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Drone with LiDAR System

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Abstract: Although the use of both drones and LiDAR (light detection and ranging) has become common in geology in recent years, LiDAR scanning from drones is still in its infancy. The technological development related to drones as well as laser scanner instruments has gradually reached the point where these can be integrated. A modest improvement of detection success was found, but was not as convincing as one would perhaps expect given the relatively large increase in terms of ground points. This has led us to the conclusion that very dense vegetation obstructs laser beams from reaching all the way to the bare earth. As regards accuracy in documenting geological features, the study showed more significant improvements. The last part of the paper is dedicated to a discussion of the pros and cons of using LiDAR from drones compared to conventional airborne laser scanning from aero planes or helicopters. The main advantages concern flexibility, low flight altitude and small laser footprint as well as the advantages of a far-reaching field of view. The disadvantages are related to price, battery capacity, size of area and especially the requirement of line of sight between the drone operator and the drone, a fact that restricts the efficiency in terms of mapping large areas. Nevertheless, the final conclusion is that LiDAR from drones has the potential to make a substantial improvement to geological remote sensing.
***Keywords*: LiDAR system, laser scanning, mapping, remote sensing**

I. INTRODUCTION

Drones with LiDAR are being flown over certain areas, and resulting maps are being developed to highlight, survey, and monitor grounds where assets such as towers and wind turbines could and have been built.

In areas that are prone to flooding, LIDAR is being used to provide much improved accurate measurements that can help improve risk assessment outcomes and enhances the ability to create more effective emergency planning processes. In areas of the world affected by drought, the vegetation density technology is being used to improve drainage systems that allows water to be used more efficiently.

LIDAR can even go as far as detailing when vegetation appears on the ground and how dense it is, which is a technology previously non-existent and would take countless man-hours to incorporate into planning. However, what really brings LIDAR into the limelight is the level of accuracy it can provide.

In fact, in high-fidelity modes, a LIDAR drone can provide detailed information of 100-500 data points per square meter with an impressive accuracy of 2-3 centimetres. This is previously unfathomable

II.LITERATURE REVIEW

1) *Development of a 3D mapping using 2D/3D Sensors for Mobile Robot Locomotion* ˆ Authors: C. Joachim, H. Roth ˆ Institution: University of Siegen ˆ Conference: International Conference on Green Computing Communication and Electrical Engineering (ICGCCEE), pp. 1-5, IEEE, 2014 ˆ Abstract: This paper presents a simultaneous localization and mapping algorithm (SLAM) by using a new 3D sensor namely the photonic mixer devices (PMD). The PMD camera enables 3D image grabbing within a few milliseconds and gives an important impulse in visual 3D sensing. This camera is capable of capturing reliable depth images directly in real-time. The PMD is also compact and affordable, which makes it attractive for versatile applications including surveillance and computer vision. However, the PMD based device has still limited resolution and provides only grey scale information. To achieve the virtual geometric data, the rather new 3D PMD and 2D RGB colour cameras are combined to generate visually realistic 3D maps. Visual input from the 2D camera not only delivers high resolution texture data but also enables the mobile robot to enhance the 3D data calculated from the range output of the PMD camera. Precision robot locomotion is implemented in order to register the 3D geometric data simultaneously.

