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High Efficiency Intelligent Street Lighting System Using a Zigbee Network and GSM

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Abstract: ***The proposed street lighting system is highly energy efficient and automated. It uses ZigBee-based wireless devices due to which street lamp system becomes more efficient. ZigBee network is connected to GSM through computer which is located in base station. Sensor combination is used to control and guarantee the desired system parameters. The information is transferred to a control terminal using ZigBee network which is used to check the prominence of the street light. Appropriate action is taken whenever system fails, by observing the status of street light.***
On the basis of the plan an automatic energy saving system for street lighting using ZigBee network is developed and tested.
Keywords: control terminal, street lighting system, ZigBee network, GSM

I. INTRODUCTION

In the present world generally street lighting system belongs to public sector. This consumes 20% of the total power and also it will contain many hurdles in the maintenance such as changing the damaged one's and also has to check weather all the lights are in working situation or not and switching on and off daily at particular times and also cost factor is very high. At present many technologies developed in all fields but the street light system is designed and developed on old methods so to improve the standards of street light system so in this paper it is tried to implement recent technologies in this field. And most of the companies are showing much importance to latest technologies by considering some of the factors such as safety of the pedestrians and night travellers and so on. In the existing system by making small changes there are many options to develop street light system according to our present day life without wasting time, power and money. The first and foremost opportunity is replacing the existing lamp with the LED(Light Emitting Diode) lamp which consumes less power and consistency time is very high when compared with other lamps. The second probability is to replace the power supply from power lines to solar energy which is available at free of cost. The third probability is adding some extra circuitry which consists of sensors such as presence sensor, emergency device, working sensor, light sensor. By which the maintenance of the system become less complex when compared with old method.

A. Objectives

In this system two street lamps are established and termed as monitoring station-1 and monitoring station-2. Practically as many as monitoring station can be designed. Each monitoring station consists of microcontroller, Zigbee, LCD, relay and different sensors. The three dedicated sensors which are LDR works for determining the information of day and night, PIR ensors which helps to detect the information of occurrence of human. Current Sensor is to measure the flow of current in the lamp load. These sensors continuously monitor the street lamps condition.

II. METHODOLOGY

Proposed methodology is divided into three parts. They are as follows:
Sensing System
Communication System
Control System
Sensing system consist of three sensor light dependent resistor, Motion sensor and current sensor. For sensing the status of street lamps, depending upon the data acquired by sensors the decision will be taken by microcontroller weather to turn ON/OFF the lamp. Communication system consists of Zigbee to transmit the sensor data of monitoring station-1 to another monitoring station towards the control station. It receives the commands from the control station to respective monitoring station for turning ON/OFF the lamp.

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Control system consists of microcontroller PIC16F877A for taking the desired action according to the sensor data of respective monitoring station.

A. Proposed model

Monitoring stations are consist of microcontroller which is used to transfer the current status of a lamp to a control station through Zigbee module and operate the lamp according to a command send from the control station with the help of relay.

The control station consists of microcontroller which is used to transfer the command received from the GSM module to a respective monitoring station through Zigbee module. It also consists of PC which stores the data base and controls the lamp through GUI via Zigbee module.

Figure 1 shows the block diagram of the proposed system. Each measuring system placed on the lamp monitors the street conditions like light intensity, presence of human being, depending on these parameters they decide to turn the lights "ON" or "OFF". The system also checks whether the lamp is working or not and sends the information through a wireless network to a control station. If any malfunction is detected.

Here a GSM modem is connected to the microcontroller in control station. In case of light sensor fails to turn off the lamp during the day time one can send the SMS to turn off that lamp. After sending, the message will be received by the GSM modem connected to microcontroller, the command will be sent from microcontroller through Zigbee to respective monitoring station to turn ON/OFF the lamp.

Each lamp post consists of several modules such as presence sensor, light sensor, Current sensor, and an emergency switch. These devices work together and transfer all of the information to a microcontroller which processes the data and automatically sets the appropriate course of action. A priority in the transmission of information is allocated to each sensor for example, the emergency switch takes precedence over any other lamp device.

