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Vehicular Communication Establishment using NRF with Emergency Alert System

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Abstract: ***The purpose of this paper is to solve the road safety issues present in our country. In today's scenario lots of accidents happen on roads which result in a huge number of fatalities. The idea is to introduce a Vehicle to Vehicle communication protocol that will enable the vehicles moving on the road to communicate with each other in a wireless medium. The wireless communication between any two vehicles is possible using Radio Frequency (RF) communication with a range of 100 meters to 300 meters depending on the module and the antenna used. This Vehicle to vehicle communication also known as V2V is essential in areas with no internet connectivity or GSM (Global System for Mobile) based communication. This established connection between vehicles is used to communicate data like accident occurrence, vehicles ahead, vehicles coming from opposite lane and other warnings. The NRF module is used to establish the wireless Radio Frequency (RF) communication between vehicles. The NRF modules present in both the vehicles communicate with each other and send the message over a wireless medium. This type of communication is much more reliable than internet or mobile based communication. All the functions are controlled by an Arduino Uno R3 microcontroller which integrates all the sensors present. This technology prevents accidents on roads which is one of the most major issues in our country causing loss of lives. The connected vehicles on the roads provide smooth traffic, tackling congestion and in case of any human error the vehicle can communicate with the other vehicle in a quick and wireless medium cautioning the other driver thereby avoiding fatalities.***
Keywords: Vehicle to Vehicle Communication, NRF, Arduino Uno, road safety, accidents, alert system.

I. INTRODUCTION

In today's scenario accidents are one of the major issues worldwide. Thousands of people are affected by road accidents almost every day. The number of fatalities involved in road accidents every day is large and terrifying. In a country like India, this has become a very worrying issue. The main reasons for accidents are due to lack of concentration while driving, not following the traffic rules, rash driving and not knowing properly about the surrounding vehicles. Now imagine a scenario where two vehicles are traveling along the same lane of the road one after the other and the vehicle behind wants to overtake the vehicle moving in front of him but there is another vehicle coming from the opposite lane or may be in the same lane just a bit ahead and has no idea about it, so when the driver tries to overtake it may result in an accident endangering lives of the people travelling in the vehicles. In the scenario mentioned above if there was a way in which the vehicle in the front would communicate or alert the vehicle moving behind that there is a vehicle coming from the opposite lane or a vehicle moving besides it then the accident could be avoided. This is possible by using NRF. The model name is nRF24L01 which is a wireless transceiver module that is based on radio frequency communication and has a fantastic range. It can send and receive messages in a single channel and has a low power consumption.

When this kind of technology is implemented in modern vehicles it makes it smart, we can achieve V2V which is nothing but vehicle to vehicle communication. This will ensure that even in high traffics or tough environmental conditions the accident rate can be reduced. Also if a scenario happens, where an accident occurs, then an alert system will trigger messages to surrounding vehicles that an accident has happened. This kind of alert system is necessary in case an accident happens because no system is full proof.

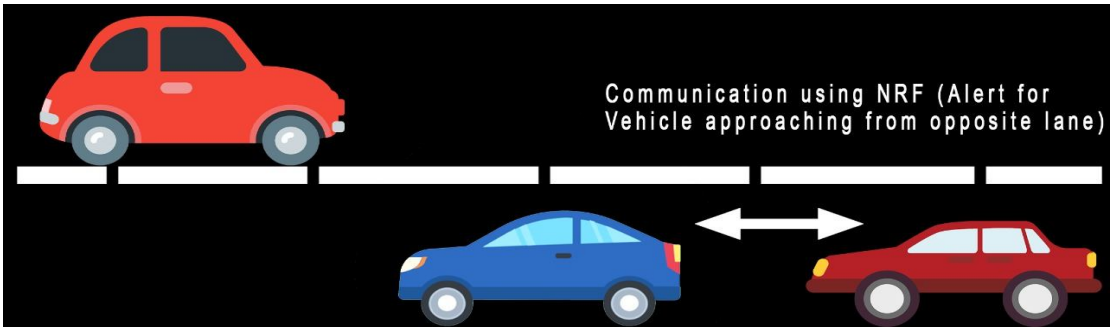

Fig 1. Schematic of V2V communication

The paper contains the introduction to "VEHICULAR COMMUNICATION ESTABLISHMENT USING NRF WITH EMERGENCY ALERT SYSTEM" where we come to know about the implementation of this Vehicle to Vehicle technology. Section (II) lists out all the related works which are used in this paper. Section (III) contains the methodology and lists out the various hardware components, software used in the system. Section (IV) shows the results and discussions where the end result of our implemented system is shown. Section (V) contains the conclusion part of the paper.

