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Electronic Gyro Engine Kill Switch

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Abstract: ***This paper proposes a precautious system for situations faced by two-wheelers or four-wheelers vehicle at the time of topple, rollover conditions. This system is in form of an autonomous kill switch which works on gyroscope and accelerometer module (M.P.U. 6050) working on an Microcontroller board and relay which connects kill wire to chassis. At the time of roll over first thing to be done is to kill engine to avoid further causalities, but sometimes it is not possible to kill engine which can lead to further accidents such as in two-wheeler it can harm pillion if present. To prevent such a situation, the autonomous gyro kill setup is invented which can be applied in vehicles such as motorcycle, autonomous/self-driving cars that uses specific algorithms for proper functioning and also generates the maximum output from the device.***
Keywords: Arduino, M.P.U. 6050, Kalman filter, relay, kill switch, vehicle safety, vehicle rollover, gyroscope, acelerometer

I. INTRODUCTION

This paper proposes a conclusion for a problem faced by two-wheeler, four-wheeler or an off-roading vehicle whenever they encounter a rollover and engine remains working/active state. Many insurance companies recommend to cut-off the engine's operation, if the engine is inverted, the oil pick up for the oil pump would immediately start sucking air instead of oil and within a few minutes the rod and main bearings would overheat causing either engine seizure and increases the risk of explosion. All these sudden actions disturb the stroke cycle resulting in destroying the engine [14]. In the case of 2-wheeler, after the accident occurs the throttle can be pulled unintentionally while lifting up the vehicle while the engine is running or the throttle can be stuck which can cause skidding of vehicle on its position and in dragging the driver and pillion along and might lead to severe injuries to both the vehicle and driver. To prevent these situations, the electronic solution is been proposed that can be used to avoid these kinds of causalities which makes decisions more rapidly and more precisely and can be installed in a very compact space and kill the engine.

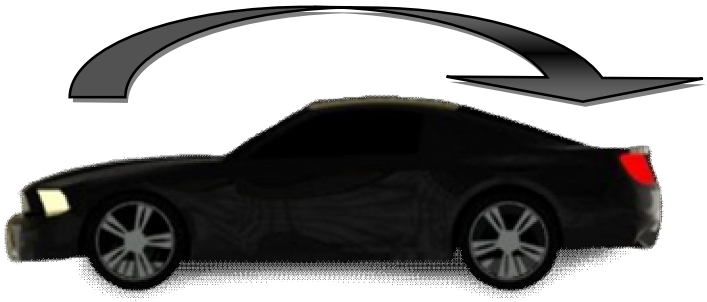

Fig. 1: Pitching of Vehicle

Fig. 2: Rolling of vehicle

To define a motion of a body in space, three planes are required which are pitch, roll, and yaw. In this system, for the operation of the device only two planes are needed which are pitch and roll. Pitching is a case where the nose of the vehicle either moves vertically up or down, this mostly takes place during sudden braking. Rolling occurs when the vehicle rolls horizontally, which usually occurs while taking a turn at high speed. Yaw plane has been neglected in this system because it is the axis at which the vehicle turns either left or right.[17]

II. WORKING

The system works by comparing the current angle with reference angle and detecting the difference between them usually vehicle topples near 46 degrees or more and at -46 degrees or less. However, it can be used to warn drivers at different angle degrees and notify them. This solely depends on design of the vehicle as when the C.O.G. of a vehicle comes out of chassis and contributes its mass to make rollover possible.

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Therefore, if roll or pitch angle exceeds 46 degrees or is less than -46, then a rollover should be detected [3] and if the difference between the current angle and the calibrated angle is greater than 46 degrees or the defined angle [16] then the system will check those for 3 sec or given equivalent time that will be used to check whether the situation is under drivers control or not and if not it will pass a signal to relay that will turn N.O. (normally open) of relay to close. This will connect the kill wire to chassis and the engine will get killed.

