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Smart E-Toll using IoT: Design and its Implementation

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Abstract: ***Smart toll collection is one of the automatic identification technologies that has been used to reduce manpower, time in maintaining the toll system in the highways. This paper proposes an efficient and low cost vehicle-to-roadside communication technique called Smart E-Toll using RFID which automatically collects toll from the moving vehicles and monitors them as they cross the toll plaza. Each vehicle is identified by a unique ID through its RFID tag. When this tag is interrogated by a reader it transmits the ID of the vehicle over a radio frequency link. This ID is processed further and the cash is deducted from the user's account. Further this RFID card can also be used to block the stolen vehicles from passing. The number and the type of vehicles passing can also be tracked from the database.***
Keywords*: IoT, RFID, E-TOLL, WEB APP, ARDUINO*

I. INTRODUCTION

Present days, with the expansion in rush hour gridlock the vehicles at the Toll square need to sit tight in the long lines for quite a while. The whole procedure is manual and requires labour to manage and subsequently tedious. As of now, because of the ascent in the vehicles, there is a great deal of social occasion of the activity at the toll corners. The reason for this activity at the toll booth is because of the manual working of the toll charge accumulation. Every vehicle on normal needs to remain at the toll booth for about a moment for the payment of the toll expense. Electronic toll accumulation framework is the innovation that permits the programmed toll gathering from the prepaid record enlisted on the name of vehicle proprietor, deciding if the vehicle is enrolled or not and educates the toll specialists staying away from toll infringement. By this it isn't important to convey a great looking measure of money and furthermore security too. The vehicle proprietors are enlisted with their vehicles with appropriate data and their record is made, where they can revive their record with basic sum. At the point when the vehicle goes through the toll entryway, the data is shared between RFID tag and RFID reader and the sum is charged from the proprietors account. This strategy decreases the movement clog issues, additionally directs the movement time and diminishes the fuel utilization.

II. LITERATURE REVIEW

Dr.S.Asif Hussain et.al [1] has developed an Automatic toll E-Ticketing framework for transportation frameworks. An ease effective procedure called Electronic Toll gathering utilizing RFID is examined. Accepting that the proprietor keeps up a prepaid record with the goal that toll charge is deducted consequently from drivers account at toll square, this is identified by utilizing Infrared Proximity sensor. RFID labels are utilized to peruse every vehicle with the assistance of RFID reader. An IR recipient is utilized to get these heartbeats and sends it to a controller (MSP 430 platform), which at that point transmits the vehicle number through the RF transmitter situated in a vehicle.

S.Ravichandran et.al [2] has proposed a framework and technique for security at toll booth. The exchange is performed through radio recurrence correspondence. The shrewd framework involves a database of clients that are spared and have enroll on their versatile application. The procedure is "Programmed toll accumulation utilizing RFID card". Executing this diminishes the movement issue at toll stall. As indicated by the creator each path has been separated into two classifications: one path for drivers who have adequate adjust and other for other classification. A dynamic transponder RFID is situated on the upper right corner within the vehicle's windshield. The RFID stores data, for example, vehicle proprietor name, address, portable number, kind of vehicle, vehicle tag number. The versatile application has all the above subtle elements alongside the any legislature endorsed recognizable proof number. In this approach the vehicles tag is utilized as the record number where client cash is debited when they energize.

Kasturi shah [3] has built up a framework from camera which is utilized for catching the QR code mounted on front side of vehicle which will be sent to QR code translating process, if the data is real which is as of now put away in focal database, the sum will be deducted and blasts will open naturally, on the off chance that it isn't then vehicle will be blocked. In the event that the adjust in the

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proprietor's prepaid record is low or if the vehicle isn't outfitted with a tag, at that point the proprietor needs to pay physically. Information is separated from designs exhibited in both level and vertical segments of the picture.

Cheng Wang et.al [4] has proposed a plan of toll booth framework, which incorporates the quantity of toll channel. The proficiency of the toll benefit framework is estimated by the sitting tight time for instalment in light of the line demonstrate hypothesis that is the connection between the quantity of paths and administration productivity work, which incorporates number of toll stations, the methods for charging and length of the toll channel.