II. RELATED WORKS

The paper [1] discusses about Vehicle to Vehicle Communication technology in detail and also tells about its practical implementation. In [2], the paper discusses about Vehicle to vehicle Communication in order to reduce accident rates on roads due to overtaking and over speeding of vehicles.

In [3], the paper talks about vehicle safety and communication on roads to avoid accidents and to improve road safety. The paper [4], discusses about anti - collision approach to avoid accidents on roads, as lots of accidents are due to collision of vehicles, this kind of technology can prove to be helpful in avoiding major accidents. In [5], the paper discusses about Vehicle to Vehicle Communication in Non Reachable areas i.e. areas where network availability is low to nil.

The paper [6] discusses about Vehicle to Vehicle communication using a latitudinal and longitudinal based algorithm for road safety purposes. In [7], the paper talks about implementation of Vehicle to Vehicle Technology using Wireless Sensor Networks. The paper [8], discusses about Vehicle to Vehicle as well as Vehicle to Infrastructure Communication for road safety purposes. In [9], the paper talks about Vehicle to Vehicle Communication using LiFi, that is light based communication, which proves to be inefficient in certain aspects like, LiFi communication does not work well under sunlight.

In [10], the paper talks about various application of Vehicle to Infrastructure type of communication, this is implemented based on longitudinal based algorithm. The paper [11] talks about emergency alert system for elderly people using Vehicular Ad-Hoc Network Technology. In [12], the paper discusses about an efficient and a quick alert system in case of an accident on roads, this quick response system will enable to save lives. The paper [13], talks about an accident emergency alert system via a mobile application, this kind of technology proves to be very quick and efficient in case of an accident so that the required safety measures can be taken in a quick time. In [14], the paper discusses about a quick emergency alert system using Internet of things and an Android application. This will enable quick and effective communication about the accident occurred on the road. The paper [15], discusses about an accident detection system via wireless medium.

III.METHODOLOGY

The high rate of road accidents is the main motivation behind this idea. In our Proposed approach we will be using NRF modules that will communicate with each other using radio frequency that will allow us to establish V2V (Vehicle to Vehicle Communication). This system would be cost efficient providing the best results ensuring vehicle to vehicle communication (V2V). Basically it consists of modules which detect the vehicles moving besides it and communicate with them to ensure safe transit on roads to reduce the accident rate. Arduino Uno R3 microcontroller is the heart of the system which is based on the Arduino microcontroller architecture.

It will interface with all other sensors and modules. Microcontroller receives the information from all the sensors and modules and processes the data for further actuation. The most important sensor are the NRF24L01 modules that establish the connection between the two vehicles.

So when the first vehicle detects a vehicle or experiences any sudden speed change it sends the signal to Arduino Uno which triggers the NRF module to communicate this information to the other NRF module present in the other vehicle.

An Ultrasonic sensor placed in Vehicle - 1 is used to detect any vehicle moving besides it or coming from the opposite side. It analyses and sends the signals to the microcontroller which is the Arduino Uno R3. The Arduino then triggers the NRF module present in the vehicle to communicate this information to Vehicle - 2. The NRF module present in Vehicle - 2 receives the information that there is a vehicle ahead and is not safe to overtake.

This information is passed on to the Arduino Uno R3, which then displays a message on the display present in the vehicle, thereby giving a warning about the vehicle coming from the opposite lane.

The ultrasonic waves are based on the SONAR concept which transmits and receives the waves at a frequency of 40 kHz. The objects are detected using this very same concept. When the Vehicle containing the Ultrasonic sensor detects a vehicle passing by, it notifies the Arduino which in turn makes the NRF module to communicate the information to the vehicle moving behind.

