. *Thrust Calculation*

For building a drone, the thrust to weight ratio should be 2:1, i.e., total thrust needed for flying the drone is twice the weight of the drone.

But as the motor output and thrust isn't linear and changes throughout the throttle range, so for efficient thrust we build a 20% safety factor of the required thrust.

Thus, our formula for total needed thrust becomes:

Thrust needed = ((2x Weight of the Drone) + 20%)

Consider that weight of our drone is 80 gm. Therefore:

Total thrust needed = ((2x80) + 20%) = (160 + 20%) = 192 gm.

So now thrust needed per motor will be:

Thrust per motor = 192/4 = 48gm

Component	weight	quantity	Total
Motor	5	4	20
Propeller	1	4	4
Frame	11	1	11
Battery	29	1	29
Circuitry	16	1	16
Total			80
Calculation	((2*Weight of drone) + 20% Buffer)/4		
	((2*80) +(20% of 160))/4 = 48		
Needed:	Thrust=48 g/motor	Given:	Thrust=48g/ motor

B. *Flight time Calculation*

Battery Capacity decides the total flight time of the drone. The formula for calculating:

Total Flight Time = [(Battery Capacity x Battery Discharge) / Average Amp. Draw] x 60

Battery Discharge is considered as 80% or 0.8 because if we discharge the battery 100%, it needs a jumper to start charging which reduces the life of the battery and can also cause battery to explode.

Sr.No	Components	Max.Current(With load)	Quantity	Total Current
1	Motor- (8520 coreless)	1.6A (approx)	4	6.4A
2	Flight Controller Circuit	180mA	1	180mA
3	Reciever	30mA	1	30mA
4	MPU6050	3.9mA	1	3.9mA
5	LED	30mA	1	30mA
6	Buzzer	100mA	1	100mA
7	Camera	100mA	1	100mA
		Total		6.84A
	We are considering 7A as average current drawn.			
	Flight time = (Battery Capacity x Battery Discharge / Average Amp Draw) x60			
	Battery Capacity	Flight Time		
		7A	8A	10A
	1000mAh	6.8min	6min	4.8min
	1200mAh	8.23min	7.2min	5.76min
	2500mAh	17.14min	15min	12min
	3000mAh	20.6min	18min	14.4min

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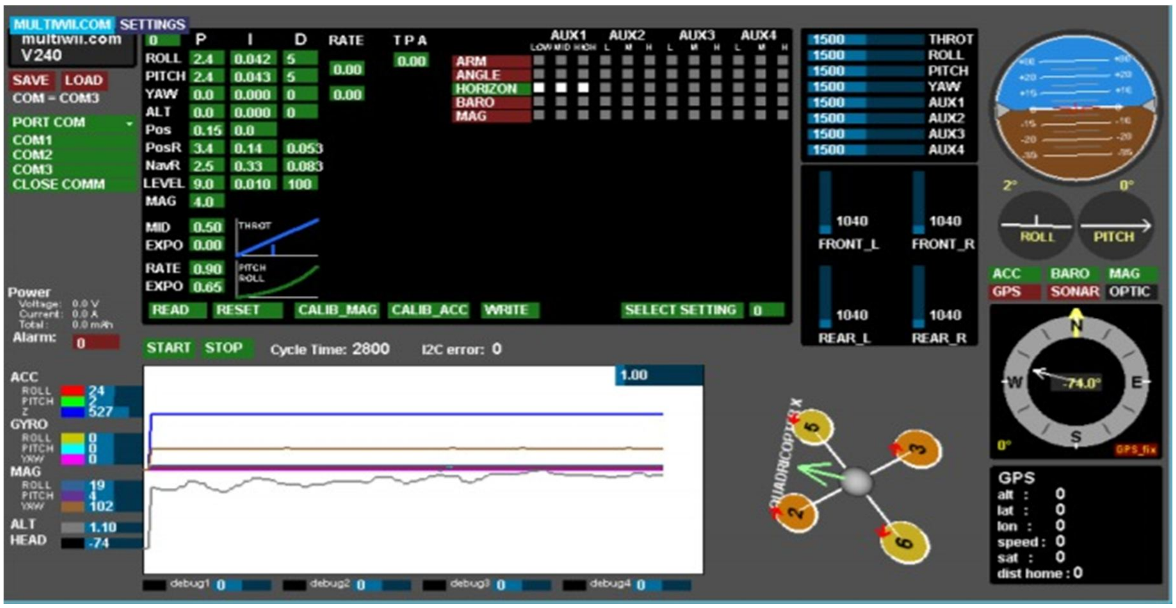
C. Simulation