Rafiya Hossain et.al[5] has built up a vehicle toll instalment through the Internet. The IoT construct instalment framework is situated in light of source and goal point choice and in addition calling a web benefit on an incorporated web application. The web benefit call suggests transmitting approval information, for example, (hashed) client ID, vehicle class and tag, and in addition all coveted toll instalment data as JSON information. A short time later, the web application forms the got information and understands the instalment electronically finished an electronically (on the web) instalment benefit. With a specific end goal to understand the instalment, the web application transmits the prepared JSON information from IoT gadget as extraordinary web demand to online instalment benefit after which gets JSON arranged reaction from the online instalment framework

Amit Roy et.al [6] has proposed a framework which utilizes an ANPR (Automated Number Plate Recognition) system to gather the essential data of the vehicle when going through the roadway. An essential thing must be finished by all vehicle proprietors that is to keep a perfect number plate and to interface their email ids and Credit Card with the License Plate Number. The ANPR framework utilizes a wide point camera used to catch pictures of the number plates of the vehicles going through the parkway. ANPR framework utilizes optical character acknowledgment procedure to recognize the License Plate of each vehicle. It at that point passes the data to the principle STTCS where the framework coordinates the License Plate number in its database to gather the data about Credit Cards and proprietor. The framework deducts the amount from the proprietor's record and sends an e-bill of the charging to the proprietor's email id.

S. Vasantha Kumar et.al [7] has proposed an Automated Toll System which is utilized for toll accumulation with help of RFID strategy without labour, and furthermore talks about the strategy to get the stolen vehicle with the assistance of RFID method. The methodology that is taken after to get the stolen vehicle: RFID labels contain reception apparatuses to empower them to get and react to radio-recurrence questions from a RFID handset. A RFID tag is introduced on every vehicle with read/compose memory. A RFID reader gadget peruses this information when close to toll framework from the vehicle and contrasts it and the information in the PC database, if ID is in defaulter i.e. grievance is in police headquarters about lost or something for security reason nails get up with the goal that it won't ready to go outside and it will get consequently captured then permits the entrance as needs be by opening the door. However, ID isn't in the defaulter list, toll gathering is brought and nails goes down and door get open .The whole framework is created as an installed framework utilizing miniaturized scale controller and related gadgets

S.Sibin Raj et.al [8] has build up a framework which includes android versatile, QR code, and the database for making the client account. It has subtle elements which connect to the ledger for the instalment at the toll court. The client examines the QR code and makes the instalment at the toll court through the usefulness of the portable utilization of his android telephone. The client filters the QR code utilizing his portable camera. This technique can be utilized to maintain a strategic distance from the surge at the toll court.

III.SYSTEM DESIGN AND IMPLEMENTATION

Figure 1 shows the existing scenario of the toll collection at toll plazas.

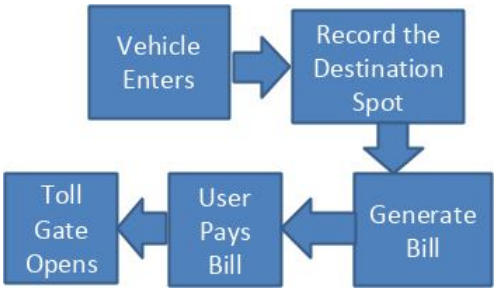

Fig 1. Existing System

RFID cards are attached to each vehicle and initial payment is made to recharge the RFID card. This model proposes a concept, design and implementation of a web application used for vehicle toll payment. The design and implementation model implies usage of an IoT device which initiates vehicle toll payments request calling web application's web service functions. Further, the web

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application realizes the user (driver) desired toll payment over an electronic payment system. The web application itself is developed to be hosted on a server directly or on a virtual machine using virtualization technology on the physical server.

The RFID card is a transponder located on the object to be identified and is the data carrier in the RFID system. The RFID card consists of a microchip that stores data and a coupling element, such as a coiled antenna, which is used for radio frequency communication. The RF reader consists of a reader and data processing subsystem. The RF reader is used to induce power into the tag coil to energize the RFID card; provide a synchronized clock source to the RFID card; act as a carrier for return data from the RFID card. The Wed App is used to support the smart E-toll application on all the devices. Every RFID card has a user account which is accessed through this web app. The web app hosted on cloud, stores all the transactions occurred over the toll. It is also used for blocking and monitoring of vehicles whenever required. The Web Application is built as shown in the figure 2.