The NRF module receives the information that there is a vehicle ahead and is not advisable to overtake, thereby alerting the driver which eliminates the risk of accident. This kind of technology will enable smooth traffic flow and reduce the accident rates which will avoid the loss of lives. Moreover, the prototype has ability to detect emergency situation. After detecting the emergency situation, the alert system generates alert for an ambulance. The alert message should include GPS coordinates of the accident location. Here, we used GPS module to send this message. Based on the endorsement of the alert message, the receiver may transmit an alert message to the nearby emergency services like a police station, ambulance etc. The overall system flow is shown in Fig. 2.

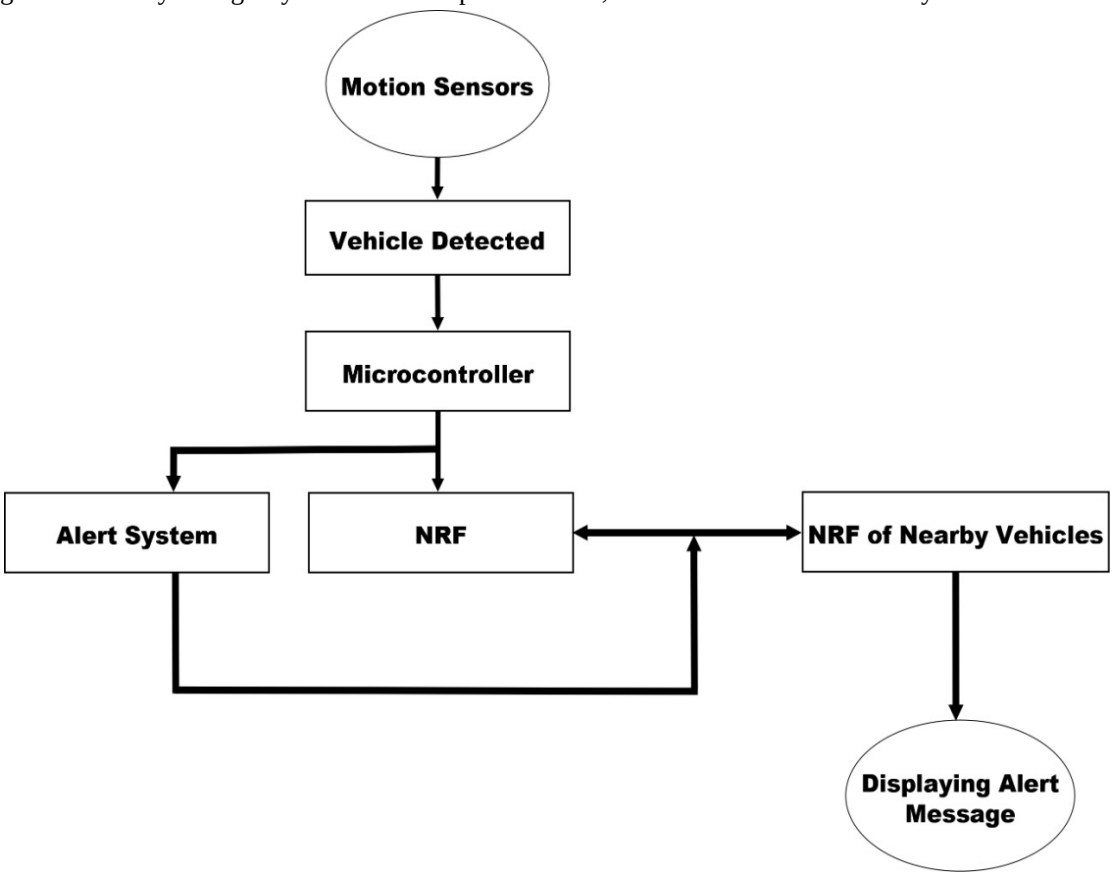

Fig 2. Flow diagram

A. Hardware Required

1) Arduino Uno: The microcontroller used in this product is the Arduino Uno R3. It is the heart of the system. The input, output sensors and display are connected to this unit. It can process lots of data and gives the desired output. This microcontroller board is coded in the Arduino IDE software. Based on the code fed and the connections made, the desired output can be derived.

