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LPG Leakage Detection and Controlling using IOT Module

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Abstract: Speculations have been on compromise from significant time and age in the field of kitchen home automation. Predominantly it was termed as domotics or home analytics to be called whole. Although there have been several advancements in this domain, there has never been a distant operation application when it came to this vital part of the kitchen automation. Here in the paper, the LPG distant control operation of the regulator knob enables the paper to have a multi variant of security and reliability factor. Also, the paper aids for monitoring and utilization aspect of the paper helps determine the entire content of fuel present in the cylinder for greater economic balance of the fuel with near zero wastage factor. Gas explosions has been a prime problem statement supporting the paper on multiple levels, to overcome that we come up with a gas leakage detection system to increase the safety of the human factor and henceforth makes the operation of the whole system simplified with increase in safety factor
Keywords: Domotics, Security and reliability factors, Distant Operation

I. INTRODUCTION

Like many countries, India relies on LPG and cooktops for most of its cooking needs. A national action plan aims to expand liquefied petroleum gas (LPG) access to 50% of the country's population by 2020. While the country's southern urban areas have made progress toward this goal, LPG use for cooking remains low in the north. Far too many people affected by crises must risk their health, safety, and livelihoods to cook a meal for their families. Without access to modern cookstoves and fuels.

The main motive behind this paper is to design an innovative and structurally beneficial LPG cooktop that which can effectively controlled on a distant basis to make life much simpler for the homemakers who are the prime users of this component.

The paper aims to control the regulation aids of both the LPG cylinder and the flame control of the stovetop. The paper aims to have a microcontroller, a WIFI based android platform and stepper motors to produce a solution for all the challenges.

A. Objective

The main objective of the paper is to find an ideal solution to minimize the efforts of the homemaker and the reduce all forms risks to its best capability. The paper also aims at creating a multitasking environment for the user and the automation creates a unique and modern experience for the user for healthy and quick cooking practice with the best of efficiency. The operations performed by the paper include

1) Distant control of LPG cylinder regulation to avoid accidents and mishaps.
2) System to analyze the amount of LPG left in the cylinder, thereby making it easier to save the fuel.
3) A fully operational LGP leakage sensor to provide necessary safety measure.
4) All time troubleshoot option to scan and detect any error at any point of time within the system effectively and efficiently.

Looking to bring about a safe, efficient, fully automated stove craft system that is fully accessible and controlled using any android handset.

B. Problem Statement

In every household LPG may leak as a gas or a liquid. If the liquid leaks it will quickly evaporate and form a relatively large cloud of gas which will drop to the ground, as it is heavier than air. This may lead to massive danger and accidents. To overcome this is a gas cylinder regulation remote control system. This saves time and safeguards from most forms of danger. It also ensures judicious usage. Safe and efficient cooking methods is the key to saving energy and time with use of the right tech. It is no groundbreaking technology, but it can have the potential to significantly decrease our efforts and minimize the risks when comes to utilization LPG as a cooking fuel. These small solutions can bring big changes and can bring about modernization of the very basic daily equipment, a domain rarely looked upon of LPG with almost zero wastage.

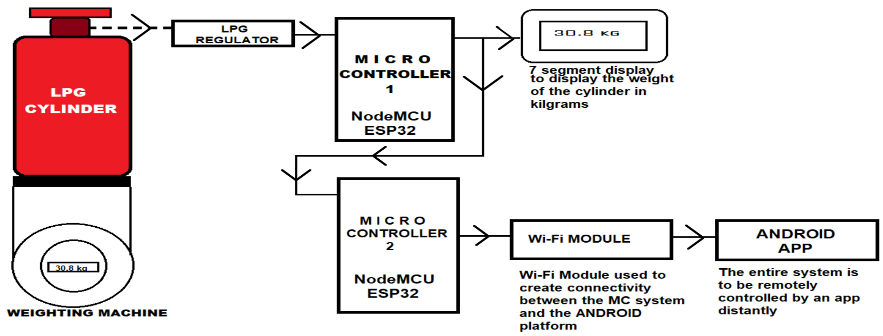

Fig1: Block diagram representing the working of LPG leakage detection and controlling module.

