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Smart Traffic Light and Street Light Management System

Prabhakar Sharma[1], Shubhika Jain[2], Urja Bagga[3], Dr. Prashant Panse[4]
[1]*B.Tech. Student, Department of Information Technology, Medi-Caps University, Indore.*
[2]*B.Tech. Student, Department of Information Technology, Medi-Caps University, Indore.*
[3]*B.Tech. Student, Department of Information Technology, Medi-Caps University, Indore.*
[4]*Associate Professor, Medi-Caps University, Indore.*

Abstract: ***Nowadays traffic management is a domain in which a huge amount of work is done to improve the conditions on the road. A major reason of which is the delays of the red light due to hard coded delays and not on the basis of real time traffic. Therefore the need for simulating and optimizing traffic control to better solve the increasing congestion. In this project we aim to propose a method for detecting the real time traffic and controlling the traffic light on the basis of it. This project aims for designing and executing the advanced development in embedded systems for energy saving of street lights and control of traffic lights based on traffic destiny. We are doing this using IR(infrared) sensors and Arduino Uno. We are doing this in an energy efficient manner by using Solar panel to provide the electricity required by the system.***

The most amount of light consumption in the city is that of the streetlights. There is a lot of wastage of energy as the streetlights remain illuminated throughout the day. [1] In Indore it was observed that these lights were consuming almost 4,000 units of electricity and were costing an additional expenditure of Rs 12.4 lakh per month to the government.

In this project we aim to reduce the energy consumption by the use of solar panels to provide the electricity supply to the streetlights. We also aim to automate the switching on and off of the streetlight to control the unnecessary illumination of the streetlight and thus saving of electricity wastage. We are automating the streetlight system using an Arduino Uno, Light Dependent Resistor(LDR)and Real Time Check(RTC).

Keywords: Traffic Management, Street Light Management, Arduino Uno, Real Time Check (RTC), Solar Panel, IR sensor, LDR sensor.

I. INTRODUCTION

A. Smart Traffic Light System

Indore is not only number one in cleanliness but also in buying vehicles. [2] More than 4.63 lakh vehicles were sold in the last three years, which is highest in the state. Indore is followed by Bhopal, Jabalpur and Gwalior. As per data sent by the road transport department to the union government about registered vehicles, 423 new vehicles came on city roads every day.The traffic on the road of Indore is continuously increasing day by day whereas patience level in citizens is continuously getting low.They are not in a state to wait for sometime and they are even more frustrated when they have to wait without any reason and when they have an option to go. Real life example of this problem is Traffic signal. People get frustrated because of waiting for long and they get more frustrated when another signal is open but there is no crowd on that signal whereas their signal has a lot of crowd but the time for which signal is open is very less for them to pass. The rapid increase in the number of vehicles (private or public) has led to the overall growth in traffic causing longer travel times and traffic congestion. Hence the traffic jams during rush hours are a daily issue which needs to be tackled. So in this research paper we aim to minimize this problem by proposing a method to control the traffic signals on the basis of the real time traffic and not some hard coded programs. The method used to detect the real time traffic is using IR sensor which will be mounted at certain distance to estimate the number of vehicles on the road and for how much time the signal shall be opened for the easy passage of the vehicles on the road. There will be also a upper limit for the signal to be opened as it is not feasible to keep a signal open for a very long time as it will be a problem for the people standing on other signal.

B. Smart Street Light System

The current scenario for street lights is that they are operated manually. The street lights are turned on at night and are turned off in morning. Nowadays it is seen that some street lights remain lit the whole day which leads to the wastage of energy. [3] Indore municipal corporation(IMC) has identified over 8000 streetlights which remain active all 24 hours in various areas such as Mahalakshmi nagar, Annapurna, Patnipura, MG road etc which costs an extra of Rs 12.4 lakh per month.

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Each of these poles has a bulb of 50W which remains lit for 24*7 and its monthly electricity bill is Rs 180.If we add these up for the whole country then it will be a large amount of wastage of resources as well as economy.

In this research paper we propose the automation of the streetlight system and the controlling of the on/off of the streetlight on the basis of the natural light intensity.The natural light intensity will be checked using LDR sensor.To make this system more efficient we will use solar panel to our system work and the lighting of the streetlights.To make our system fault tolerant we will also be connecting an external power supply.