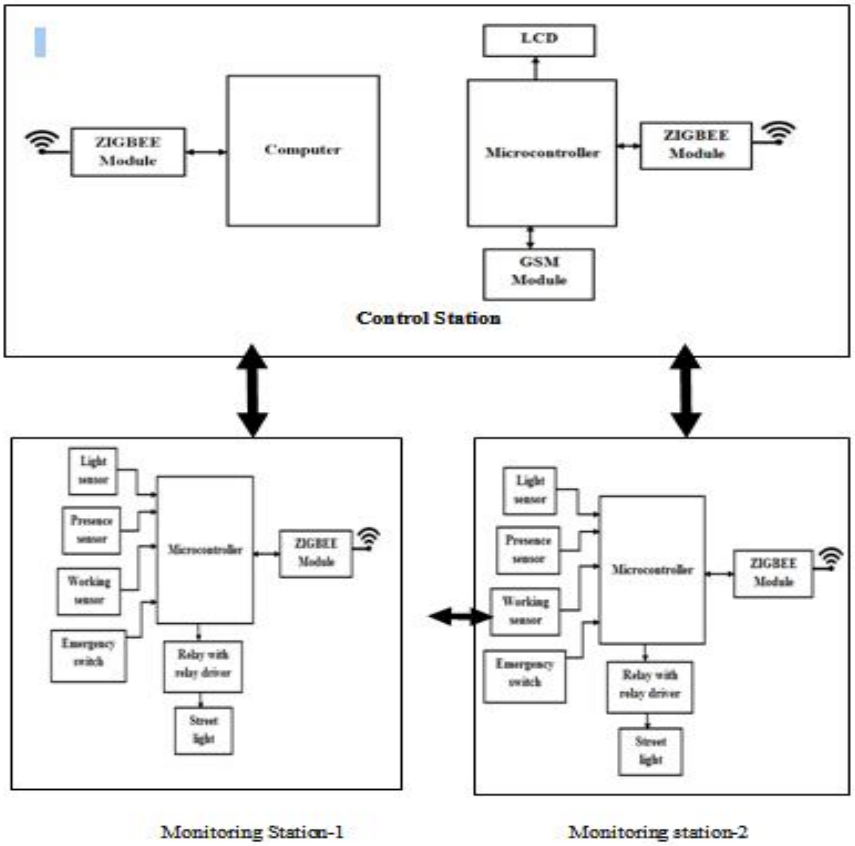


Figure 1 Block diagram of the proposed system

B. Presence Sensor

The task of the presence sensor is to identify the route of a vehicle or pedestrian, giving an input to turn on a lamp or a group of

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lamps. This function depends on the pattern of the street; in case of a street without cross-roads, a single sensor is enough (or one at each end in case of a two-way street), while for a street requiring more precise control, a solution with multiple presence detectors is necessary.

This feature allows switching on the lamps only when necessary, avoiding a waste of energy. The main challenge with such a sensor is its correct placement. The sensor should be placed at an optimum height, not too low (i.e., to avoid any erroneous detection of small animals) nor too high (for example, to avoid failure to detect children). A study of the sensor placement enables deciding the optimal height according to the user needs and considering the specific environment in which the system will work.

C. Light Sensor

A light sensor can measure the illumination of the sunlight and provides information. The purpose of this measurement in this system is to check the day light to keep the street light OFF during a day and to turn ON the light in night.

D. Current Sensor

This sensor is useful to improve fault management and system maintenance. It is possible to recognize when the lamp is switched on. The system is able to identify false positives, because identified parameters are compared with the stored data (e.g., lamps are switched off during daylight and the sensor incorrectly senses a fault, but the microcontroller does not report the malfunction because of additional logic functions). The information is reported through the Zigbee network to the station control unit, where the operator is informed about the location of the break-down lamp and can send a technician to replace it. The system current is 1.5 A, so a sensor suited to detect this current is necessary. An suitable threshold value to detect the operation of the lamp has been set between 1 and 1.5 A. The chosen sensor is the ACS712 of the Allegro Microsystems, an economical and accurate solution for AC or DC current sensing, particularly suitable for communication systems. It is possible to store in the microcontroller's memory the current value which flows in the LED lamp in ordinary operating conditions, enabling the online power consumption measurement.