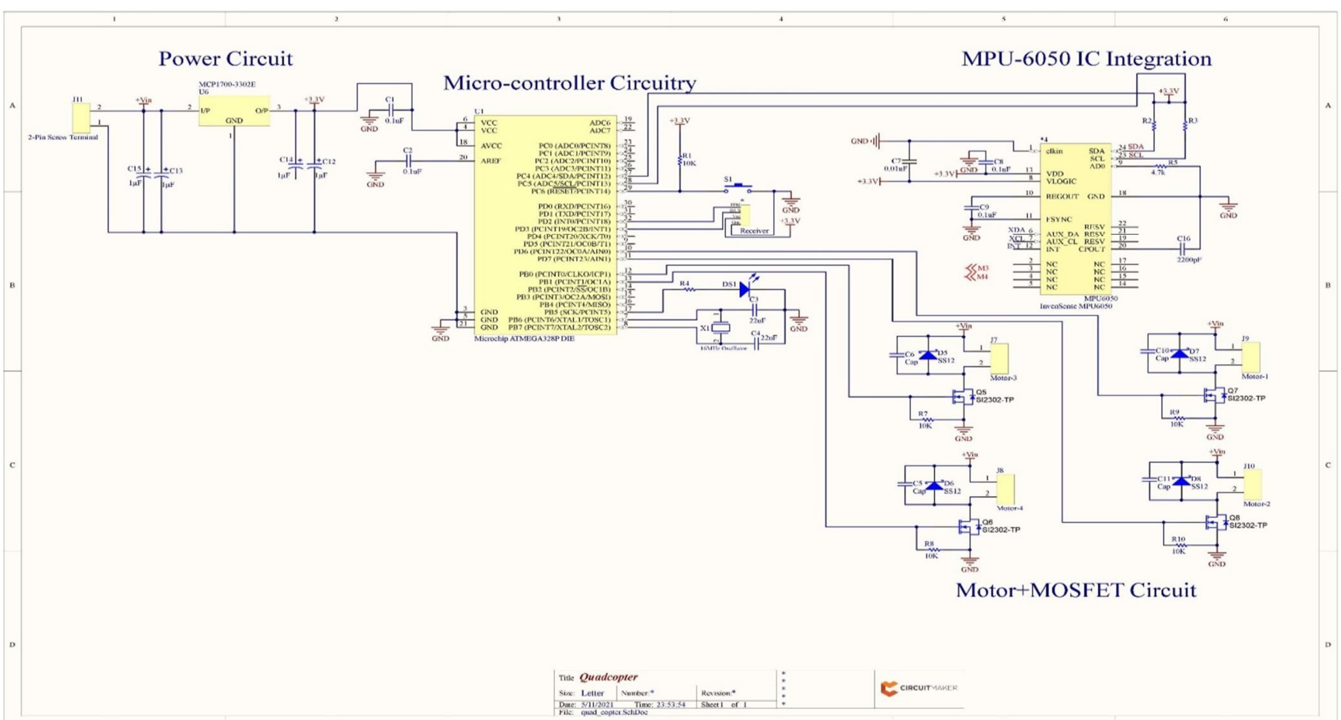
We are making use of MultiWii 2.4 as the software for our drone with customization so as to reduce the size of the program and making it only compatible with our drone.

Hence using MultiWii Conf for simulation of drone and ground control station. It accommodates the PID parameter tuner, attitude indicator, provides us with the speed of motors and radio signal and gives other relevant data.

As MultiWii Conf is an open-source platform, we can easily customize the GUI (Graphical User Interface) as per our preference. The sensor graph helps in understanding, debugging and adjusting the accelerometer and gyroscope.



IX. CIRCUIT DIAGRAM



X. CONCLUSION

The project has shown that MultiWii has proved to be unexpectedly powerful in controlling the quadcopter's complicated system and also provides customization as it's open-source.

The overall performance of the sensors was also positive, even though at start had faced some issues due to instability of the control system which was found to be result of inexact calibration. After running multiple tests, we rectified the mistake.

Our project is based on a surveillance drone which has applications in many fields like: Surveying a farm or mining filed, in finding a safe route for people from disaster prone areas.

