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Integrated Vehicle Monitoring System

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Abstract: ***Integrated vehicle monitoring system uses the Radio Frequency Identification(RFID) tag, GPS and GMS modules to emerge as a convincing solution to the vehicle security system as well as automatic toll collection method employed at tollgates. To overcome the concerns regarding the security of the vehicle and congestion caused at tollgates, the system helps efficiently using Internet of Things. RFID reader fixed at tollgates detects the RFID tag attached to the incoming vehicle and toll deduction takes place through a prepaid card assigned to the particular RFID tag that belongs to the vehicle's owner. Accident and alcohol detection have been incorporated into the system for safer human driving. The whole system is developed providing multiple functionalities using limited hardware components so that the journey becomes easy and safe.***
Keywords: Radio Frequency Identification(RFID) Tag, Prepaid card, GPS and GSM modules, vehicle security, toll gates .

I. INTRODUCTION

In the present scenario, road transportation of goods and personnel is prominent. The main idea of Integrated Vehicle Monitoring System(IVMS) is for safer human driving and comfortable payment of toll tax on highways. The system is incorporated with Automatic toll tax system, Vehicle tracking system, Accident Detection system and Alcohol detection system. The execution of the system is simple as it makes use of

A. RFID technology for identifying the vehicle uniquely.
B. GPS and GSM module for location tracking.
C. Arduino microcontroller for processing and transmitting the information.

Transportation has become the basic need in the society ;indirectly increasing the vehicle density on highways. In the Automatic toll tax system, the toll tax is automatically deducted from the vehicle owner's prepaid card whenever a vehicle approaches the toll booth using RFID technology. The main idea of this system is to reduce the time and need for carrying exact cash to pay at toll booths. Vehicle tracking system is common system incorporated , where we can track the location of the vehicle using GPS and GSM modules.

Increase in number of vehicles also leads to high chances of accidents. Accident detection system is used to detect the accident of the moving vehicle and report it to the registered mobile numbers. This triggers immediate attention ,the location of the vehicle can be tracked and can be moved to hospitals for immediate care. This system is implemented to make sure more number of lives are saved without any delay in reaching the accident site.

The rate of drinking and driving accident cases have increased significantly and are likely to emerge as one of the most significant problems in the future. To overcome the dangers of driving when a person has consumed alcohol , alcohol detection system is incorporated into the IVMS. The sensor senses the alcohol beyond threshold and controls the engine of the vehicle by ensuring the safety of the passengers.

II. LITERATURE SURVEY

A. Khaliq, K. A., Qayyum in 2017 proposed the prototype designed for an automatic accident detection using Vehicular Adhoc Network(VANET) and Internet of Things(IoT) . This application will be able to detect accident and severity of the emergency level with the help of mechanical and medical sensors deployed in the vehicle[1] .

B. Sathe Pooja in 2013 developed a vehicle tracking system which focuses on the modification of the common car alarm system by employing GPS, GSM and SMS to avoid car thefts. The practical model of this paper proved to be very efficient, cheaper, and a reliable system for security[2].

C. B. Hari Kumar in 2016 introduced a Vehicle Monitoring and Tracking System using GPS and GSM Technologies focusing on vehicle security. The security of a vehicle is provided by tracking its location using GPS and transferring of the information to the owner's mobile using GSM if the vehicle is subjected to theft. It also has the special feature of automatically slowing down of the vehicle speed as soon as the locations detected by GPS are schools, hospitals[3].

D. Aung Myint Win in 2014 used an RFID Based Automated Toll Plaza System to transform manual transaction to automated toll collection with the help of RFID technology. This paper suggests to use the passive tags as they are better than the active tags because of low cost, low power consumption and also radio signals environmental factors[4].

E. Pratiksha Bhuta in 2015 introduced an Alcohol Detection and Vehicle Controlling system which aims at reducing the road accidents in the near future due to drunken driving. The system detects the presence of alcohol in the vehicle and immediately locks the engine of the vehicle. It has a high affectability to liquor and little affectability to Benzene[5].

F. Desai M in 2017 described a system which can monitor or track the location and vehicle parameter of different test vehicles from a centralized place for research and development purposes. This system is designed mainly to help the Development team of an automobile company which helps them to make required changes in vehicle or components depending on observations and results of the test vehicle[6].