E. Emergency Switch

The system has an emergency button, which can be useful in case of an emergency. This device excludes the entire sensor system with the objective to immediately turn on the lamp. The light will remain on for a stipulated time. After that, the button must be pressed again. This prevents the system from being accidentally active even when the necessity ends.

F. GSM Control Unit

The SMS sent from a person or operator will turn ON or OFF the street light if the system having any problem with Zigbee network. It will direct the node-1, node-2, and monitoring station to change the status of street lamp.

III. RESULT AND ANALYSIS

The possible contribution of the system is use to reduce the power consumption of a street light. It is a humble approach to diagnose the street light running conditions with an intelligent program within a microcontroller based dedicated system.

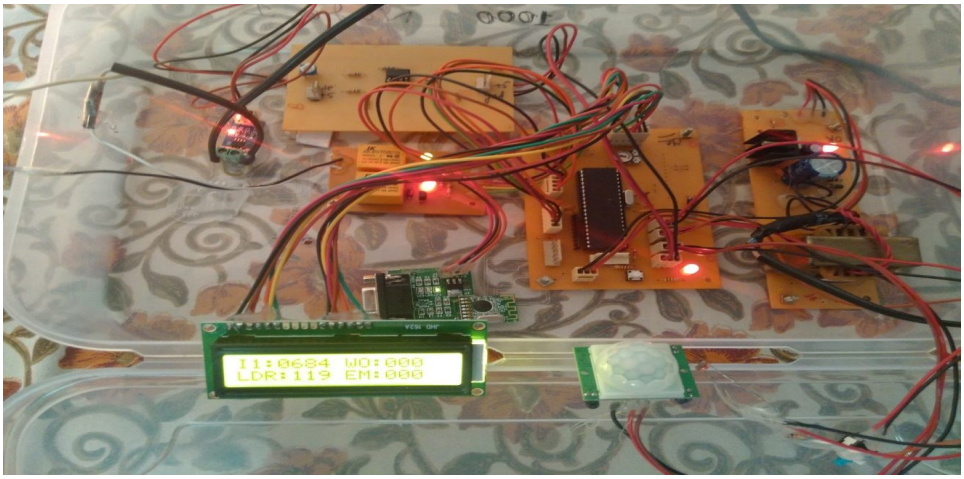


Figure 2 Monitoring Station

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the uniqueness of the proposed system is that the abnormal running conditions of street light installed at different locations are detected, diagnosed and reported to control station. Also the street light can be control through a mobile