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2) *LiDAR Sensor for Autonomous Vehicle* ˆ Authors: Ife Khairul Alam Bhuiyan ˆ Institution Independent University, Bangladesh ˆ Abstract: Automotive Radar and LiDAR sensors represent the key components for next generation driver assistance functions (Jones, 2001). In contrast, LiDAR sensors show large sensitivity towards environmental influences (e.g., snow, fog, dirt). Both sensor technologies today have a rather high-cost level, forbidding their widespread usage on mass markets. Velodyne's vision for its LiDAR technology is simple: to market it wherever sophisticated 3D understanding or visualization of the environment is required. High-definition LiDAR has applications in robotics, map capturing, surveying, autonomous navigation, security, manufacturing and automotive safety systems. Advanced driver assistance systems ADAS, where LiDAR is a key solution, do not only provide a more comfortable driving experience but also able to reduce the severity of accidents or even prevent crashes entirely.
3) *Application of lidar to Atmosphere Pollutant Mapping* ˆ Authors: Rafi Ahmad ˆ Institution: Engineering and Instrumentation, San Diego, CA, United States ˆ Conference Optical Science, Engineering and Instrumentation '97, 1997, San Diego, CA, United States ˆ Abstract: The favoured scheme for the remote monitoring of atmosphere pollutants is based on the differential absorption of radiations by the target species. The sources of these radiations are the Rayleigh or Mie scattering from the distributed atmospheric aerosols at to slightly different wavelengths. This technique is known as deferential absorption lidar (DIAL) and offers the best range capability compared to other remote sensing techniques. However, the DIALs are complex and one system is dedicated to monitor only one species. The accuracy in DIAL measurements are also critically dependent on environment and instrumental parameter. The other promising technique for remote pollution monitoring is the Raman lidar. This is based on the detection of Raman back-scattered signals from the pollutant species and allows detection of several species simultaneously. However, Raman lidars do not allow long range capabilities. The application of lidars for atmosphere pollutant mapping is ultimately tied up with trade-offs between required or desired sensitivity, range capability and the data averaging time. The state-of-the-art of the two most promising lidar technologies, their limitations and recent advances in their applications are reviewed in this paper
4) *3D Indoor Mapping System using 2D LiDAR sensor for Drones* ˆ Authors: M.R. Shahrin, Fazida Hashim ,W Mimi Diyana W Zaki, Aini Hussain, Thinal Raj ˆ Institution: University Kebangsaan Malaysia ˆ Conference: 2nd International Conference on Electronics, Communication and Aerospace Technology (ICECA), pp. 1214-1218, IEEE, 2018 ˆ Abstract Most 3D scanners are heavy, bulky and costly. These are the major factors that make them irrelevant to be attached to a drone for autonomous navigation. With modern technologies, it is possible to design a simple 3D scanner for autonomous navigation. The objective of this study is to design a cost-effective 3D indoor mapping system using a 2D light detection and ranging (LiDAR) sensor for a drone. This simple 3D scanner is realized using a LiDAR sensor together with two servo motors to create the azimuth and elevation axes. An Arduino Uno is used as the interface between the scanner and computer for the real-time communication via serial port. In addition, an open-source Point-Cloud Tool software is used to test and view the 3D scanner data. To study the accuracy and efficiency of the system, the LiDAR sensor data from the scanner is obtained in real-time in point-cloud form. The experimental results proved that the proposed system can perform the 2D and 3D scans with tolerable performance.

III.PROJECT METHODOLOGY

To accomplish the above objectives, we have used the following software and hardware components. Hardware Requirements Ardupilot APM 2.8 Flight Control Board for RC Multi Rotor Drone This is the new APM 2.8 autopilot module. The sensors are exactly the same as with APM2.6, this version is ideal for use with multi-copters and rovers. The APM 2.8 is a complete open source autopilot system and the bestselling technology that on the prestigious 2012 Outback Challenge UAV competition. It allows the user to turn any fixed, rotary wing or multirotor vehicle (even cars and boats) into a fully autonomous vehicle; capable of performing programmed GPS missions with waypoints. Available with top or side connectors. This revision of the board is designed for vehicles (especially multi-copters and rovers) where the compass should be placed as far from power and motor sources as possible to avoid magnetic interference. On fixed wing aircraft it's often easier to mount APM far enough away from the motors and ESCs to avoid magnetic interference. APM 2.8 has an onboard compass so this is designed to be used with the 3DR uBlox GPS with Compass so that the GPS/Compass unit can be mounted further from noise sources than APM itself.