G. Stanley Uzairue in 2018 introduced an IoT-Enabled Alcohol Detection System for Road Transportation Safety in Smart City to reduce road accidents related to drunk..The system is divided into sections; the interlock section and the monitoring section. The interlock section is made up of the MQ-3 Sensor (alcohol sensor) which senses the alcohol molecules in the air breathe of the driver, an ATMEGA 328P microcontroller, a buzzer, an LCD screen, LED, Wireless Fidelity (Wi-Fi) modem, DC motor, Global Positioning System (GPS) and a push button as the ignition key. The monitoring system is a webpage built to view the BAC concentration levels of the driver as well as the coordinates of the vehicle[7].

H. Nasr, e. In 2016 introduced an IoT approach to vehicle accident detection reporting and navigation, conveys a system solution which instantly notifies the Public Safety Organizations (PSO) headquarter whenever an accident takes place and pinpoints its geographic coordinates on the map. This system is highly advantage as the information about the number of passengers and their medical health data is available readily , this reduces time taken by the medical care centers to determine the person's health details[8].

III. PROPOSED SYSTEM

Integrated Vehicle Monitoring System involves integration of the existing modules with the automation of toll gate payment by reading the RFID tag present on the vehicle. This system sends notification to the user whenever an accident, theft or vehicle passing through the toll gate is detected. This system is proposed to provide a cost-effective monitoring of the vehicle with the modern needs of the user.

This system deals with the simplification of procedure followed by passengers to pay toll at toll collection booths, like making it automated, vehicle theft detection, alcohol detection etc. All these activities are carried out using single smart card (RFID tag), thus saving the efforts of carrying money and records manually.

1) *Automatic Toll Tax System*: The RFID Readers mounted at toll booth will read the prepaid RFID tags fixed on vehicles' windshield and automatically respective amount will be deducted. If the tag is removed from the windshield then cameras fixed at two sites at toll plaza take snaps of the front and back number plate. Since every vehicle registration ID is linked to the users account, toll can be deducted from the account bank directly.
2) *Vehicle Tracking System*: When the vehicle is stolen, the owner registers a complaint on the website with its registration ID and unique RFID tag number. Now when the stolen vehicle passes by the toll plaza, the tag fixed on it is matched with the stolen vehicle's tag in the database at the toll booth.
3) *Alcohol Detection System*: An alcohol sensor is used in this system which measures the alcohol percentage and generates an alarm once the measured alcohol percentage crosses the set threshold value. At this, engine locking is done and an SMS is sent to the registered mobile number with the location of the vehicle.
4) *Accident Detection System*: When the accident occurs, the accelerometer senses the acceleration and sends a signal to the Arduino. This system notifies to the nearest medical centers and registered mobile numbers about the place of accident using GSM and GPS modules.

IV. INTERFACES

1) *Micro Controller Unit(MCU):*One of the most popular and generally used microcontrollers is ATMEGA328. A microcontroller is a circuit board which has a chip on it, can be programmed to do many things such as reading data from the sensors, actuators etc., Arduino Uno board is manufactured by an ITALY company by the name Arduino. The largest chip of the Arduino board is ATMEGA328, which is a 8 bit AVR RISC based controller with 32KB flash memory, 2KB SRAM. This controller operates at a voltage of 5v and with clock frequency of 16MHz.

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Fig.1 Arduino Board.

It contains ICSP (In Circuit Serial Programmer) connector which is used to connect an external hardware devices. The unique thing about the Arduino board is it has the preloaded software known as boot loader program that allows to use more simple programming language to program the modules. It has a poly fuse which is used to protect the UART ports from over current or shorts.