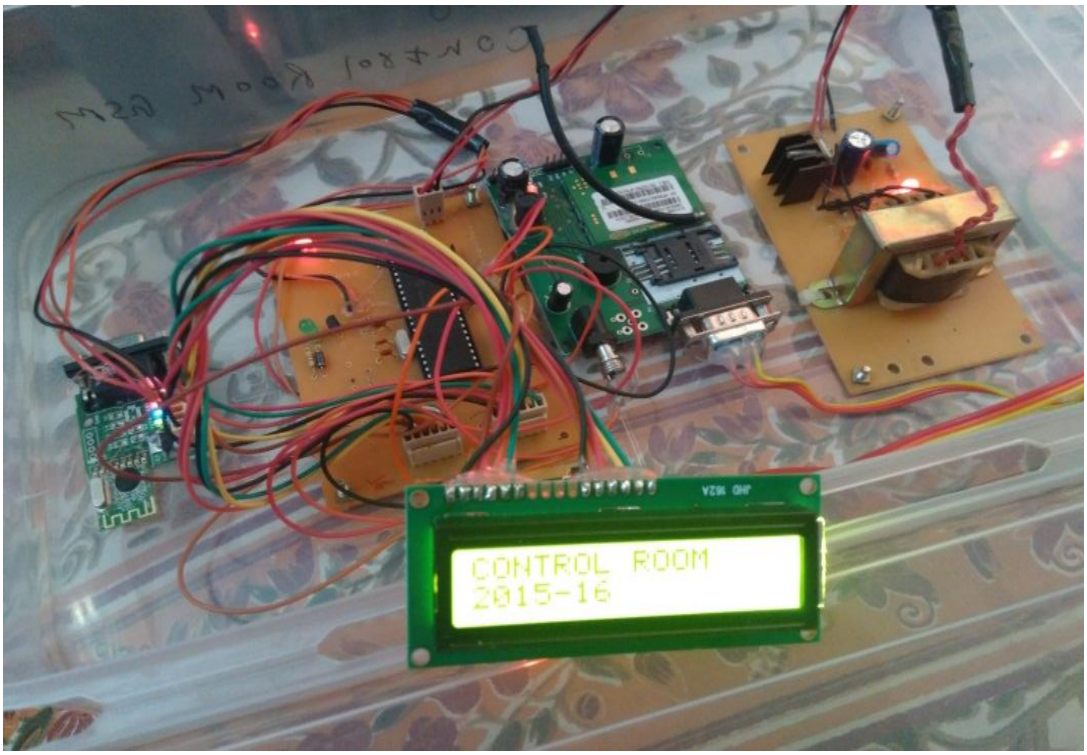


Figure 3 Control Station GSM

This system minimizes the consumption of electricity and contributes for saving the energy. This system will increase flexibility, cost effectiveness and will be small in size in terms of product. This system will consume less power and will reduce complexity.



Figure 4 Sensors Status on LCD

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A. Comparison of Normal and proposed system

Different types of load were used for testing the system, some of them are describe below.

FTL = Fluorescent Tubular Lamp, HPSVL = High Pressure Sodium Vapor Lamp, MVL = Mercury Vapor Lamp.

In normal system the lamp is continuously ON for 12 hours but in the proposed system the experimented values considering the lamp was ON for four hours which can be changed showing various factors like season, fog, or might be the frequency of vehicles or persons.

From the below table one can predict that the traditional street lights having various types of bulbs in which FTL T12 40W - 1.2m were consuming 18 units per month was reduced to 6 units per month so saving of 12 units is observed, which means the saving is 66.66%.

In another case the street lamps currently installed in few district of Maharashtra in which by considering FTL T5 28W - 1.2m is consuming 10.08 units per month where as by applying this project then in that case the total time of four hours if it is ON then it will consume 3.36 units per month which means the saving of 66.67% of energy.

The total power consumption in x hours is calculated as (Rating*x/1000) (kWh). The total power consumption in a month is calculated as (total power consumption in 1 day*30).The billing amount is considered as per Municipal Corporation Areas Energy Charge (Rs. /kWh) of Maharashtra state electricity distribution co. ltd. as Rs 5.80/-.

Table 1

Comparison of normal and proposed system

Type	Rating (W)	NORMAL SYSTEM			PROPOSED SYSTEM			UNITS SAVED
		UNITS FOR 12 HOURS	UNITS PER MONTH	COST PER MONTH (RS)	UNITS FOR 4 HOURS	UNITS PER MONTH	COST PER MONTH (RS)	
FTL T12 40W-1.2m	50	0.6	18	104.4	0.2	6	34.8	12
HPSVL 70	82	0.984	29.52	171.216	0.328	9.84	57.072	19.68
MVL125	145	1.74	52.2	302.76	0.58	17.4	100.92	34.8
HPSVL/MVL 150	175	2.1	63	365.4	0.7	21	121.8	42
HPSVL/MVL 250	285	3.42	102.6	595.08	1.14	34.2	198.36	68.4