II. LITERATURE SURVEY

[4] Hernani Pires, Andreia M. Carreiro, proposed the development of an energy management system for public lightening management which will help the municipalities in reducing the energy consumption by the public lightings and to properly monitor and control the streetlight.In this project they proposed a solution with remote communication technology so that the user can get the effective information for analysis, controlling and management of the infrastructure.This will be helping in energy conservation, so that we can create a greener and sustainable world.In this method the complete real time usage of the energy due to streetlight will be recorded and will be sent through certain network protocols to a web based platform.

[5] Vishu Gupta and Rajesh Kumar, presents a method for smartly controlling the traffic lights and solving the continuously growing problem of traffic congestion.In this paper the optimisation of a single junction is proposed using adaptive control techniques .The algorithms used in this paper is HNN(Hopfield Neural Network) and GA(Genetic Algorithm).The HNN is used to determine an effective effective and optimised sequence of for the traffic lights, whereas GA is used to predict an optime green light duration which should fall between a particular range so that no lane has to wait for a longer time.In the situation of any congestion the HNN will be providing with an effective sequence which will solve the congestion problem.

[6] Philip Tobianto Daely, Haftu Tasew Reda , Gandeva Bayu, IEEE Design of Smart LED Streetlight System for Smart City with Web-Based Management System .Most existing works for smart streetlight systems are related to Wireless Sensor Networks . This Research Paper Proposed Correlated color Temperature based illumination of LED Street lights integrated with Zigbee wireless Communication and a web-based system that will monitor the weather changes and accordingly sets the LED street light using the sensor data as input.

[7] Volodymyr Miz , Vladimir Hahanov Smart Traffic Light in Terms of CTMS based on IOT.This uses the approach of Cognitive Traffic management System(CTMS) which implements the virtual analog of existing physical traffic lights . It's system generates control signals using various sensors and car users data which is analyzed and processed by Big Data approach for further use in optimizing the current traffic light management system.

[8] Ezgi bingol, Murat Kuzlu and Manisa Pipattanasomporn, proposed a unique solution to manage street lighting remotely using LoRa (Long Range) technology so that the cost of urban street lighting is reduced and maintenance services can be improved. In this paper many existing solutions have been reviewed.The salient features of proposed solutions include alarm management, adjusting brightness level remotely and setting on/off times based on astronomical clocks. The system consists of LED light fixtures each with an embedded controller which calculates energy consumption to demonstrate energy savings due to LED light fixtures, and adjust their brightness. It also includes a LoRa gateway, a LoRa network server, a central unit and GUI (Graphical User Interface) to monitor and deliver detected anomalies via SMS/email to operators by the centralUnit.This solution ensures energy savings and increased efficiency of maintenance services.

[9] U.Hernandez-Jayo, I.Angulo**,** presented a design of intelligent street light system using wireless technologies and by doing a depth analysis of the deployment scenario so that deployment can be done in existing facilities and cost of investment is minimized. Main features of the design are providing sensing capabilities to end nodes so that environmental information can be obtained and minimize energy consumption , light regulation which includes managing light intensity of streetlight and autonomous adaptive system which includes system working in an autonomous way, according to the changing environment conditions.Also in future this proposed design can be used for development of other intelligent systems.

[10] Anurag Kanungo, Ayush Sharma, Chetan Singla**,** presented a method to use live video surveillance from the cameras at a junction for calculating the real time traffic density, using image and video processing, and switching the signal accordingly.It uses an algorithm where the cameras mounted on the junction will be capturing the live photos and videos of the traffic and broadcasting it to the servers where image and video processing will be used to calculate the traffic density on each side of the road which will be deciding the light duration and the proper sequence of lights.It will be help in reduction of power and fuel consumption.The significant data recorded by the camera will also help in future road planning and analysis.

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[11] M.H Mogadhan, N. Mozayani , A Street Lighting Control System Based On Holonic Structures and Traffic system.This approach of holonic structure is based on traffic rate in streets and multi agent systems. This controls the traffic light system by intelligent agents in holonic organization which is mounted on the traffic infrastructure. It is divided into levels which causes the traffic lighting system to work dynamically.

III. DESIGN AND METHODOLOGY

A. Smart Traffic Light System

A four way junction is used to demonstrate the proposed system.We have taken the Bhawarkuan square of Indore as our reference junction where the square is approximately 50 metres in length.

This system consists of IR sensors mounted on the sides of the road at the traffic junction on each side as it is a four-way junction.We will be mounting 6 IR sensors on each side of the junction at a distance of 20 meters from each other which will totally be covering a distance of 120 metres from the signal.This means the IR sensor will checking the density of vehicles on road tll a distance of 120 meters from the signal.