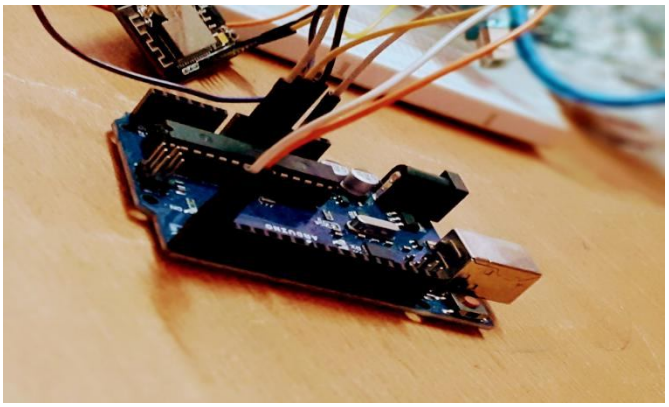

Fig. 3. Arduino Uno R3

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2) *Ultrasonic Sensor:* It is one of the crucial sensors of this product. The ultrasonic sensor is used to detect any kind of object or motion in front of it. The module used here is the HC SR04 Ultrasonic sensor as shown in Fig.3. It is based on the SONAR (Sound Navigation and Ranging) concept. The sound waves are emitted by a transmitter and received by the receiver, based on the time at which the receiver receives back the sound, the distance of the object is calculated. Ultrasonic sensor is preferred over an Infrared sensor because it is not affected by sunlight and it also gives accurate distance readings. The ultrasonic sensor is placed on all sides of the vehicle, when the sensor detects a car near by it, the sensor notifies the microcontroller about the incoming vehicle and the microcontroller notifies the vehicle via NRF module by displaying a alert message.

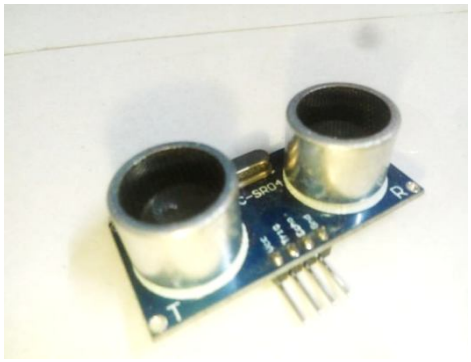

Fig. 4. Ultrasonic Sensor - HC SR04

3) *NRF24L01 Module:* The NRF module is a wireless transceiver module, in this scenario it is capable of both transmitting and receiving the data. The operating frequency of this module is 2.4 GHz. The module has a transmitting range of 100 meters, which is more than enough when it comes to Vehicle to Vehicle Communication on roads. The module communicates in Radio Frequency, hence the name NRF. Due to radio Frequency based communication, it does not depend on internet and network availability. Due to this advantage, it holds superiority over GPS/GSM based Vehicle to Vehicle Communication. Also this type of V2V communication is far better than LiFi based V2V communication because, in the LiFi system, it does not work efficiently under sunlight. In this system, the NRF module of one vehicle communicates with the surrounding NRF modules of other vehicles. The communication is Radio Frequency based. Messages and data can be transmitted and received both ways between vehicles.

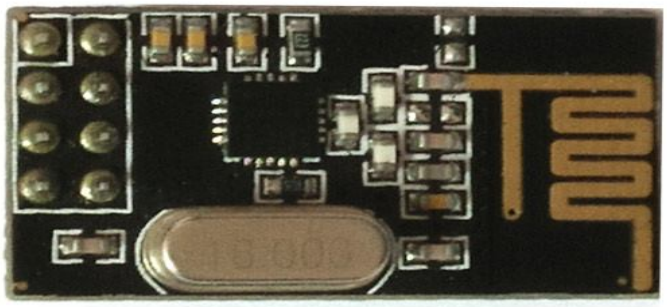

Fig. 5. NRF24L01 Wireless RF Module [16]