Fig 1 To analyze the usage of LPG consumption, the paper aims at calculating the amount of LPG content present inside the cylinder at any point of time. To do so we make analysis of the weight of the cylinder and hence subsequently measure the LPG content in terms of percentage. For this a Load Cell (CZ601) is used for conversion of mass-based tension into electronic output signal. Furthermore, usage of the NodeMCU ESP8266 module is used for better precision and overall handling of the module

II. THEORITICAL ANALYSIS

A. NodeMCU ESP8266

NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added. NodeMCU has a UART buffer size of 128 chars whereas Arduino UNO has only 62 chars. Android runs on devices of all shapes and sizes, providing you a vast opportunity for continued user engagement. Android initially came into existence with the sure-fire idea that developments are given the power and freedom to create enthralling Mobile applications while taking advantage of everything that the mobile has to offer. Environment Dynamic Monitoring and Remote Control of Greenhouse designed with ESP8266 NodeMCU. NodeMCU Choreography Automation by CoAP designed with NodeMCU. An IoT based Smart Garbage Alert System designed using NodeMCU. A Smart Power Meter to Recharge Electric Vehicles in Communal Parking Areas using NodeMCU. A Geo tagged internet of things (IOT) device for radiation monitoring designed using NodeMCU. Implementation of a System for the Evaluation of Environmental Factors that Use the Internet of Things with the help of

NodeMCU had been designed. A Very Low Cost, Open, Wireless, Internet of Things (IoT) Air. Quality Monitoring Platform has been designed using NodeMCU. A Mongoose RTOS based IoT Implementation of Surveillance System had been designed using NodeMCU. Design and Fabrication of Smart Home with Internet of Things Enabled Automation System is suggested using NodeMCU.

NodeMCU uses an on-module flash-based SPIFFS (Serial Peripheral Interface Flash File System) file system. NodeMCU is implemented in C and is layered on the Espress if NON-OS SDK. The firmware was initially developed as is a companion paper to the popular ESP8266-based NodeMCU development modules, but the paper is now community-supported, and the firmware can now be run on any ESP module. Generally, we can find NodeMCU Dev boards of make Amica, DOIT,Lolin & D1 mini /Wemos etc. in market. Amica produces NodeMCU ESP8266 Development Boards v1.0(Version2) with designed hardware specifications.

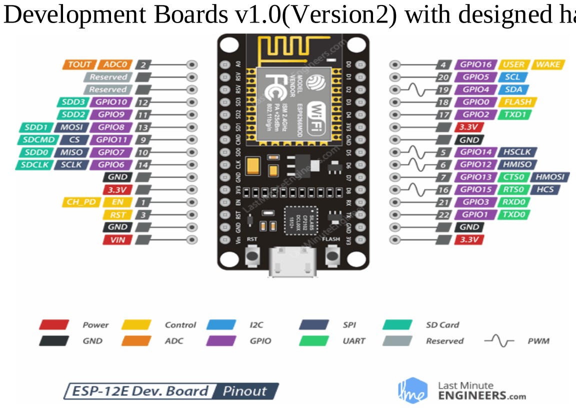

Fig2: Pin out description of a standard NodeMCU ESP8266 module that is being used

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B. Load Cell CX601 (80kg)

A load cell is one of the most used components in all the weighing scales. A load cell necessarily converts force in terms of mass into electronic output signals and hence acts as a transducer, types of which are: - Pneumatic, Hydraulic, Digital, IC based etc. We have here developed one such load cell using a little-known component named a strained gauge using a load cell CX601. A strain gauge again is here one such component where when a mechanical displacement is subjected to it, converts change in resistance. It is a thin wafer like material that is easily attached and soldered to the load cell wheat stone arrangement. The coil used here has a resistance between 345ohms to 360ohms that varies on application of force. The whole application is based on the principle of resistivity that is the resistivity of a given conductor is directly proportional to the length of the conductor and inversely proportional to the area of cross section. Resistivity is the basic property by means of which current flows in a coil. greater the resistivity, lesser will be the rate of flow of current. Now the universal truth in case of a strain gauge is that when weight is applied on a strain gauge there is compression on the coil area and resistance goes up. From the output voltage obtained we set the threshold from the obtained research data over full to empty weights of a standard LPG cylinder and convert it into percentage basis. It is calibrated as 100% = 30kgs. Subsequently it shows reduction with respect to usage.