Arduino UNO board connected with the traffic lights as well as IR sensors.IR sensors will be sensing the real time traffic and sending the data to the arduino where the time duration for the signal will be calculated on the basis of the data sent by the arduino and the the logic which has been programmed.In this way the on/off of the streetlights will be done on the basis of real time traffic , removing the problem of unnecessary delays which are caused due to hardcoded logics.

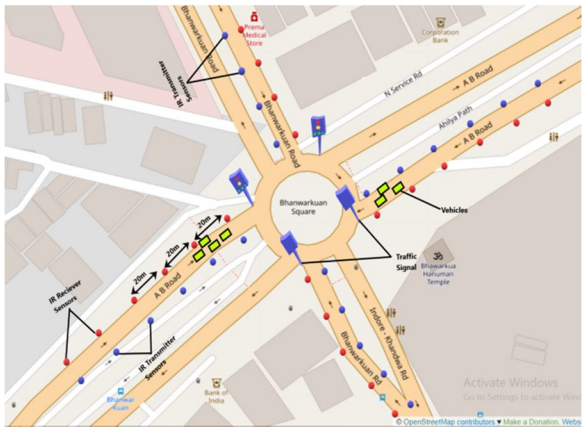

Fig 1.Four way junction design[12]

The time for which the traffic lights will be switched will be on the basis of how much density of cars is being measured by the IR sensor. Let the sides of the junction be named S1, S2, S3, S4.For instance we take any one side, let S1 and the IR sensors on the side S1 be named I1, I2, I3, I4, I5, I6.

Let's assume that it is the day time when traffic is not very much so if the IR sensor of side S1 has traffic only till n^{th} sensor(where n is between 1 and 6).So the traffic signal will opening for:-

time=(n*7+3) seconds, where 3s is the time for yellow light.

The time for each IR sensor is taken as 7 seconds because:-

The average speed which a vehicle can pickup as soon as the signal is open is approximately 25-30 km/hr.

distance=speed*time

=25 km/hr*7 seconds

=(25*5/18) m/s*7 seconds

=48.6 metres

Distance≈50 metres which is the size of the square.

So switching the signal for 7 seconds for each IR sensor will let each car till that sensor cross the signal.

According to this algorithm the maximum time for which the signal will be open is 45 seconds.

If the traffic density is more(at the peak hours) then also the maximum time for any side signal will be open is 45 seconds.If we would open any particular side for more than this time then it may be a problem situation for the people at the other sides of the junction.

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This algorithm may provide us with the traffic density estimation and the optimisation of the traffic light on the basis of real time vehicle density on the road.This will reduce the fuel consumption as well as the waiting time.This algorithm will help in the removal of unnecessary delays of the red light due to the hard coded algorithms.
This algorithm won't be helpful if we have to calculate the exact number of vehicles on the road, but only help in the density estimation of the vehicles as some vehicles such as trolleys or trailers are much longer so it is possible that they may cover two IR sensors. But in that condition also this method will work perfectly fine as a longer vehicle may require longer time to cross the signal which may be equivalent to the time taken by two cars covering different sensors and standing one after the another.

B. Smart Street Light System

A street light pole is used to demonstrate the following system.
The system consists of a street light pole which is having an LED light.The pole is having a solar panel and an arduino board connected to it. A LDR sensor is also mounted on the pole to detect the surrounding light intensity and to start the street light with respect to the natural light intensity. A real time clock module is also connected to get the real time.
If the sensor will be sensing the light intensity the whole day, then it will be consuming much energy and also there are chances of failure of sensors very frequently.
So as per the weather in our country we drew a conclusion that before 5 p.m , there is always light in the environment, except some natural conditions such as storms or heavy rain.
Therefore we assume that in the atmosphere light prevails before 5 p.m.
So the LDR sensor will be checking the light intensity 2 times.Once at 5 p.m and second time at 6 p.m. As soon as the LDR sensor senses the resistance less than 200 ohms, then it will light up the street light.
There are possibilities that the sensor may not sense darkness in the atmosphere, as in summer there are chances that there is light in the sky.In that case the street lights will be made on at 7 p.m automatically.
This algorithm will automate the on/off of the streetlights and will also help in saving energy.
The energy will be saved as solar energy will be used to light the streetlights and even the working of the Arduino system.

IV. IMPLEMENTATION AND RESULTS

[13] The circuit diagrams are made using proteus software application.