4) *GPS Sensor:* The sensor used here is the GPS NEO 8M which is used to give the exact latitude and longitude of a location. When an emergency is detected by the prototype, the Arduino UNO triggers the GPS module to send the exact latitudinal and longitudinal coordinates of that location to the established communication channel.

a) *For Example*

- Accident occurred at location of
- Latitude=1591.2095
- Longitude=1916.2597

B. Software Required

1) Arduino IDE: Arduino IDE is an open source platform. It is where all the lines of code for an Arduino program is written. This is used for integrating various sensors with the microcontroller. The various data received from the sensors are processed by the Arduino IDE for different functions and applications.

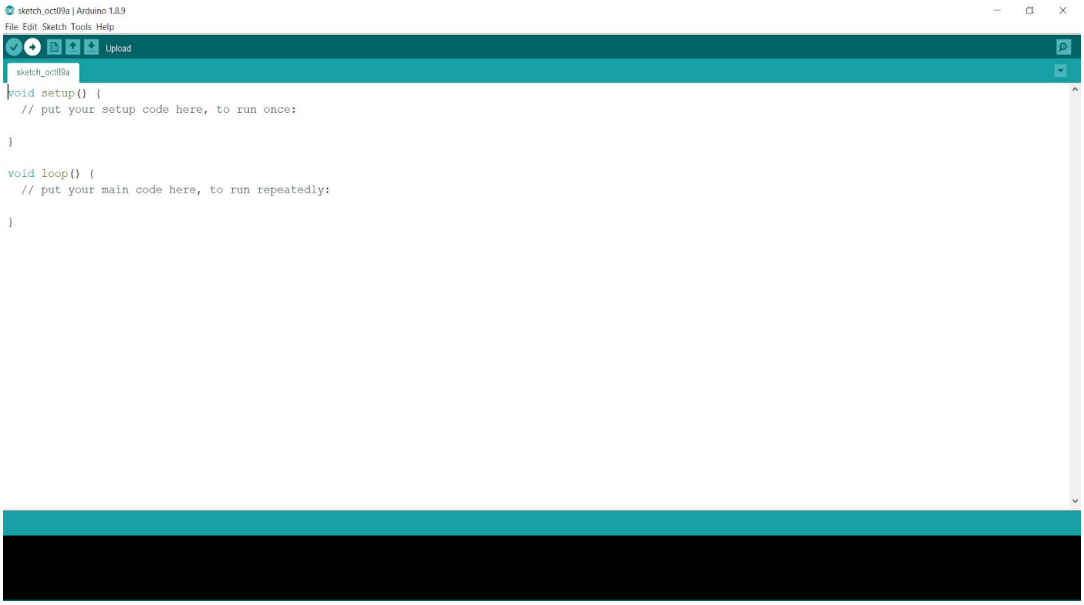

Fig. 6. Arduino IDE software

IV. RESULTS AND DISCUSSIONS

Once the hardware connections are made and the software coding was applied to the setup, the ultrasonic sensor placed in the body of the vehicle detects vehicles around it and notifies the surrounding vehicles via NRF modules fitted on the respective vehicles. The communication was based on Radio Frequency communication. This entire process is controlled and executed using the Arduino Uno R3 microcontroller.

V. CONCLUSIONS

The goal of this paper was to provide a low cost, at the same time an accurate automated system to enable communication between vehicles to ensure that the accident rate reduces. Our prototype enabled communication between two vehicles using the NRF24L01 module, via which the vehicle moving in front notified the vehicle moving behind that there is a vehicle coming from opposite and is unsafe to overtake.

The Vehicle to Vehicle Communication is revolutionary in the sense that it enables vehicles to pass on information to each other without human intervention. This technology can be implemented in driverless cars and vehicles. A more advancement can be made in this technology by using LiFi (which uses light) for communication over the NRF based vehicles which use Radio frequency based communication. Although LiFi communication is currently indoor based or used in underwater communication, with advancements in this technology it can be revolutionary in the field of Vehicle to Vehicle communication. Vehicle to Human Communication is also very much possible so that the people walking along the footpaths are also safe from accidents. Various analyses like traffic patterns and road networks can be done to make the person's journey faster and easier. This advanced technology will reduce the accident rates all over the world to a very great extent, which is the biggest threat to human life on roads.