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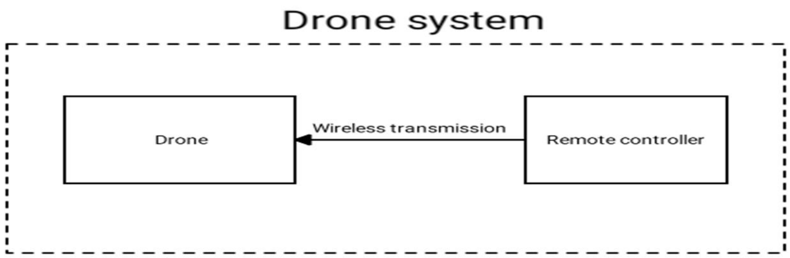

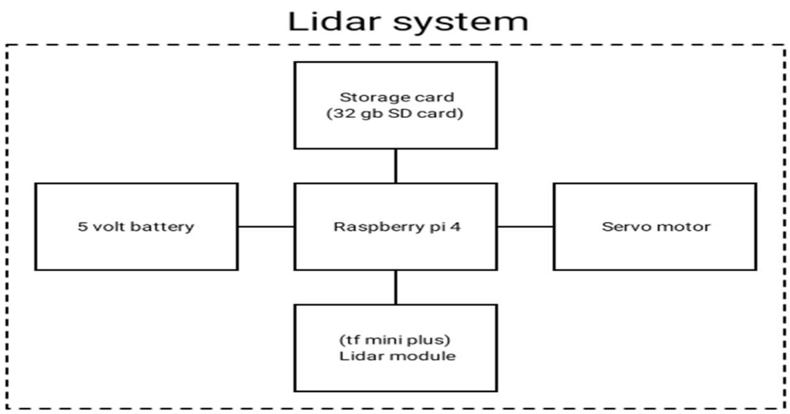

FlySky CT6B 2.4Ghz 6CH Transmitter with FS-R6B Receiver is the popular 6 Channel Radio CT6B manufactured by FlySky.Flysky CT6B 2.4 GHZ 6CH transmitter is an entry-level 2.4 GHz radio system offering the reliability of 2.4 GHz signal technology and a receiver with 6 channels. CT6B 2.4 GHZ 6CH transmitter radio is a value for money, entry-level 6 channel transmitter, ideal for quadcopters and multicopters that require the 6ch operation. This radio has two retract switches and proportional flap dials in easy reach for channels 5 and 6. It can be powered by 8 x AA Size Batteries or a 12V Power Supply. This comes with a trainer port to help beginners learn flying. It can be configured by connecting it to the computer. Use the T6config software to configure your radio on a computer

Easy Electronic Sg90 Servo Motors, Multi-color, Set of 2 The SG90 Servo Motors comes as a set of two motor modules that boasts three pairs of blades which can rotate from 0 degrees to 180 degrees. The connector wire measures 150mm in length which is sufficient to install it on a breadboard. Simply plug in the included arm and gear assortment and start experimenting for your next DIY project

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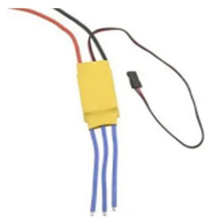
30A Electronic Speed Controller Electronic speed controller (ESC) is a electronic circuit to vary the speed, direction and possible to act as a dynamic brake, of a brushless motor. This particular ESC is recommended with A2212 brushless motor (1000kv, 1400kv,2200kv). Specifications - Weight: 23g, dimensions: 45.0*24.0*9.0mm, current(A): 30- 40, BEC: 3A, PWM: N/A, Li-Po : 2-3, Ni-Mh/Ni-cd : 4-10Ni-Mh, constant current: 30A Max 40A



TFMini-S Micro LiDAR Distance Sensor for Drones UAV UAS Robots (12m) TFmini-S is a single-point ranging LiDAR based on the TFmini upgrade. The blind zone is shortened from 30cm to 10cm, the outdoor performance andaccuracy of different reflectivity are improved. The distance range is not disturbed by ambient light, which can be consistent with the indoor range and the accuracy is further optimized. The error performance at 10% reflectivity approaches the background of 90% reflectivity, and the interface supports UART and I2C switching at any time. It can achieve stable, accuracy, sensitive and high-frequency range detection.