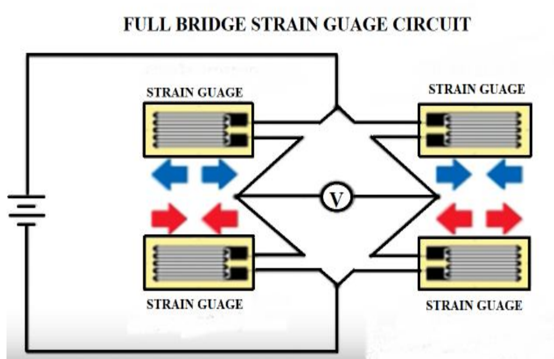
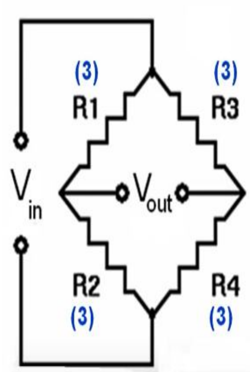


Fig3: Circuit description of strain gauge arrangement

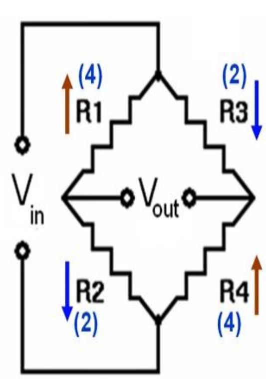


$$V_{in} = 5.00\ volts$$

$$V_{out} = \left(\frac{R_4}{R_3 + R_4} - \frac{R_2}{R_1 + R_2}\right)V_{in}$$

$$V_{out} = \left(\frac{3}{3+3} - \frac{3}{3+3}\right)5.0$$

$$V_{out} = 0$$



$$V_{in} = 5.00\ volts$$

$$V_{out} = \left(\frac{R_4}{R_3 + R_4} - \frac{R_2}{R_1 + R_2}\right)V_{in}$$

$$V_{out} = \left(\frac{4}{2+4} - \frac{2}{4+2}\right)5.0$$

$$V_{out} = \left(\frac{4}{6} - \frac{2}{6}\right)5.0$$

$$V_{out} = 1.667\ volts$$

Fig4: Output voltage generation design when weight is applied on the load cell

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C. Bipolar Stepper Motor

One of the easiest and inexpensive way to control stepper motors is to interface L298N Motor Driver with ESP8266. It can control both speed and spinning direction of any Bipolar stepper motor like NEMA 17. As L298N module has two H-Bridges, each H-Bridge will drive one of the electromagnetic coils of a stepper motor. By energizing these electromagnetic coils in a specific sequence, the shaft of a stepper can be moved forward or backward precisely in small steps. However, the speed of a motor is determined by the how frequently these coils are energized. Below image illustrates driving stepper with H-Bridge. In our paper, we are using NEMA 17 bipolar stepper rated at 12V. It offers 200 steps per revolution and can operate at 60 RPM. If you do not already have these specifications, find out now as you will need them for the sketch. Before we start hooking the motor up with the module, you will need to determine the A+, A-, B+ and B- wires on the motor you plan to use. The best way to do this is to check the datasheet of the motor. For our motor these are red**,** green**,** blue and yellow**.**

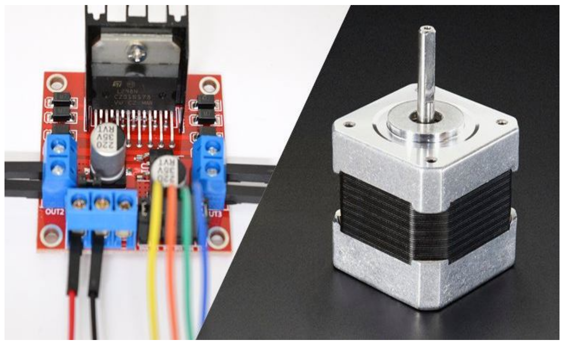

Fig5: LM298 motor driver circuit and NEMA 17 Stepper Motor

SPECIFICATIONS	QUANTITY
RATED VOLTAGE	12V DC
CURRENT	1.2A at 4V
STEP ANGLE	1.8 DEGREES
NUMBER OF PHASES	4
MOTOR LENGTH	1.54 inches, 4-wire, 8 inch lead
OPERATING TEMPERATURE	-10 degrees to 40 degrees
UNIPOLAR HOLDING TORQUE	22.2 oz-in