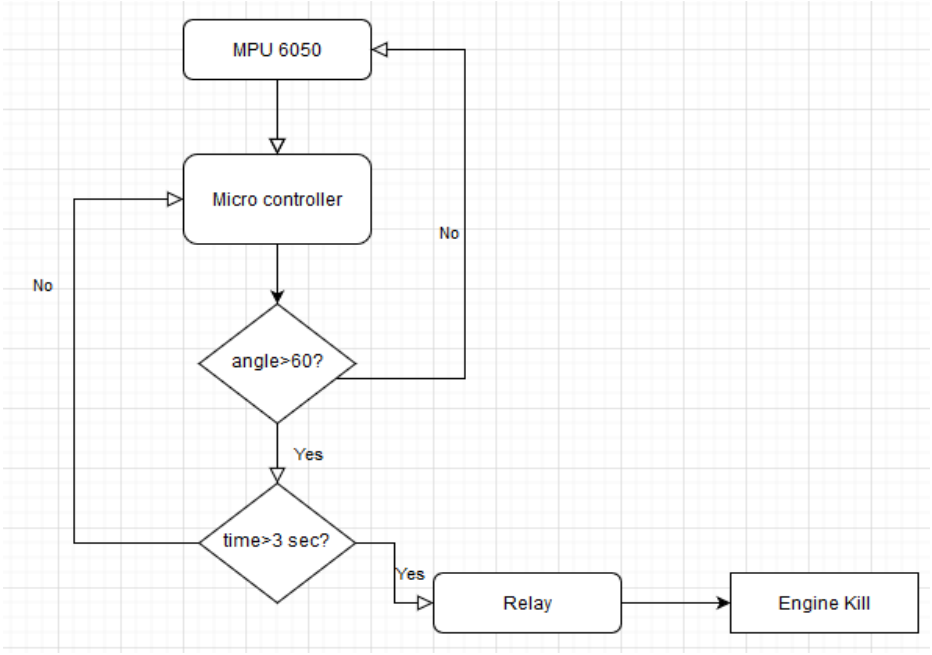

Fig. 3: Project flow Chart

Table 1. Components Required

Software	Arduino 1.6.5
Development Board	Arduino UNO
Processor	Atmel ATMega328 P
Power Supply	12V direct from battery
Gyro	MPU6050
Relay	7A Solid State Relay

III.DESCRIPTION OF SUB-COMPONENTS USED

A. Arduino UNO

Arduino is an open-source hardware and software company, project, and user community that designs and fabricates a range of single-board microcontrollers and microcontroller kits for basic robotics enthusiasts. Arduino boards can read inputs and turn those into an output. Arduino IDE (Integrated Development Environment) is used to upload programs to the Arduino boards and these microcontroller boards can be used to perform intended tasks. Arduino uses Atmel Atmega 328P which is a powerful microcontroller in use that provides a highly flexible and cost-effective solution to many embedded control applications. [12][13]

B. MPU 6050

The MPU0650 sensor is the board that has an accelerometer and gyroscope sensor fusion in it. It interprets motion in 3 planes those are Roll, Pitch, and Yaw. The accelerometer records the acceleration and the tilt angle of the vehicle. The data is processed to acceleration and rotational motion using the formulae to analog readings in m/s2 and rad/sec respectively. Planes here are in Cartesian XY-plane and YZ-plane as the vehicle if tilted in XZ-plane is either drift or yaw provided intentionally and if we convert it to axis it is required to work upon X-axis and Z-axis to solve the problem. It is an inertial unit that works on I2C communication pins and by utilizing an appropriate algorithm and its calculations and changing the output as desired. The desired outcome can be attained.

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C. Relay

The relay is a switch that works on the principle of electromagnetic induction. Switching between the on and off position is done with the help of an electromagnet. A relay can be operated with a small amount of power and can be used to control devices that draw too much power such as circuit breakers and isolators. Since the spark plug in a vehicle requires about 14000V at about 0.03 A, which comes to around 42 watts, though the coil used to control the relay needs only a few watts to pull the contacts. May be required. A relay is like a remote-control switch and has many applications due to its long life, high accuracy, relative simplicity, and proven high reliability. These are very useful when it is required to control a large amount of voltage or current with the use of a small electrical signal [16].