FTL = Fluorescent Tubular Lamp, HPSVL = High Pressure Sodium Vapor Lamp, MVL = Mercury Vapor Lamp, Low Pressure Mercury Fluorescent Tubular Lamp (T12 &T8), Energy-efficient Fluorescent Tubular Lamp (T5), Light Emitting Diode (LED) [6]

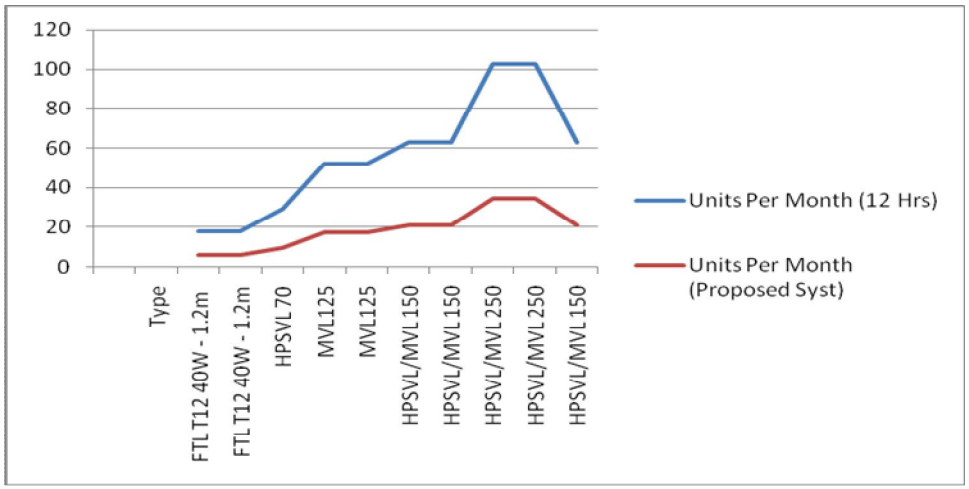


Figure 5: Graph of unit consumptions per day

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B. Graphical Output

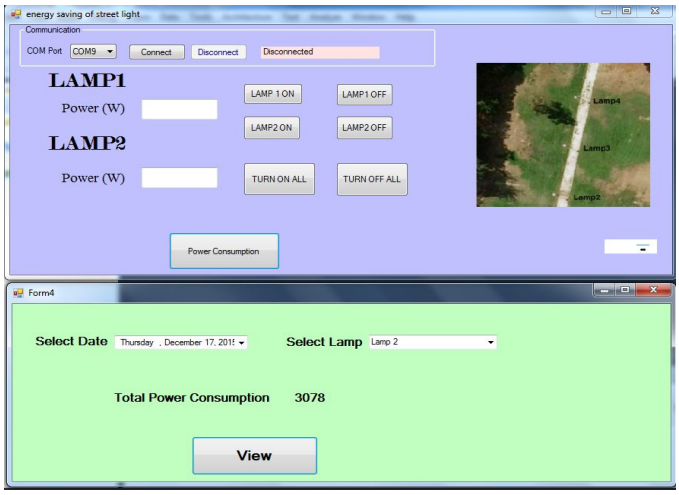


Figure 6: Graphical result windows

The GUI shows the status of two Lamps power consumption, it also provide the respective control buttons to turned ON & OFF the lamps. It maintains the day wise data base of power consumption of each lamp as well as total power consumption for the future reference.

IV. CONCLUSION

This system provides an efficient and smart automatic control system with the Zigbee technology. The system can reduce energy consumption and maintenance costs and also helps to reduce crime activities up to certain limit. This streetlight control system helps in energy savings, detection of defective lights and maintenance time and increase in life span of system.

Another advantage obtained by the control system is the intelligent management of the lamp posts by sending information to a central station by Zigbee wireless communication. The system maintenance can be easily and efficiently planned from the central station, allowing additional savings.

The proposed system is particularly appropriate for street lighting in urban and rural areas where the traffic is low at a given range of time. The independent nature of the power supply network enables realizing the system in remote areas where the classical installations are prohibitively expensive. The system is always flexible, extendable, and fully adjustable to user needs. The simplicity of Zigbee, the reliability of electronic components, the feature of the sensor network, the processing speed, the reduced costs, and the ease of installation are the features that characterize the proposed system.