2) *GSM MODULE:* GSM (Global System for Mobile Communication) is a communication module which was developed at bell laboratories in 1970. It is a digital cellular technology which was used for providing data and voice oriented services by using time division multiple access technique for communication purpose. It has a capacity to carry 64kbps to 120Mbps of data rates. GSM modem is a device which can be either a mobile phone or any modem which is used for communication between two different devices over any network. It works with a frequency of 1800 KHz and operating voltage is 5v. After initializing the GSM modem some attenuation commands are used to set the modem into text mode and for storing the messages. It will allow communication from anywhere, anytime and with anyone.
3) *GPS MODULE:* GPS (Global positioning system) was developed by the United States development of defense. This is used for tracking the geographical locations of any object. The GPS modem generates the signals from the satellites and converts them into the digital signals and sends them to the GPS receiver. Many satellites are placed around the point in different directions. To find the location of the object three different satellites are considered to find the position in three dimensions – east, north and altitude by calculating the distance from each satellite. The distance is calculated by finding the difference between the time at which signal transmitted and the time at which signal received. The calculated longitudinal and latitude values are then sent to the microcontroller to display it on the LCD.
4) *RFID Technology:* RFID (Radio Frequency Identification) is used to uniquely identify a vehicle depending upon the index number. It consists of two parts one is RFID tags and the other is RFID receiver. RFID tags are made up of magnetic material which is used to sense the signals. Generally barcodes identify the objects with line of sight butt RFID identifies the objects without line-of sight. RFID Reader is placed near the toll gates and tags are given to the owner, generally they are affixed on the vehicle's windscreen. The automobile owner's information is stored in the tags and as soon as it reaches the range of the reader , it gets induced and sends the information . The toll tax can be deducted from the prepaid account associated with the tag.

Fig 2. RFID Technology

There are two types of RFID. They are active RFID and passive RFID. Depending upon the application and distance to be covered those are selected. Generally for shorter distances passive RFID is selected which is less expensive and for longer distances active RFID is chosen which is a bit expensive.

5) *MQ3 Sensor*: MQ3 alcohol gas sensor is made by using SnO_2 material which has less conductivity in clean air. Whenever it comes nearby to alcohol gas it starts conducting highly according to the gas concentration. So user can sense the difference of output voltage using any microcontroller and can detect the presence of the alcohol.

Fig 3. MQ3 Sensor

V. METHODOLOGY

Integrated Vehicle Monitoring System is implemented using different modules such as vehicle tracking system, automatic toll tax system , accident detection system and alcohol detection system.

1) *Vehicle Tracking System*: Vehicle Tracking System is use to track the vehicle and send the exact location using GPS and GSM modules. GPS module is protected by using RFID technology. When the vehicle is driven by an unauthorized user by using the ignition key, the location of the vehicle is sent to the owner who can control the vehicle by using a mobile application.
2) *Automatic Toll Tax System:* This module is the special feature of whole system and is implemented using the RFID technology which is a fast and efficient way of toll tax collection. The electronic toll lines are set up with the antennas to detect the vehicles that travel by them by continuously sending out signals. To use this system, user needs to set up RFID tag and account corresponding to it. RFID tags can also be called as electronic transponders.