D. I2C

I2C (Inter-Integrated Circuit) is a multi-controller serial data bus used to connect low-speed peripheral units to an embedded system. I2C communication protocol decreases the number of both pin and wire on PCB cards by providing two cable connections, which are serial data (SDA) and serial clock (SCL), between devices and microcontrollers. In this project, the communication between MPU6050 and the Arduino is provided with the I2C protocol. Table 2 shows the connection pins between the sensor and the Arduino [12].

Table 2. Arduino UNO and MPU6050 connection

S.No.	Arduino UNO	MPU6050
1	3.3V	VCC
2	GND	GND
3	Analog A4/SCL	SCL
4	Analog A5//SDA	SDA
5	Digital 2	INT

IV. FILTER SELECTION

Filter is an algorithm used to reduce the error which is induced in the system due to the forces that are present such as inertial forces. This small force disturbs the measurement and these forces are on accelerometer therefore it is required to apply a low pass filter for corrected value. There are 2 types of filters commonly used along the complementary filter and Kalman filter. Complementary filter is used when a long time integral is needed. It consists of both high pass filter and a low pass filter with a total gain of 1. This is useful in high-frequency noise and can give good results in that situation. Whereas Kalman filter works on the prediction of value based on the past value as it compares the current value with the previous value and based on its error it guesses the upcoming value and this is a very good model for the object continuously changing its values. [6][18][19]

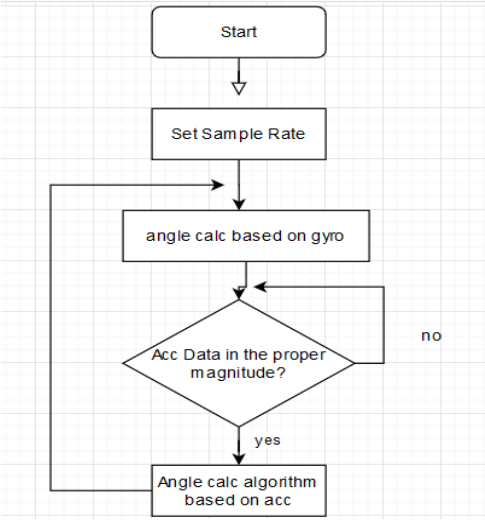

Fig. 4: Complementary filter

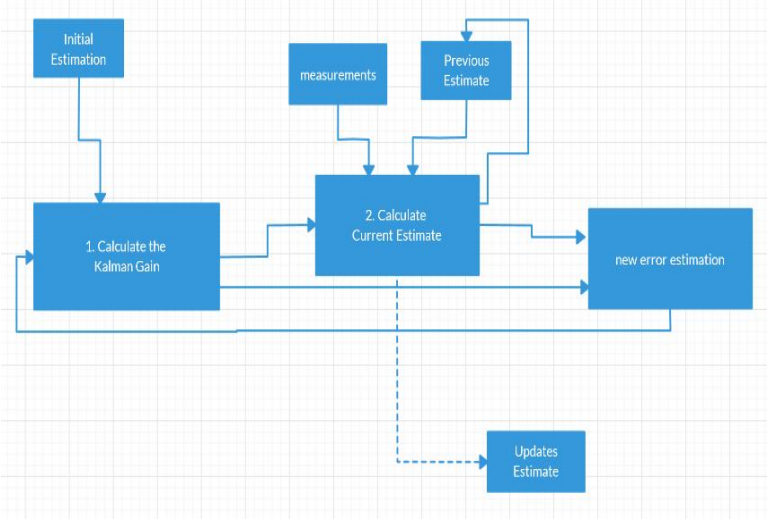

Fig. 5: Kalman Filter

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V. IMPLEMENTATION SPECIFICATION