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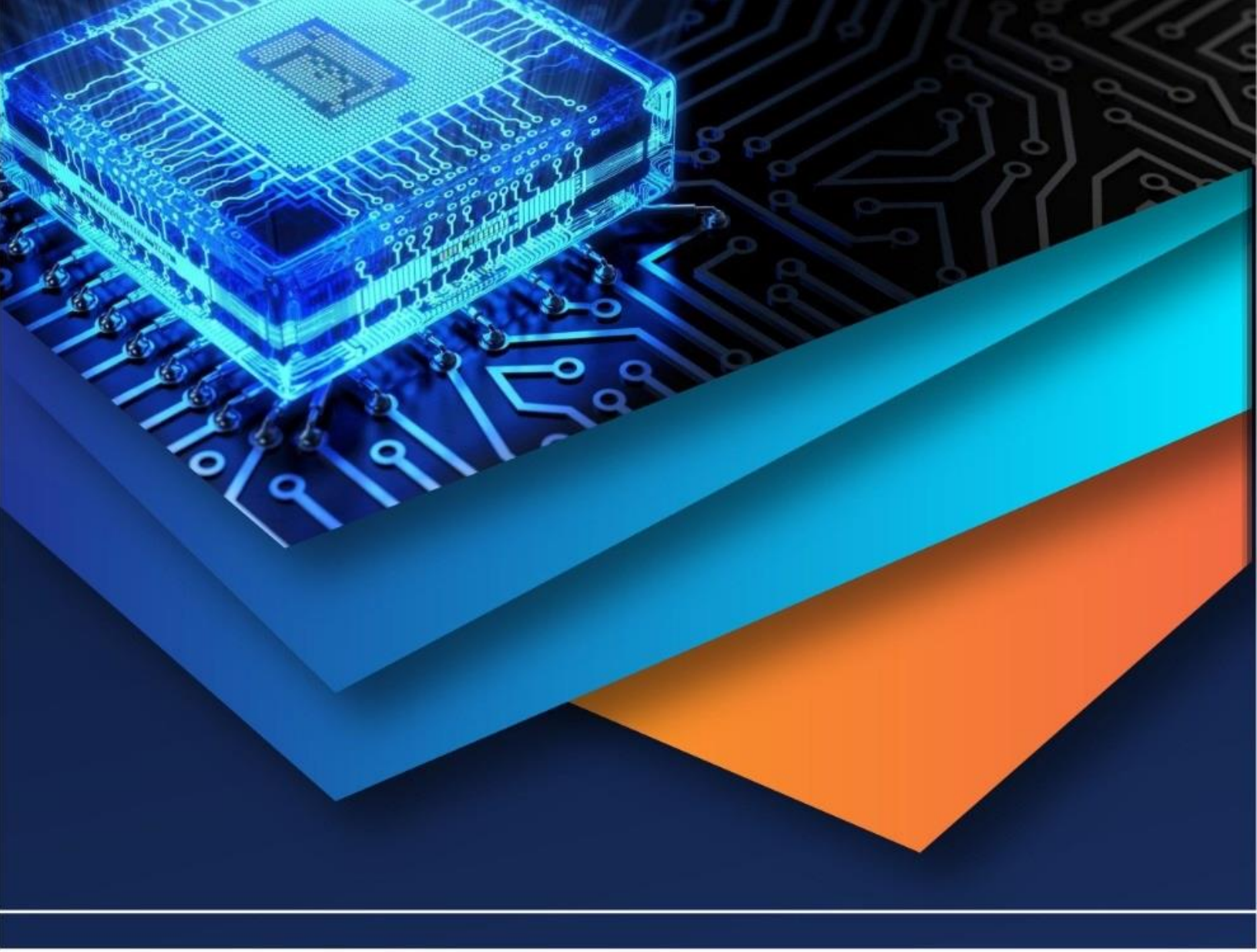

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