There are many advantages of this project but it can be dangerous too. As we are using a protocol which uses air as a medium, there is a possibility that it can be hacked and hence, can be used to show a different route while being used in the disaster-prone areas or it can also be used to spy on someone. Instead of fully focusing on advantages there should be a concern with respect to security and privacy risk. Thus, all these things should be taken under consideration to fly safely.

XI. ACKNOWLEDGEMENT

Every orientation work has an imprint of many people and it becomes duty of author to express deep gratitude for the same.

The authors received great help from the scholars whose articles are cited and included in the reference of the page.

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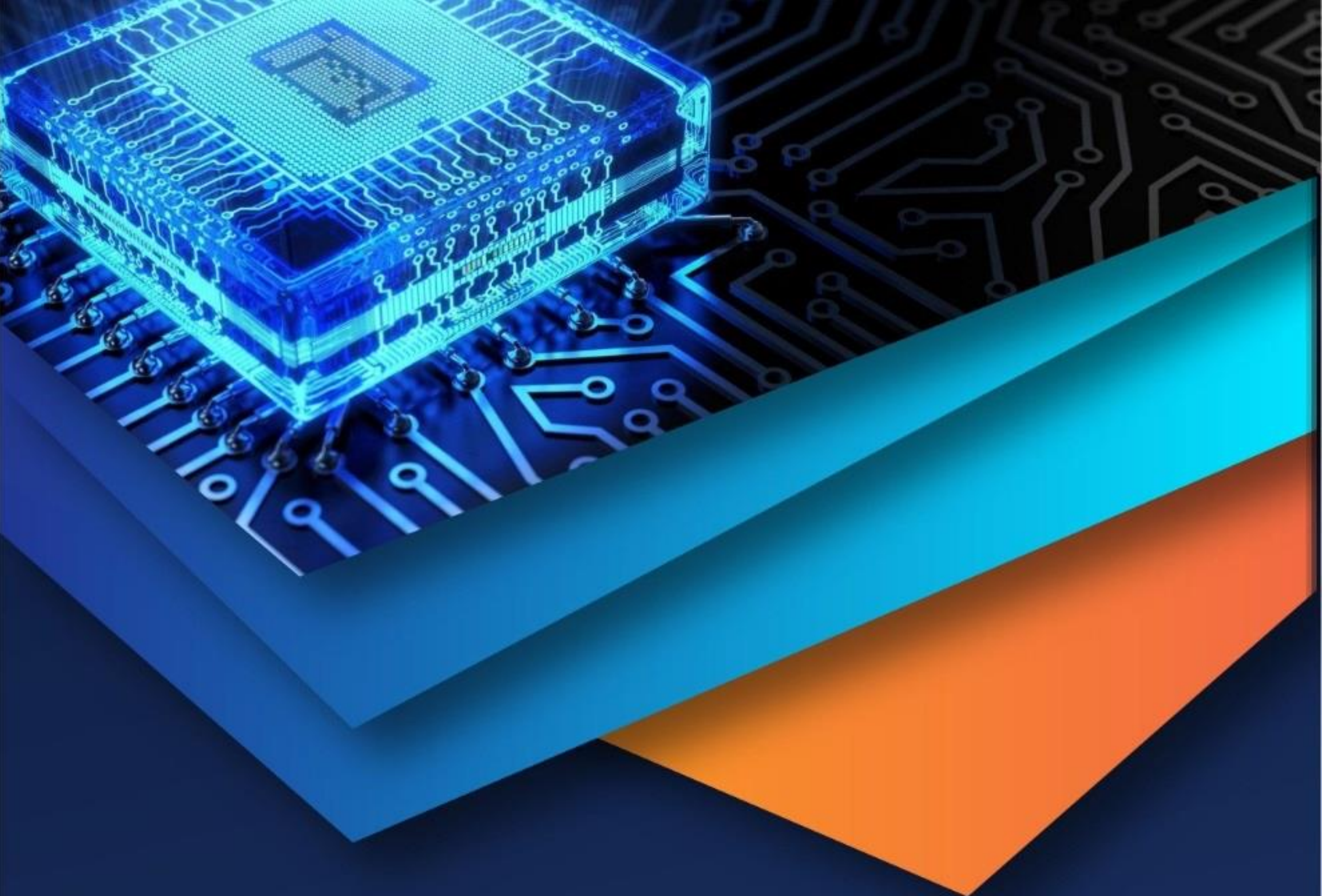

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