Fig6: NEMA 17 Stepper Motor Technical Specifications

D. MQ6 Isobutane Propane Gas Sensor

Detects the leakage of LPG up to 0.001% accuracy. It gives a signal to the microcontroller that in turn closes the LPG regulator or to be turned off via the stepper motor to prevent further mishaps when the LPG gas is detects a voltage is generated, higher the intensity of the LPG gas, greater the voltage and the subsequent action.

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remarks
Vc	Circuit voltage	5V±0.1	AC OR DC
V_H	Heating voltage	5V±0.1	ACOR DC
P_L	Load resistance	20KΩ	
R_H	Heater resistance	33Ω ±5%	Room Tem
P_H	Heating consumption	less than 750mw	

B. Environment condition

Symbol	Parameter name	Technical condition	Remarks
Tao	Using Tem	-10℃-50℃	
Tas	Storage Tem	-20℃-70℃	
R_H	Related humidity	less than 95%Rh	
O_2	Oxygen concentration	21%(standard condition)Oxygen concentration can affect sensitivity	minimum value is over 2%

C. Sensitivity characteristic

Symbol	Parameter name	Technical parameter	Remarks
Rs	Sensing Resistance	10KΩ - 60KΩ (1000ppm LPG)	Detecting concentration scope: 200-10000ppm LPG , iso-butane, propane, LNG
α (1000ppm/ 4000ppm LPG)	Concentration slope rate	≤0.6	
Standard detecting condition	Temp: 20℃±2℃ Vc:5V±0.1 Humidity: 65%±5% Vh: 5V±0.1		
Preheat time	Over 24 hour		

D. Strucyure and configuration, basic measuring circuit

Fig7: Standard specifications of MQ6LPG leakage detection sensor

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III. DESIGN AND CONSTRUCTION

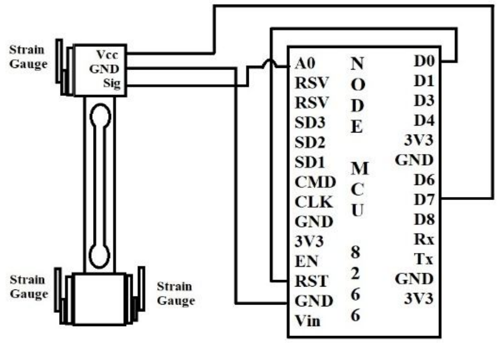

Fig8: Descriptive connection diagram of Load Cell NodeMCU construction

The above shown circuit shows our weight monitoring equipment, we have designed a unique strain gauge based amplifying device instead of using the stand HX711 amplifier.

Sig – signal output line in volts

Vcc – input in terms of 5V

RST – To reset

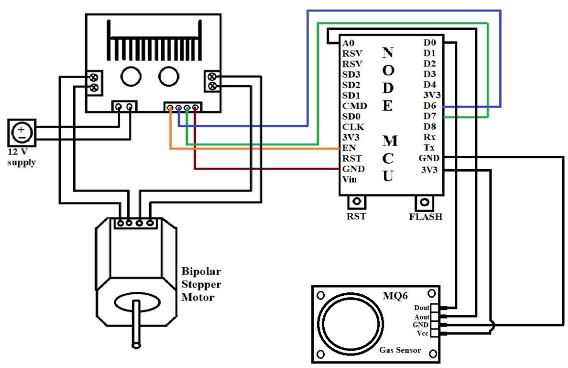

Fig9: Descriptive connection diagram of Distant control of LGP regulator and leakage detection system

This fig shows the Leakage sensor and stepper motor setup, we use a bipolar stepper motor where rotation occurs on both directions. EN – EN pin acts when function is to be done in high power and disabled when function is to be done in low power. We use a motor driver to control the steps and angular precision of the stepper motor. It is mostly used in motor driver's designing. It has two specific pins for enabling or disabling the device attached at its output.