Raspberry Pi the Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing highdefinition video, to making spreadsheets, word-processing, and playing games. What's more, the Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras. Raspberry pi also allows users to store data on board via a Sd card slot

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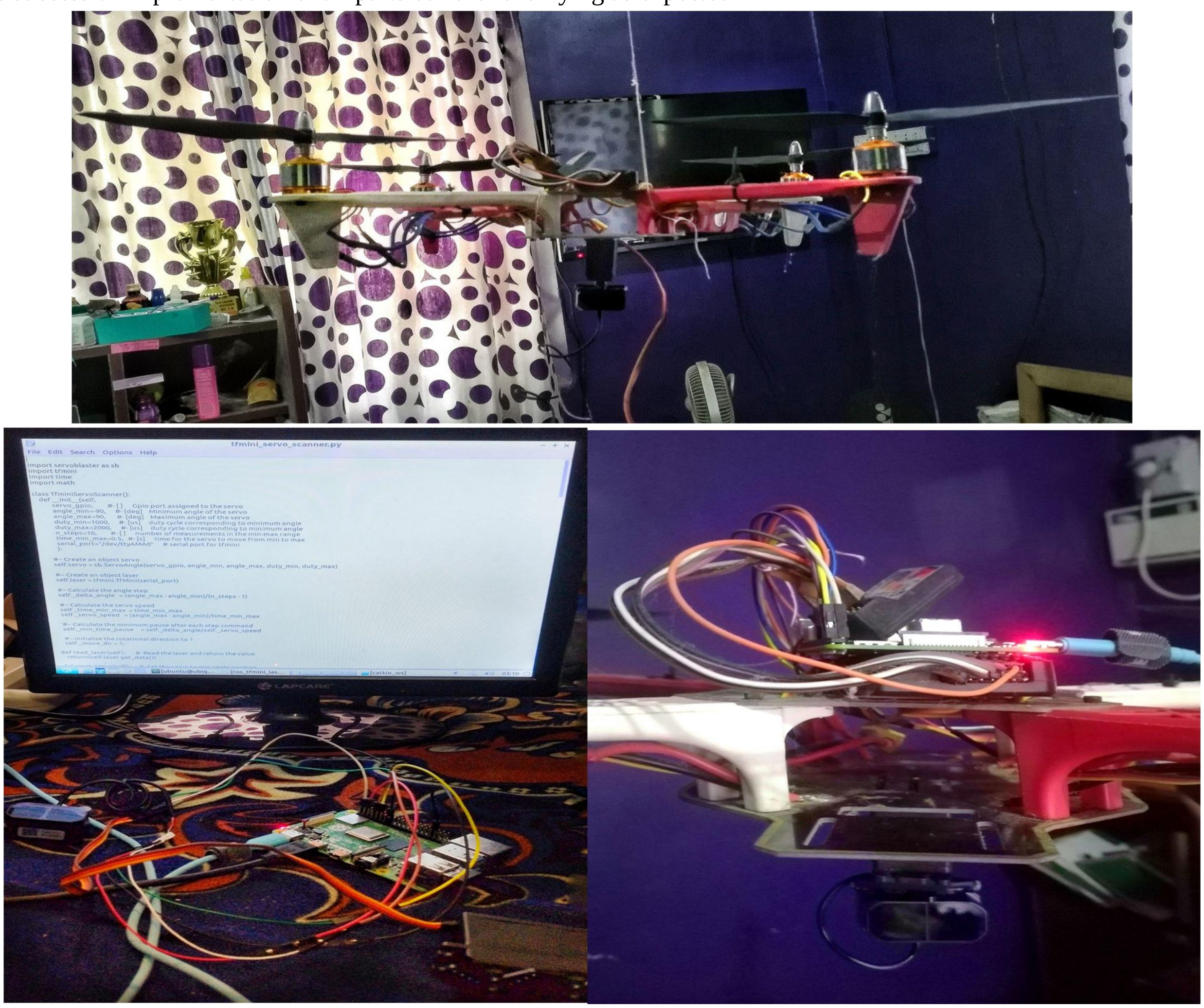
Software Requirements Mission Planner Mission Planner is a free, open-source, community-supported application developed by Michael Oborne for the open-source APM autopilot project. Mission Planner is a ground control station for Plane, Copter and Rover. It is compatible with Windows only. Mission Planner can be used as a configuration utility or as a dynamic control supplement for your autonomous vehicle