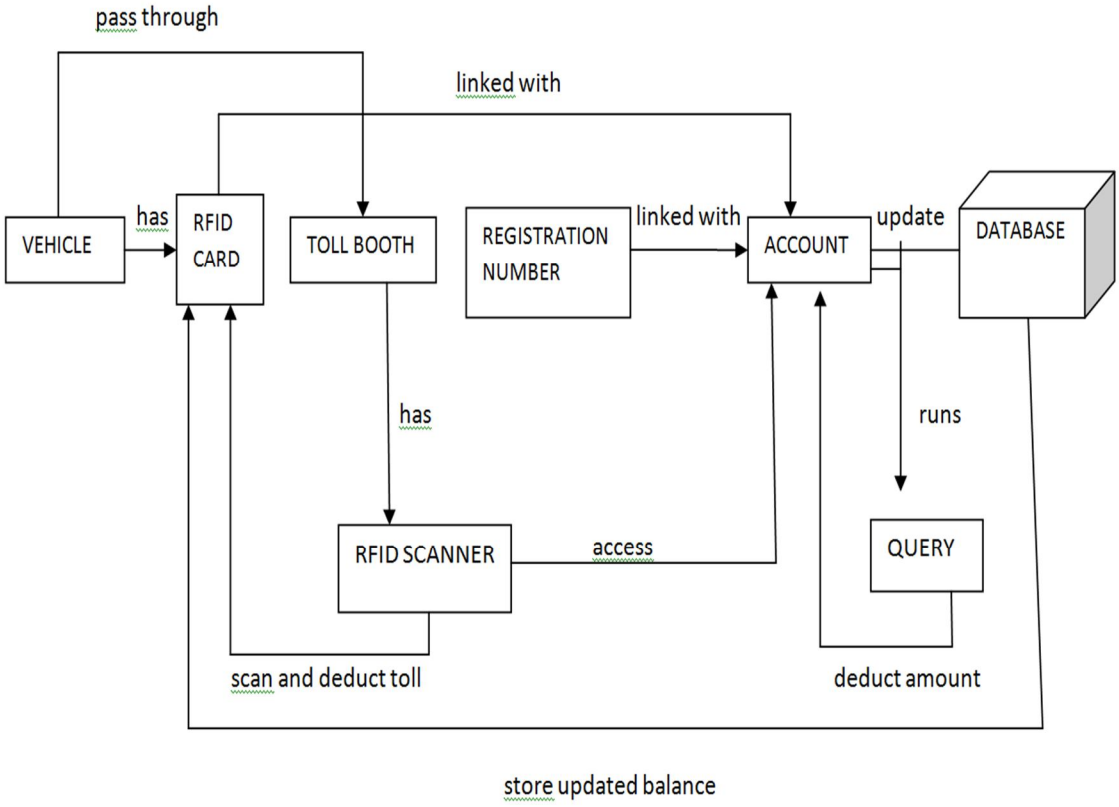

Fig 4. System Architecture of Automatic Toll Collection System.

The tags are generally installed on the windshields of the vehicle. The tag contains all the information regarding the vehicle and user's prepaid account. The antenna continuously sends out radiofrequency pulse, which returns only when it hits a transponder. These pulses are returned and received by the antenna. These microwaves reflected from the tags contains all the required information, once retrieved the required amount is deducted from the user's account. The flowchart of the automatic toll tax collection system is as shown in below fig.

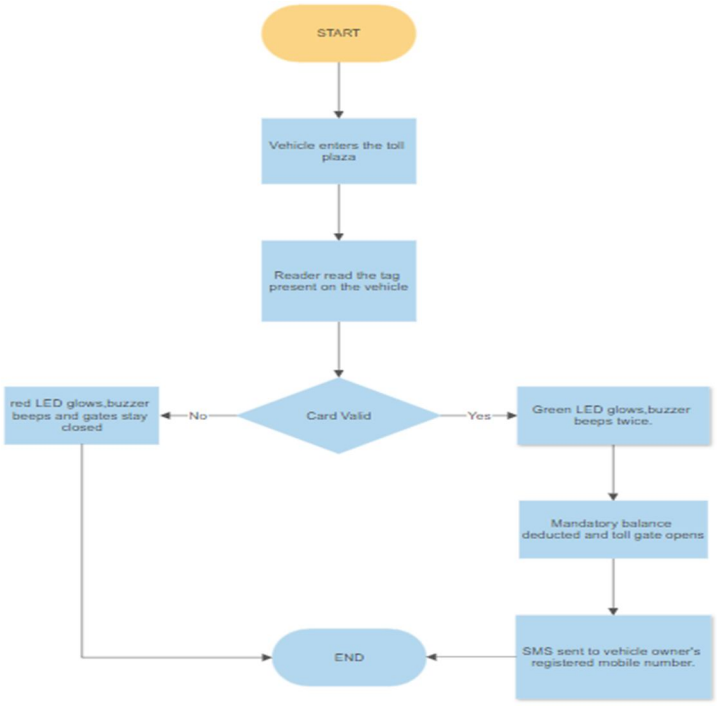

Fig 5 .Working of RFID based Toll Collection

Working of Toll Tax Automation System is as follows:

a) When a vehicle approaches the toll booth ,the reader installed near the toll reads the RFID tag embedded on the vehicle.
b) Then the reader passes the information to the MCU for processing the tag information and verifies whether the card exists or not.
c) If the card is valid , owner's name will be displayed upon the screen and the required amount is deducted from the specific user's account.
d) After this , a command is sent to the motor to open the gates of the toll for the vehicle to pass through it.
e) If the user details are invalid , the red LED will glow and no command is sent to the motor.
f) In the later case , the vehicle can be diverted towards the manual payment booth.