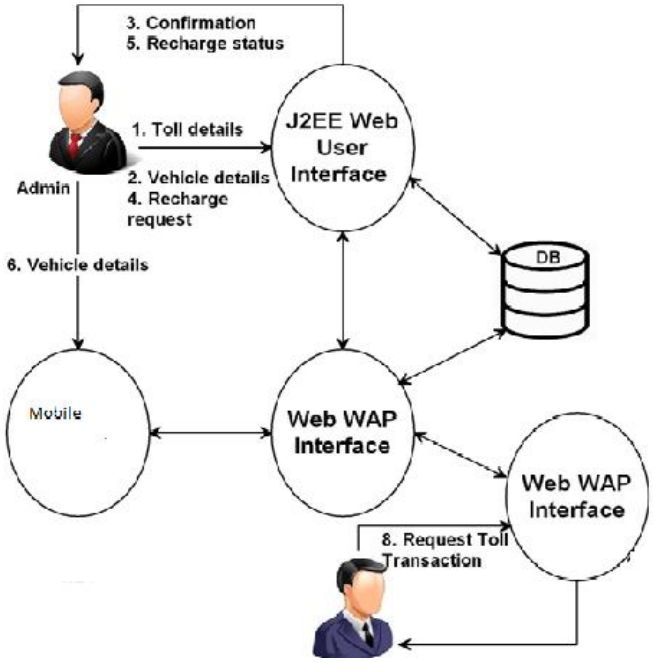

Fig 2. Proposed System

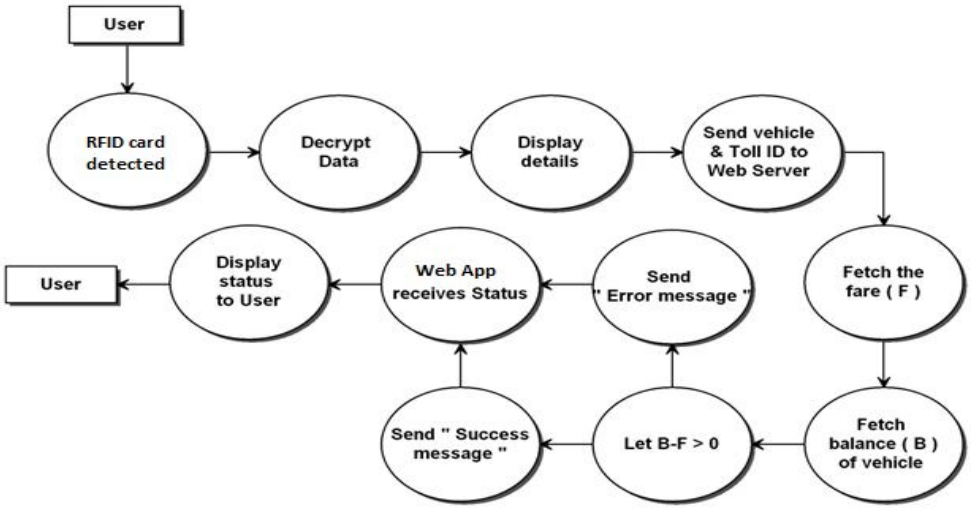

Fig 3. Working algorithm

User enters the Toll plaza and automatically RFID card of that vehicle is detected from the reader. The ID is decrypted and a record is made in the database by sending the vehicle and Toll ID to the server. The details of the vehicle and the balance is fetched and checked if sufficient balance is available. The balance is updated once the fare is deducted and the gates open to let the vehicle pass.

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A. Registration Phase

The registration of the vehicle is as shown in the figure 4

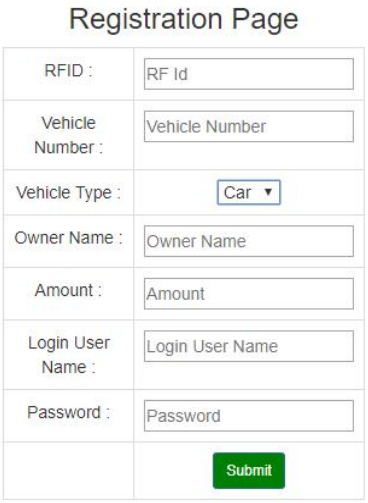

Fig.4 Registration phase

The details are recorded in this module where the vehicle type is also recorded to deduct the appropriate fares. Admin Account
Every Toll plaza has an admin who monitors everything through the admin account which can be accessed through the web app. The admin can view all the transactions made at the toll plaza by all the types of vehicles. Admin is responsible for recharging the individual accounts and also he has the privilege to block/unblock the vehicles as shown in the figure 5.