Calibration of drone Turn on your transmitter and put the throttle stick at maximum. Connect the Lippo battery. The autopilot's red, blue and yellow LEDs will light up in a cyclical pattern. This means the it's ready to go into ESC calibration mode the next time you plug it in. With the transmitter, throttle stick still high, disconnect and reconnect the battery. For PX4 or Pixhawk, press and hold the safety button until it displays solid red. The autopilot is now in ESC calibration mode. (On an APM you may notice the red and blue LEDs blinking alternatively on and off like a police car). Wait for your ESCs to emit the musical tone, the regular number of beeps indicating your battery's cell count (i.e., 3 for 3S, 4 for 4S) and then an additional two beeps to indicate that the maximum throttle has been captured. Pull the transmitter's throttle stick down to its minimum position. The ESCs should then emit a long tone indicating that the minimum throttle has been captured and the calibration is complete. If the long tone indicating successful calibration was heard, the ESCs are "live" now and if you raise the throttle a bit they should spin. Test that the motors spin by raising the throttle a bit and then lowering it again. Set the throttle to minimum and disconnect the battery to exit ESC-calibration mode.

IV. RESULTS AND DISCUSSION

After the successful implementation of all parts our drone is flying as expected



The Lidar module and servo motor are successfully interfaced with Raspberry-pi and all modules are successfully implemented on drone as shown in above figure and now drone is ready to fly.

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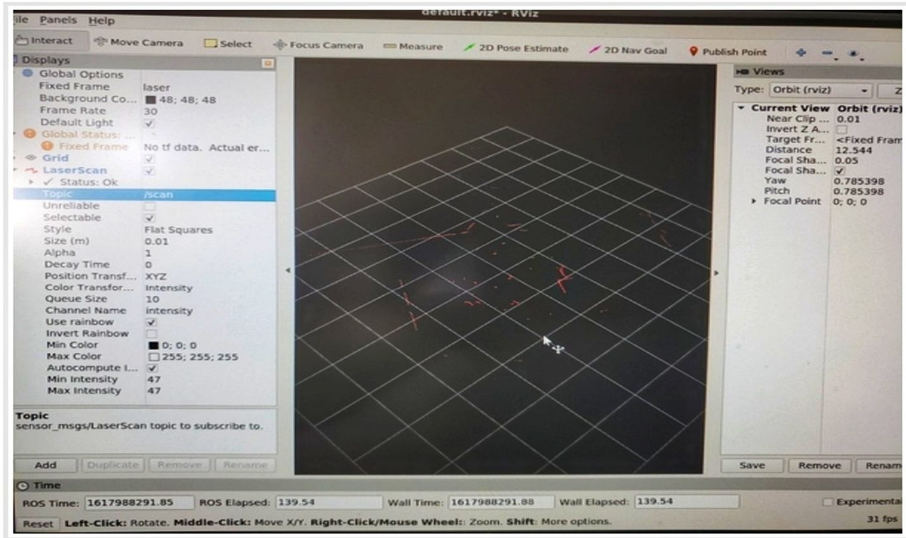

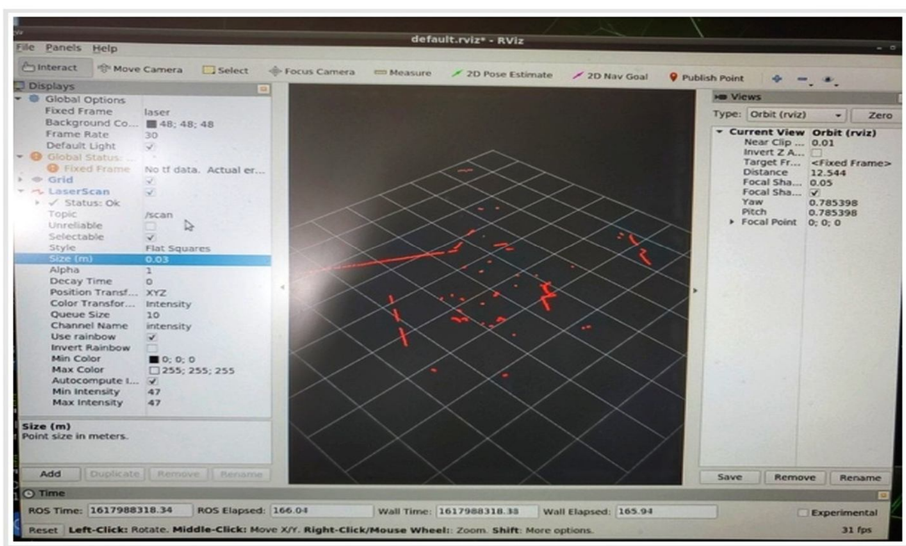

This is the mapping of data obtained from Lidar.