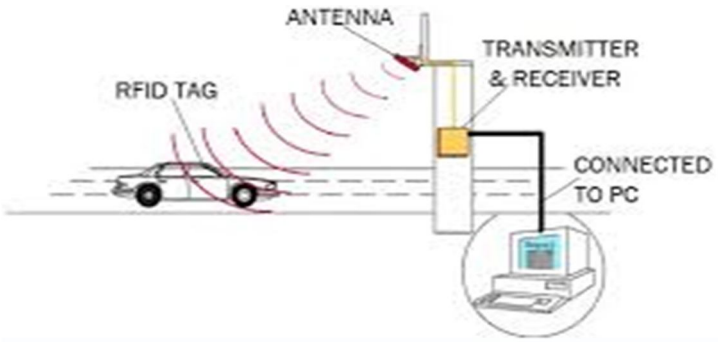

Fig 6.Implementation of RFID based toll collection system

3) *Alcohol Detection System:* This module is implemented using an alcohol sensor which acts as a breath analyzer. Whenever the alcohol percentage exceeds the threshold value, the system sends an SMS to the registered mobile number. The SMS contains the location of the vehicle and it also stops the vehicle engine.

Calculations for Alcohol Level:

a) According to MQ3 datasheet, alcohol in clean air is 0.04 mg/L.
b) The output voltage of MQ3 sensor gives 0.60 v in the clean air then alcohol will be 0.04 mg/L.
c) Now we can find a multiplier by dividing alcohol by output voltage in clean air and we get:
d) Multiplier = 0.40/0.60 = 0.67
e) Now we have a formula for calculating alcohol:
f) Alcohol = 0.67 * v
g) Where v is the output voltage of alcohol sensor.
h) We have set a threshold of alcohol while driving = 0.80 mg/L.

After reading the voltage value from sensor, when the threshold of alcohol exceeds o.8 mg/L , the buzzer and led are on indicating the high levels of alcohol and the engine is set OFF, to ensure the safety of the drive. Whenever, the alcohol is normal the buzzer and led are off, the vehicle's motor is in ON state.

4) *Accident Detection System:* Whenever an accident is detected by the accelerometer sensor , it will transfer the information regarding the vehicle's position to the registered mobile numbers and emergency health care centers to report an accident. The information is transferred through GSM module and GPS module helps in finding the location of accident spot.

VI. CONCLUSION

Integrated Vehicle Monitoring System is mainly based on GPS, GSM and RFID technologies. Multiple and effective functionalities with the limited number of hardware components is an added advantage. The automated toll tax system is an innovative method to reduce congestion at toll gates to a great extent. It has characteristics of low cost, high efficiency and high security. Automatic toll tax system is an effective measure to reduce the management costs and fees, at the same time reduces the fuel consumption and pollution.

Table 1 Performance Analysis

Parameters/Papers	Elie Nasr	Kishwer Abdul Khaliq	Rafiya Hussain	Apoorva Phaniraj	Anitha Chepuru
Technology Used	IoT device containing NFC reader,GPS, Cellular Iot and Shock sensor	VANET and Iot	IoT using RFID technology	IoT device containing GPS GSM and IoT cloud	IoT device containing Arduino, GPS, GSM,Vibration and Alcohol sensors
Cost Effective	No	No	Yes	Yes	Yes
Flexible	Yes	Yes	Yes	Yes	Yes
User-Friendly	Yes	Yes	Yes	Yes	Yes
Security	Yes	Yes	Yes	No	Yes
Design Complexity	High	High	Moderate	Moderate	Moderate
Toll Tax Collection using RFID	No	No	No	No	Yes

Performance Analysis of various systems has been done. Here, various systems are compared using different parameters. Though they have variant application features, there are some barriers like cost and complexity of the system. Our system uses RFID technology for automatic tax payment within the limited budget , which makes our system unique. The system is robust and provides multiple functions with limited hardware components .

VII. FUTURE SCOPE

A. We can deploy RFID readers and speed calculators at small distances on the highways , police can easily catch vehicle exceeding speed limit by getting the vehicle details captured through vehicle's RFID tag.