First task was to create a circuit with all these components and working principle to fulfill our required task which was done as per these schematics

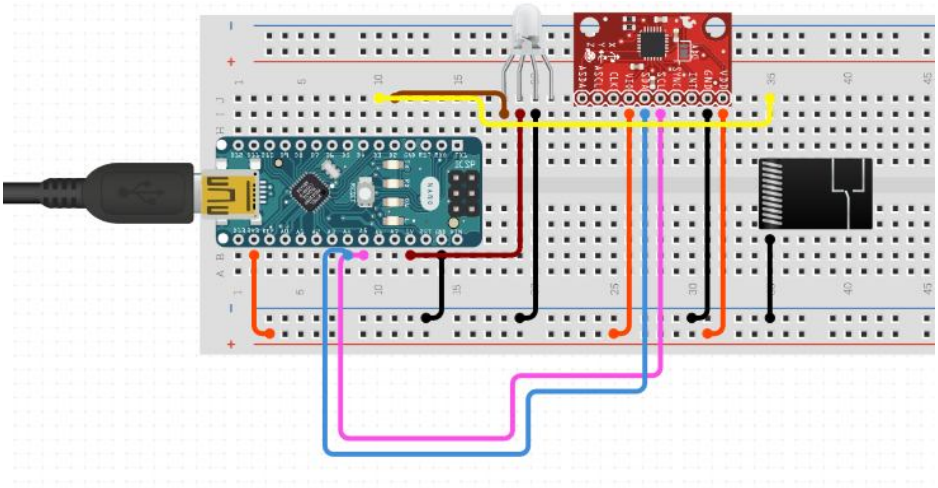

Fig. 6: Circuit Diagram of the device

The initial basic sketch was developed with raw filters and calculated the angle. While iterating with those combination the high angle fluctuation was marked due to vibration which resulted in the change of 30-40 degrees to eliminate that variation in a vibration-proof casing. After attaining good casing next target was to construct an algorithm which will be used to give reference or calibration values to the microcontroller within 5 sec of power supply as it was not feasible to work on basic angles as when we fix the sensor in casing it not always in a fixed orientation and due to which we had to plan an algorithm for reference setting or calibration.[6]

Code:

```
if(x>360)          if(y>360)          if(z>360)
x=x-360;           y=y-360;           z=z-360;
if(x<0)            if(y<0)            if(z<0)
x=x+360;           y=y+360;           z=z+360;
```

```
if(time<4)
      {a=a+x; b=b+y; c=c+z;
      delay(1);h++;}

     d=a/h; e=b/h; f=c/h;
```

After this next target was to notice whether the vehicle is hung in the condition or is dynamic and can move back to its original orientation for this time period of 3 sec was taken, as this time period was enough time to check the movement. Originally, the code has delay function but after certain iterations it was concluded that the system needed to be worked upon counter basis instead of a time basis for which another algorithm was created to check the value continuously for a repeated period of time.

Code:

```
if((x>70&&x<280)||(y>70&&y<280))
   {j++;}
    if((x<70||x>280)||(y<70||y>280))
      {j=0;}
    if(j>1000){
      {Serial.print("KILL");}
```

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After this, the static value is obtained which is almost similar to the expected value but while working in dynamic testing the obtained drift angle due to which accelerometer has to be used and then the code was changed to Kalman filters which optically estimates the statistical noise and other inaccuracies and produces an estimate of unknown variables that tends to be more accurate and noticed no drift changes there [18][6]. The complementary filter can also be used there, as it will also generate very close result but in this case, Kalman Filter gave better results

The first fair testing was performed on Bajaj discover 125cc and then the results that were obtained are as follows:

Fig. 7: Prototype Installed in a Two-wheeler

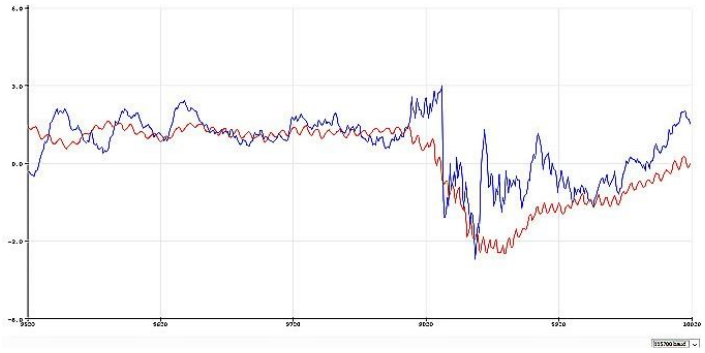

Fig. 8: Output Graph when engine is turned on

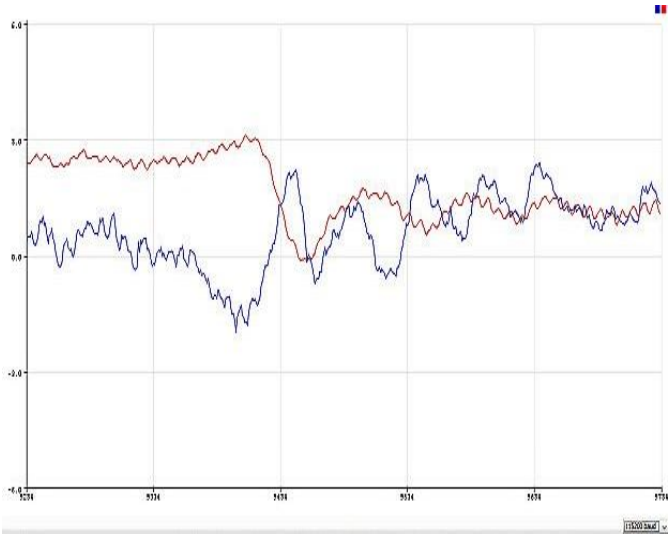

Fig. 9: Output Graph when Vehicle is Moving

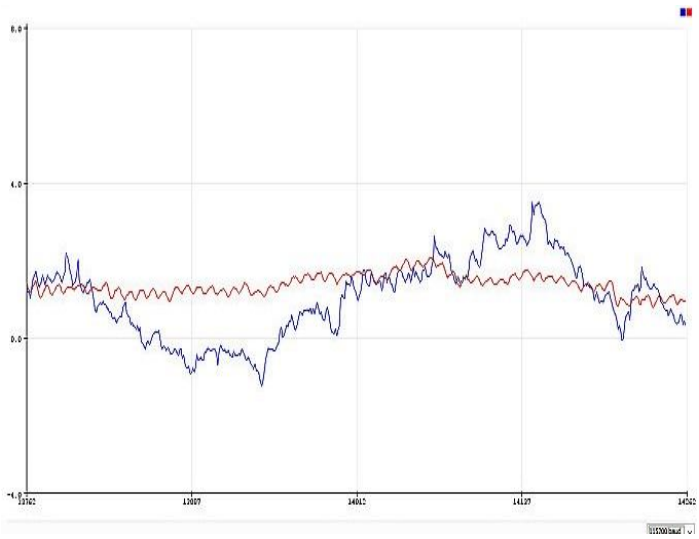

Fig. 10: Output Graph when engine is turned off

After obtaining these test results, the conclusion was made that these filters and algorithms can be used to obtain acceptable deflection of vibrations in 2-3 degrees and after calibration and vibration behaviour were tuned on a BAJA ATV off-road vehicle the results were more improved and have more accuracy. This process was repeated for many days that helped in making more precise algorithm for the final testing.