A. Smart Traffic Light System

Here traffic light is connected to digital pin 11, 12, 13 as output.
Two IR sensor modules are connected with arduino with output on digital pin 3 and 4.
Also with IR sensor modules state change buttons are connected to demonstrate the obstacle detection.
Upon the state of IR sensor module traffic light is controlled.

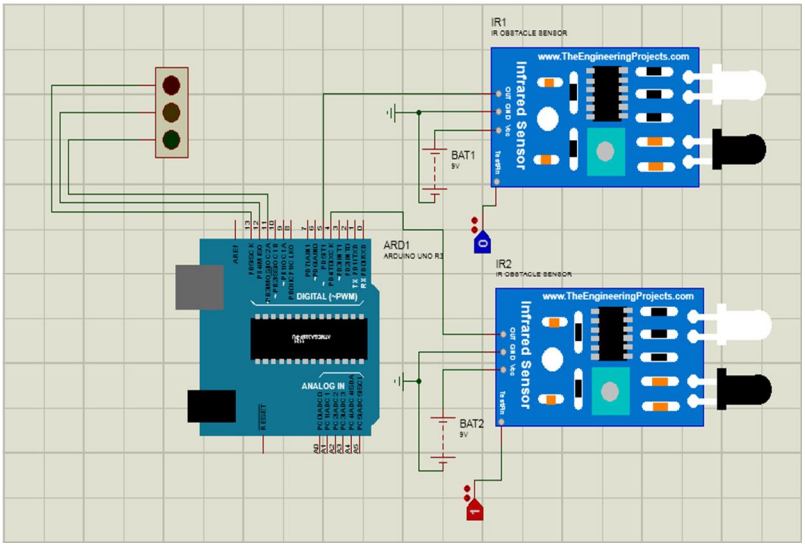

Fig 2.TrafficLight Automation circuit diagram

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B. Smart Street Light System

Here a yellow LED is connected to digital pin 11 as output, to demonstrate streetlight. Real time clock module (DS1307) is connected to arduino to get the real time. SCL and SDA pin of RTC is connected to SCL and SDA pin of arduino. On the analog pin A0 LDR sensor is connected to sense natural light intensity during evening(at fixed time).At the right of LDR sensor is a torch to throw light on it(for simulation purpose only).Also resistors are connected with RTC, LED and LDR to adjust current flow through them.

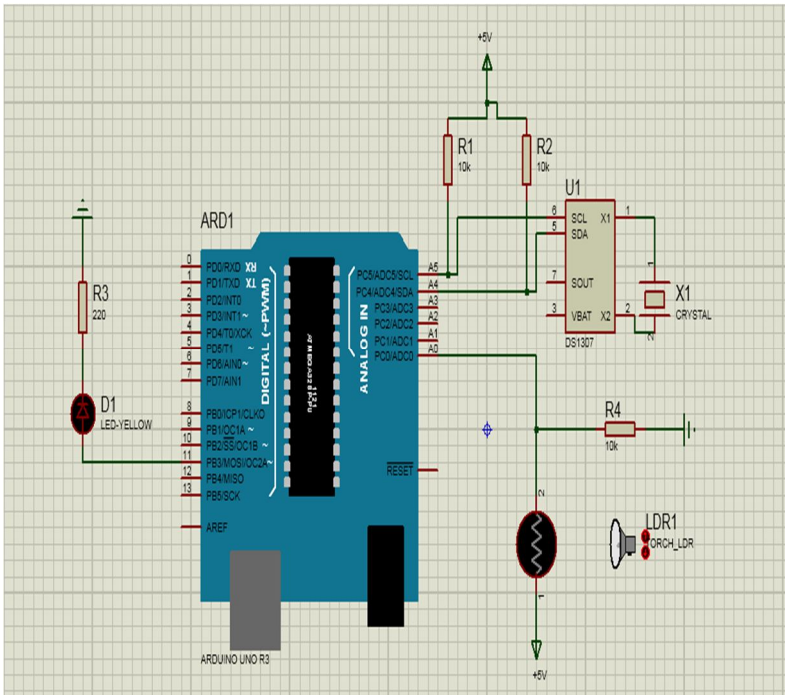

Fig 3. Street Light automation circuit diagram

1) Result: As per the implementation done, we got a Traffic Light and -Street Light management System which will be an effective system to fulfill the shortcomings of the traditional system and make the system smart.

This system will help in the optimisation of traffic lights, reducing the red light delays and also the fuel consumption.This method will help in making our traffic lights smarter and efficient.

This system will also help in making the street light system smart and also making it fault tolerant.

The overall system will be helping in controlling the usage of electricity and making this system economical and efficient.