B. Mobile app can be developed for the users for instant recharge through their bank account.

C. Remote door locking system to capture the thief.

D. The owner can switch on the digital camera recorder to record the face of the thief. This will help in identifying and capturing the thief.

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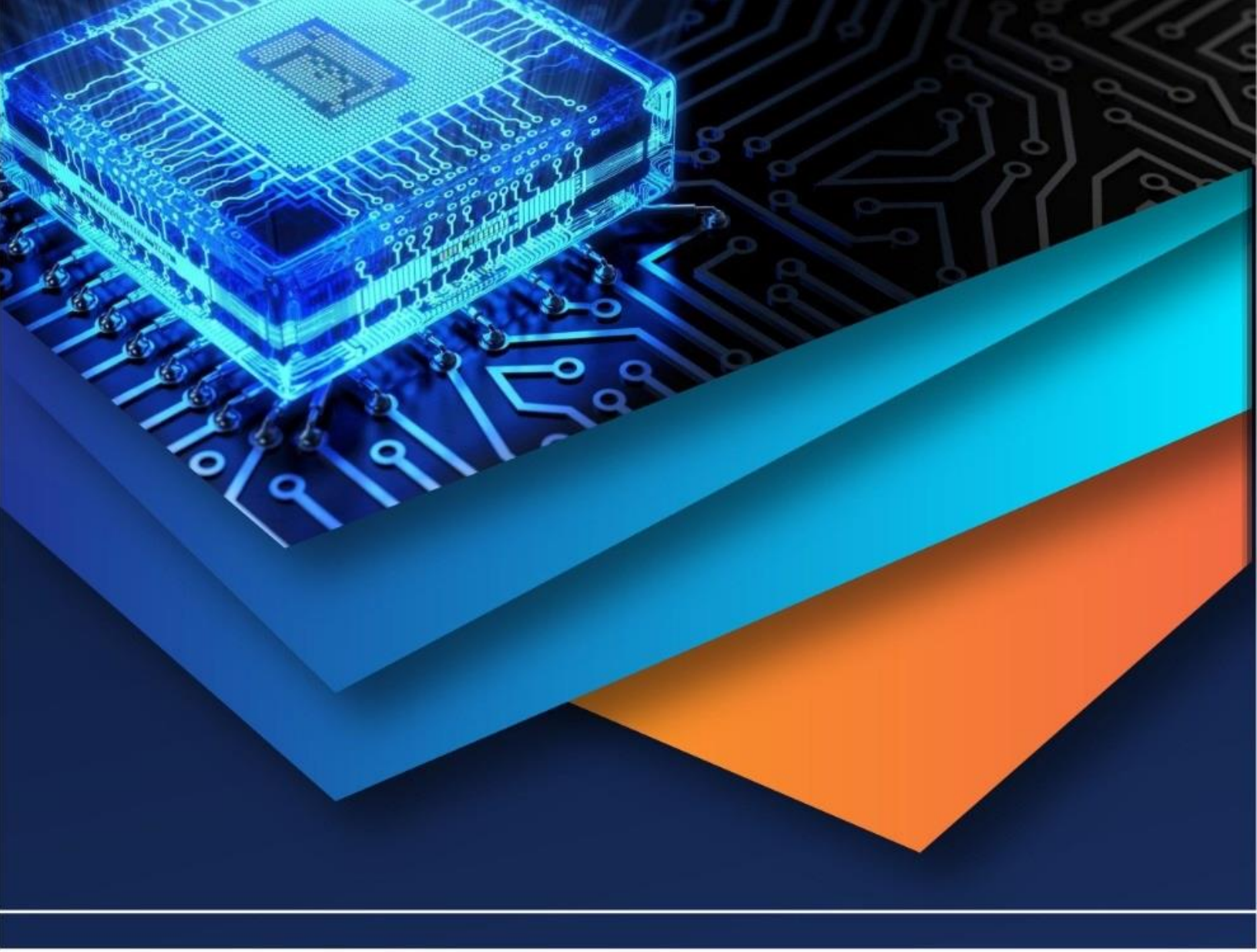

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