V. ACKNOWLEDGMENT

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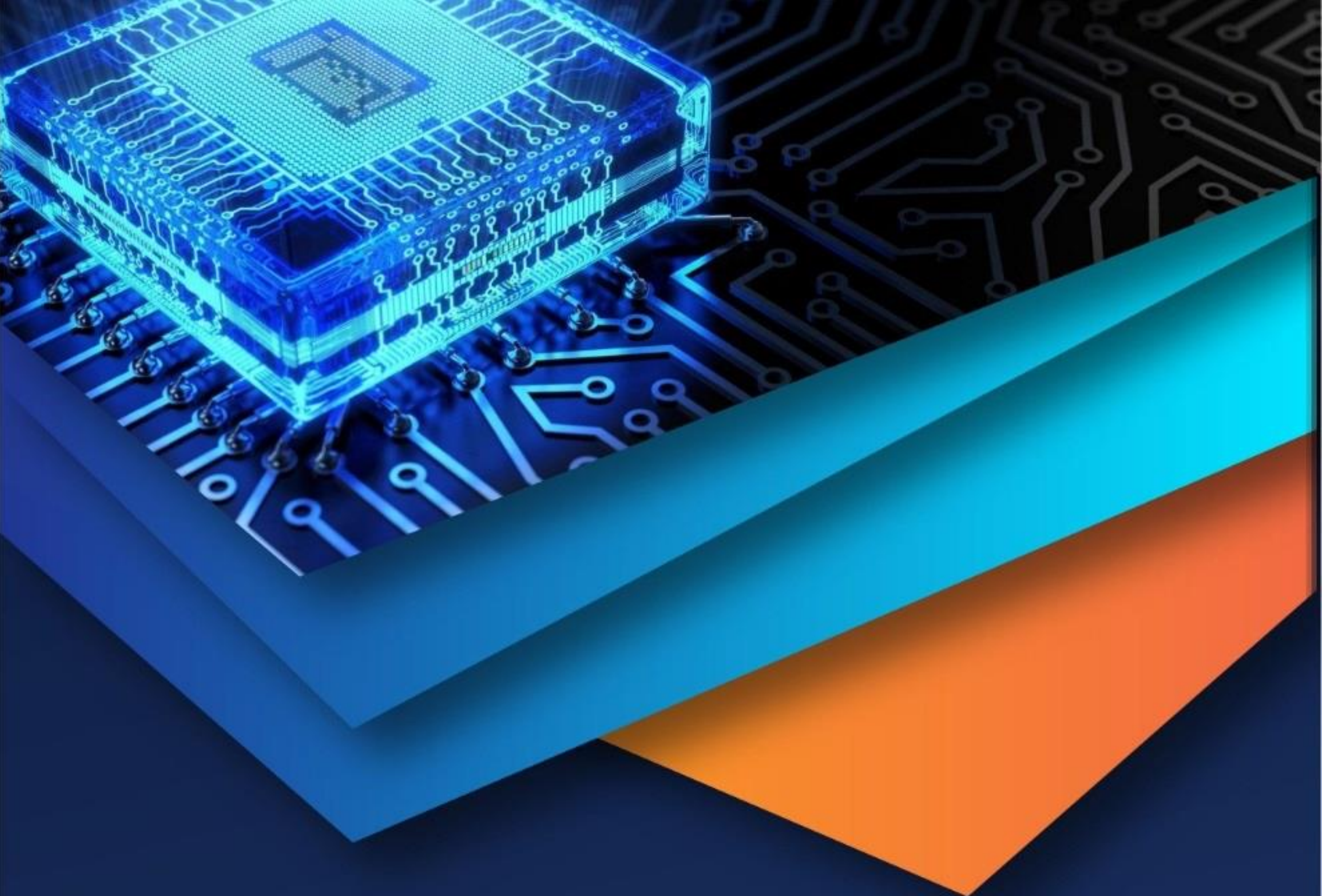

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