V. CONCLUSION AND FUTURE SCOPE

Today's world is a really busy world. No one is ready to wait for anything and anyone.So for today's world this method will be of very much help. It will solve many problems and will be very advantageous as :-

A. Less manpower required.
B. Reduction in Traffic congestion.
C. Energy Efficient.
D. Cost Efficient.

The future scope of the system is

1) An application can be made which will tell current working status of the system and report system/hardware failures directly to the traffic control board so that they can act accordingly to it.
2) Power consumption by street lights and traffic lights can be recorded to the server and periodic analysis can be done.
3) The synchronisation of the traffic signal with the other signals which are on the road.

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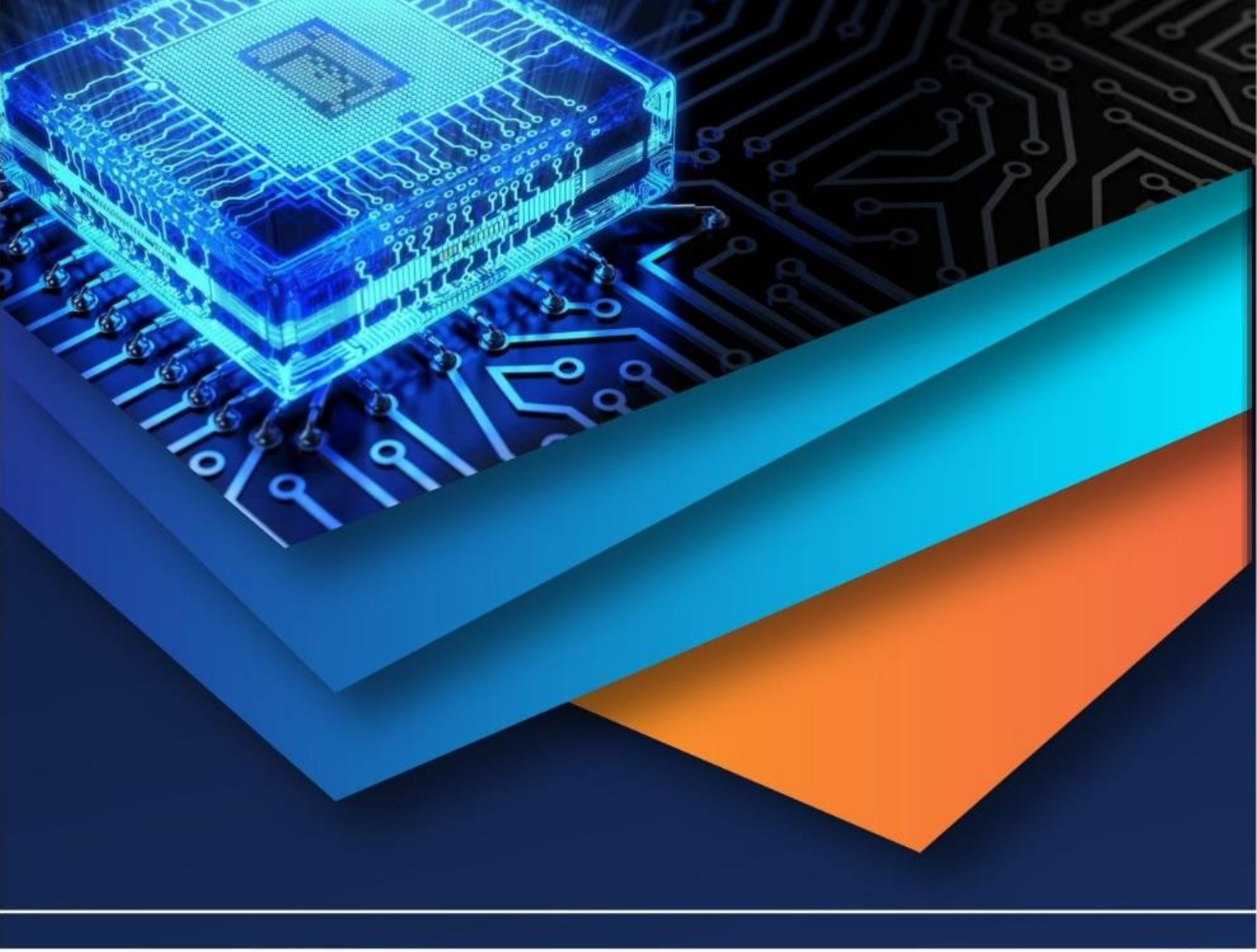

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