1	KA02-M1111	Car	Ram	27400	RFId 1 UnBlocked Successfully	2018/05/13 09:21:30	Block/UnBlock/Recharge
1	KA02-M1111	Car	Ram	27400	RFId 1 Blocked Successfully	2018/05/13 09:22:25	Block/UnBlock/Recharge
1	KA02-M1111	Car	Ram	27200	RFId 1 Toll Entered	2018/05/13 09:23:21	Block/UnBlock/Recharge
1	KA02-M1111	Car	Ram	27200	RFId 1 Blocked Successfully	2018/05/13 09:23:27	Block/UnBlock/Recharge
1	KA02-M1111	Car	Ram	27000	RFId 1 Toll Entered	2018/05/13 09:25:27	Block/UnBlock/Recharge
1	KA02-M1111	Car	Ram	27000	RFId 1 UnBlocked Successfully	2018/05/15 07:12:33	Block/UnBlock/Recharge
2	KA05-M2222	Bike	Sham	700	RFId 2 Toll Entered	2018/05/15 13:51:26	Block/UnBlock/Recharge
2	KA05-M2222	Bike	Sham	700	RFId 2 Blocked Successfully	2018/05/15 13:54:02	Block/UnBlock/Recharge
2	KA05-M2222	Bike	Sham	600	RFId 2 Toll Entered	2018/05/15 13:54:58	Block/UnBlock/Recharge

Fig. 5 Admin page

B. User Account

Figure 6 shows the user account page, where every user can access his account through the web application. User can view his overall transactions made at any toll with the timestamp. User can also view the available balance. There is also a block/Unblock option in the application which will be discussed in the subsequent sections.

Toll Management Application

Logout

RF Id	Vehicle Number	Vehicle Type	Owner Name	Balance	Transaction Status	Date	Block/Recharge
1	KA02-M1111	Car	Ram	1000	RFId 1 Registered Successfully	2018/05/02 03:48:57	Block/UnBlock
1	KA02-M1111	Car	Ram	1000	RFId 1 Blocked Successfully	2018/05/02 04:00:17	Block/UnBlock
1	KA02-M1111	Car	Ram	1000	RFId 1 UnBlocked Successfully	2018/05/02 04:00:27	Block/UnBlock
1	KA02-M1111	Car	Ram	1000	RFId 1 Blocked Successfully	2018/05/02 04:35:23	Block/UnBlock
1	KA02-M1111	Car	Ram	1000	RFId 1 UnBlocked Successfully	2018/05/02 04:35:35	Block/UnBlock
1	KA02-M1111	Car	Ram	800	RFId 1 Toll Entered	2018/05/02 05:35:21	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 Toll Entered	2018/05/02 05:35:34	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 Blocked Successfully	2018/05/02 05:36:05	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 UnBlocked Successfully	2018/05/02 05:51:00	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 Blocked Successfully	2018/05/02 06:51:50	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 Blocked Successfully	2018/05/02 06:52:26	Block/UnBlock
1	KA02-M1111	Car	Ram	600	RFId 1 Blocked Successfully	2018/05/02 06:52:36	Block/UnBlock

Fig. 6 User account page.

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C. Block/Unblock feature

Stolen vehicles, vehicles with class mismatch, vehicles with insufficient balance and those that run through (cross without payment in cash lane) are blacklisted. List of blacklisted vehicles is shared with all toll plazas. These vehicles are stopped when they cross the next toll collection point and appropriate steps are taken. The user can also block his own vehicle in case if the vehicle is stolen. Whereas the admin of the toll plaza can block any vehicle at any time. This is achieved through the Web App as shown in Figure 7