VI. CONCLUSION

In this paper, the conclusion was made that, the proposed system will help in detecting the rollover of the vehicle and complete the process of killing of the engine's working to avoid casualties. The system consists of three phases (1) Data Acquisition (2) Data Filtration and Analysis (3) Kill Switch working on the bases of the analysis. The hardware and algorithm have been designed to implement the intended functionality of the proposed system. The test result presents the promising results when the device is tested

VII. ACKNOWLEDGMENT

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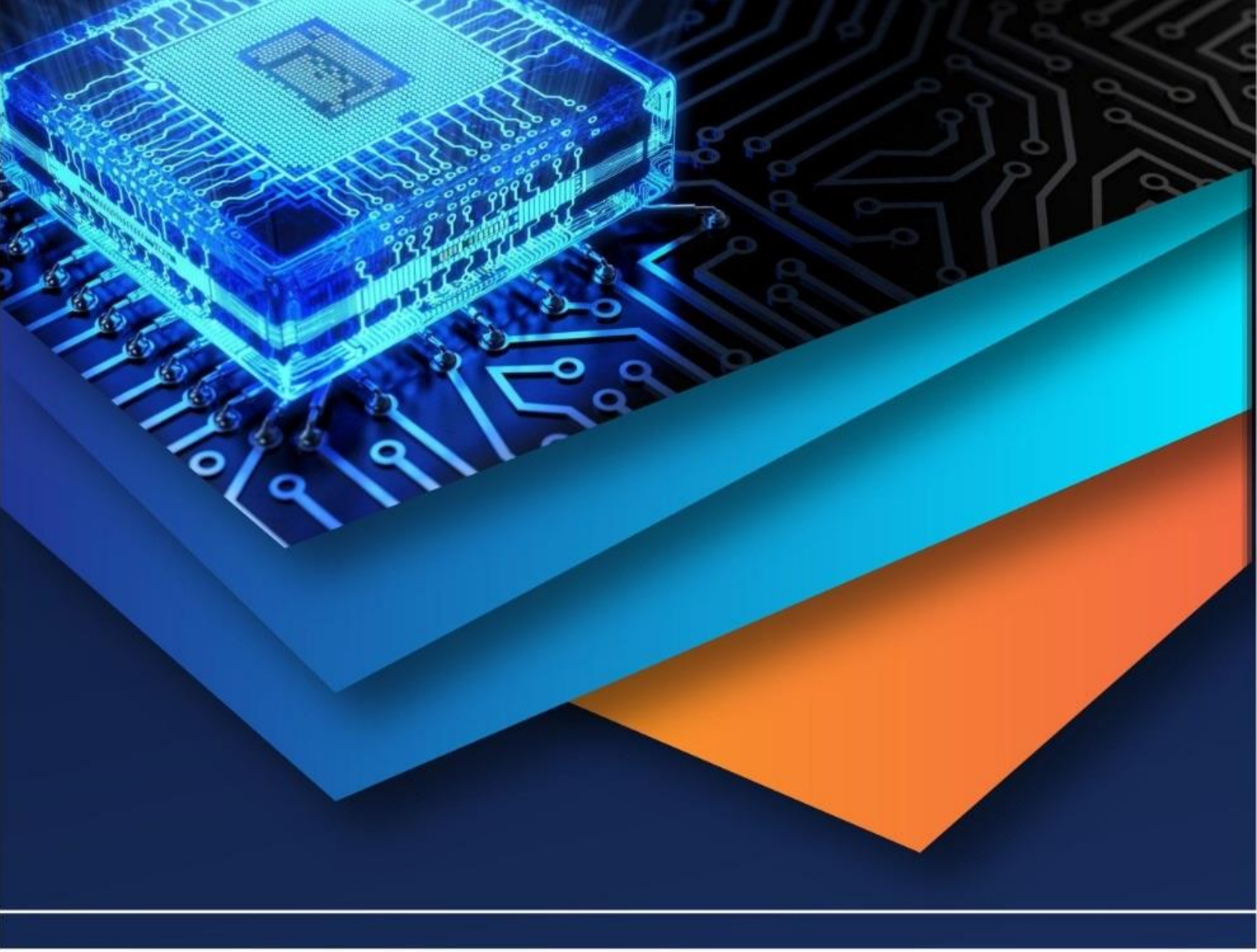

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