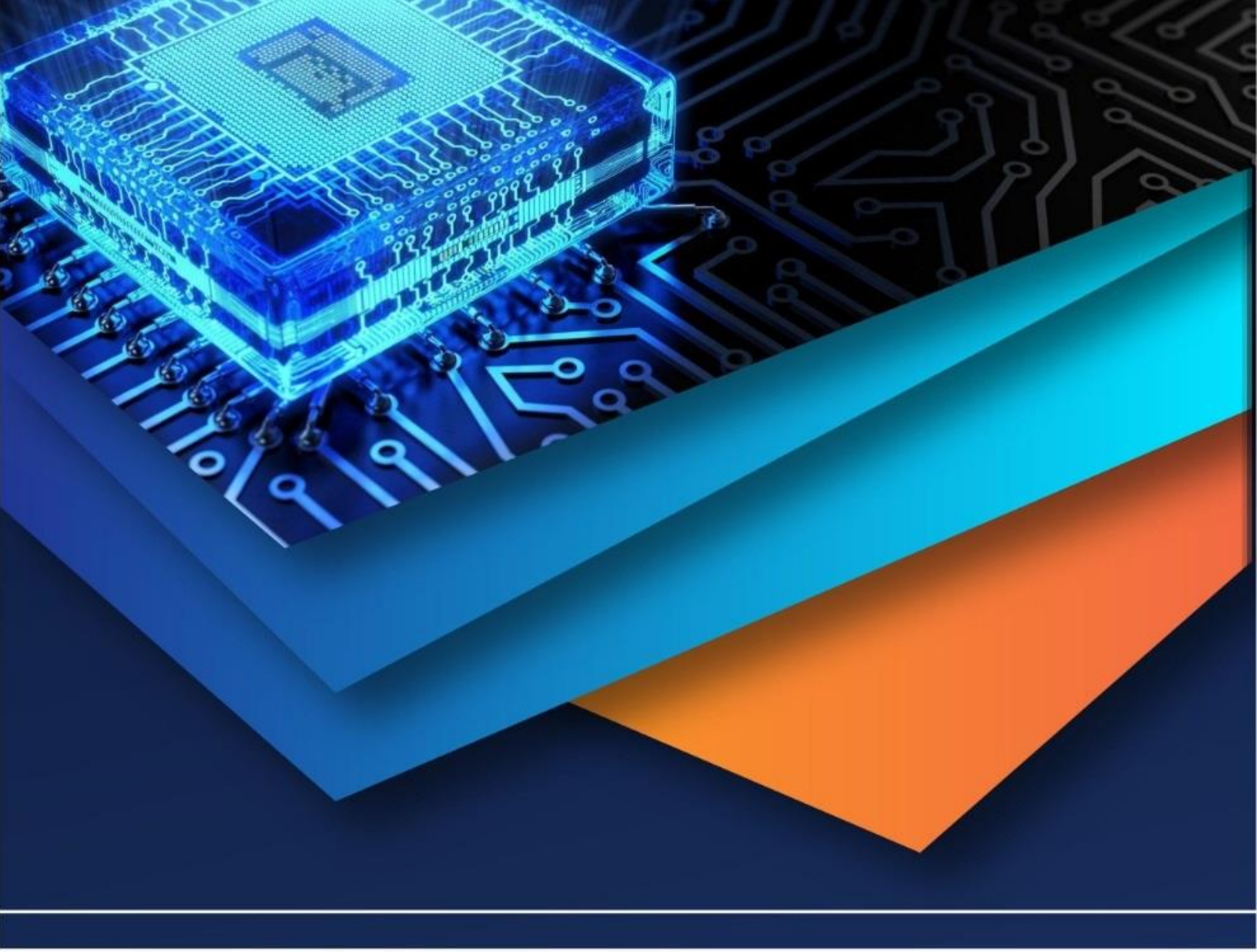
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