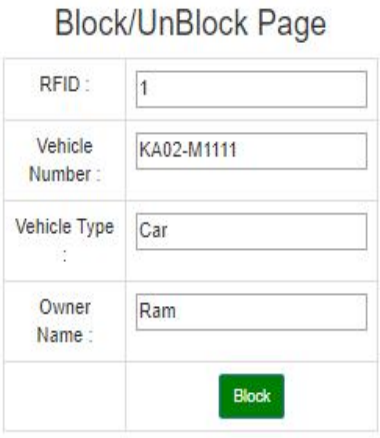

Fig. 7 Block/Unblock page

D. Working of Hardware

Whenever the vehicle with RFID card enters the RFID reader detects the card and it sends the ID of the card to the Arduino Uno. Arduino which is connected to the cloud through the Wifi Module sends the ID of the vehicle entered. The necessary computations are performed by the web application and it sends back the appropriate response to the micro-controller. Based on the response obtained it performs further computation to open the gates which operated through DC motor. Figure 8 shows the hardware architecture

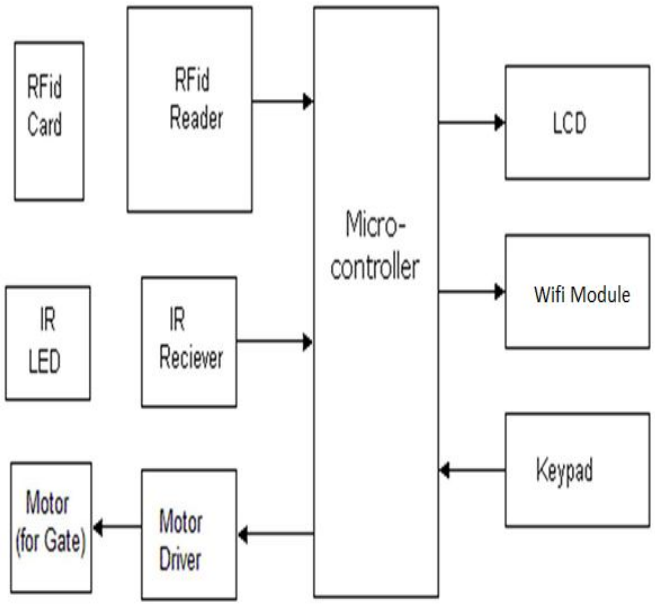

Fig. 8 Hardware Architecture

IV. EXPERIMENTAL RESULTS

The figure 9 shows the screen-shots of the user interface design of the web page that we have used for the user to register himself and also to recharge his account. Also the figure below shows the design of the web pages that will be used by the administrators for registering the user and recharging his account at the toll booth.

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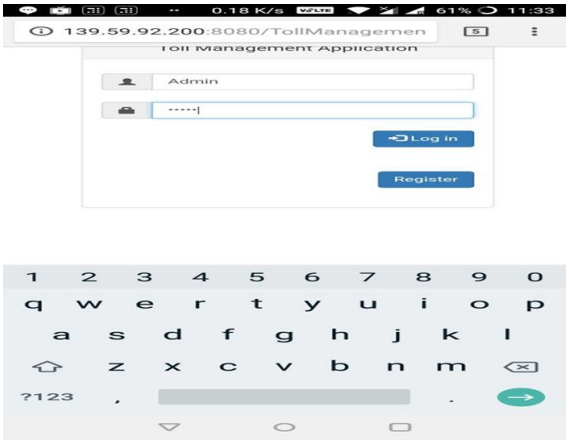

Fig. 9 Login Page

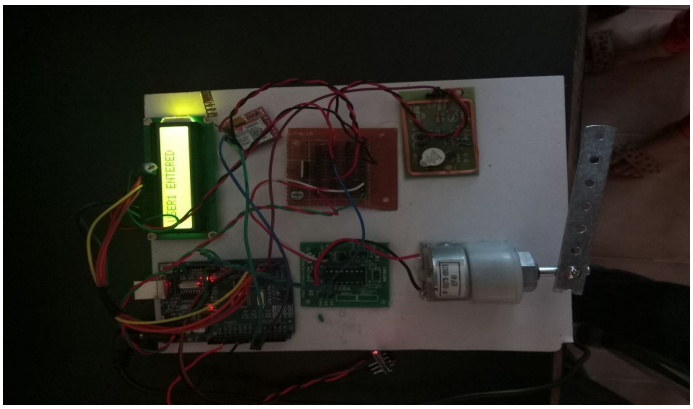

Fig. 10 Experimental Setup

The figure 10 shows the experimental setup developed for the implementation of smart E-Toll using IoT.

V. CONCLUSIONS

The IoT world has appeared to one of modem topics merging different already existing technologies as well as opening other lightweight results. This implies and led to advantage of combining loT devices in new areas. This paper discusses about one of the applications of IoT in collection of toll fee from the users in Toll Plazas. Comparing advantages and limitations of our system we can conclude that our system is beneficial for daily travelers and Toll station authorities to lessen the burden. In future the system can be further developed by making use of Aadhar authentication and auto debit from the bank accounts since the Aadhar is linked to the account. This can provide authentication as well as vehicle loss from theft since the details of the theft can be tracked using the Aadhar Information.

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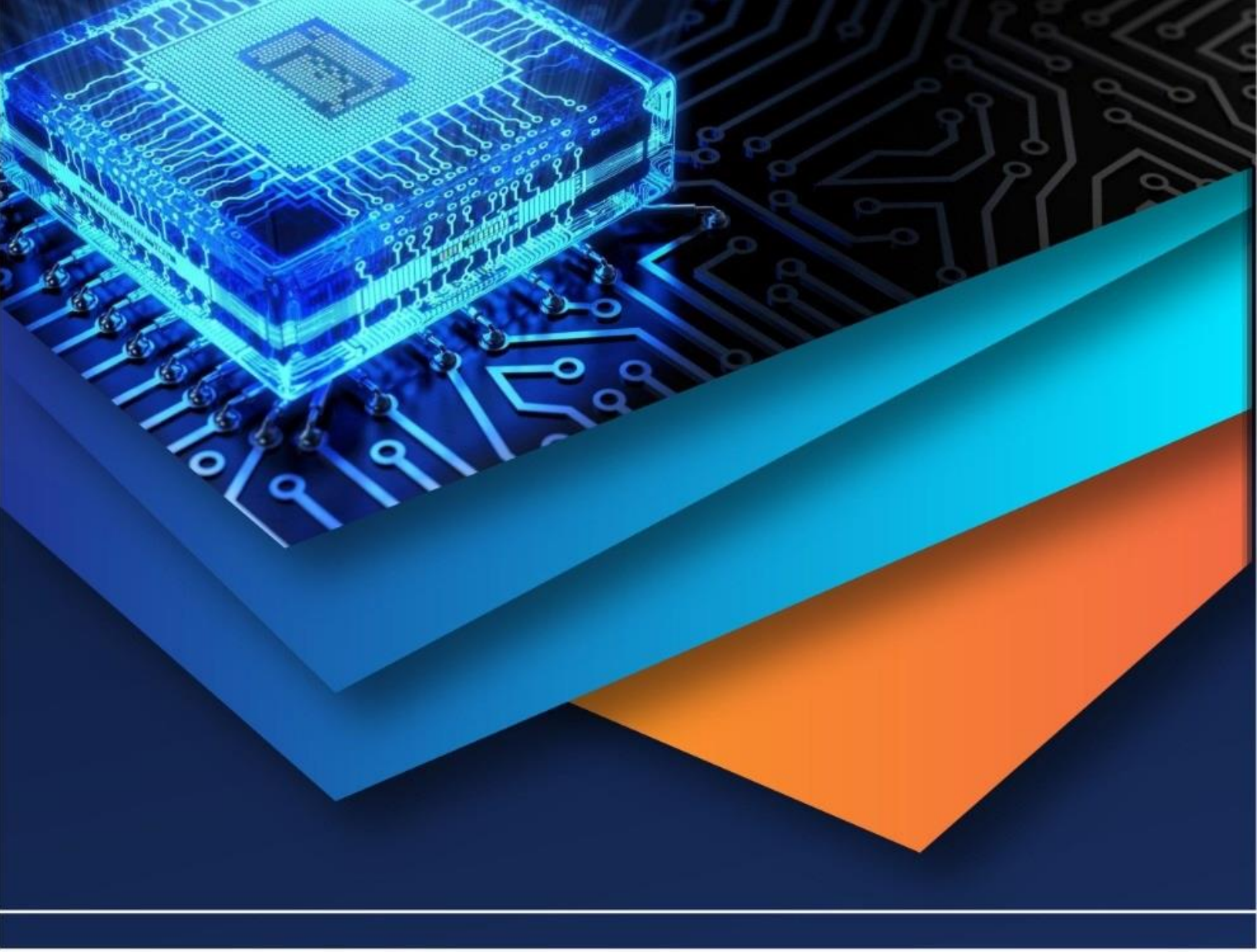

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