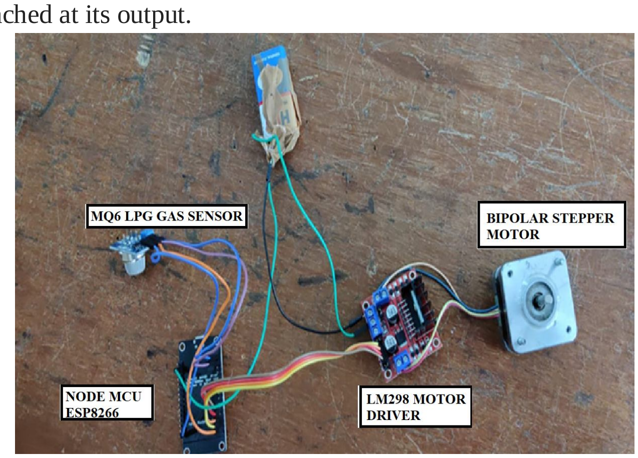

Fig10: Practical connection description of the Distant control of LPG regulator and leakage detection system module

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IV. RESULT ANALYSIS

Pertaining to observation it was noted that module developed not only aided in distant control operation of the LPG regulator. Once the tolerance level would reach 63ppm, the stepper motor enables to lock the regulator onto the off position so no chance of any accidents may occur. Furthermore, the stepper motor enables the regulator to drop back to its original position only if the LPG content drops below 63ppm.

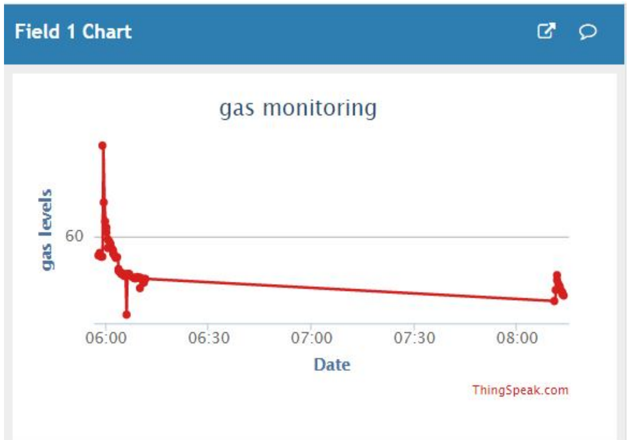

Fig11: Representation of the rise of LPG levels in the air and subsequent drop in a time of 2 hours as detected by the module

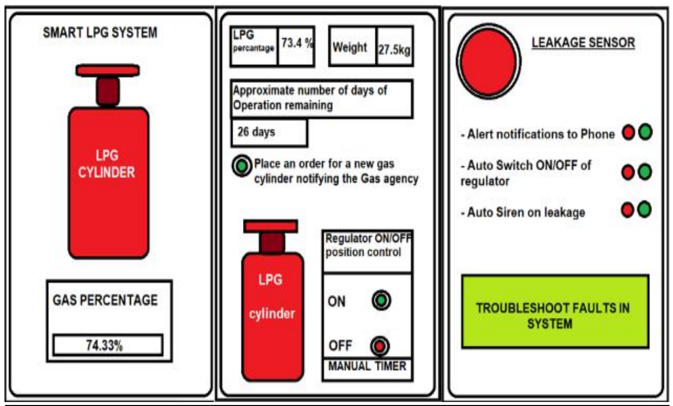

Fig12: Various templates as displayed on the IoT enabled android application

V. CONCLUSION

Safe and efficient cooking methods is the key to saving energy and time with use of the right tech. It's no groundbreaking technology but it can have the potential to significantly decrease our efforts and minimize the risks when comes to utilization LPG as a cooking fuel. These small solutions can bring big changes and can bring about modernization of the very basic daily equipment, a domain rarely looked upon. The aim of this paper is to create a full automated and controlled LPG-Stovetop system that utilizes the Android platform as a medium for control and operation of the entire LPG management system.

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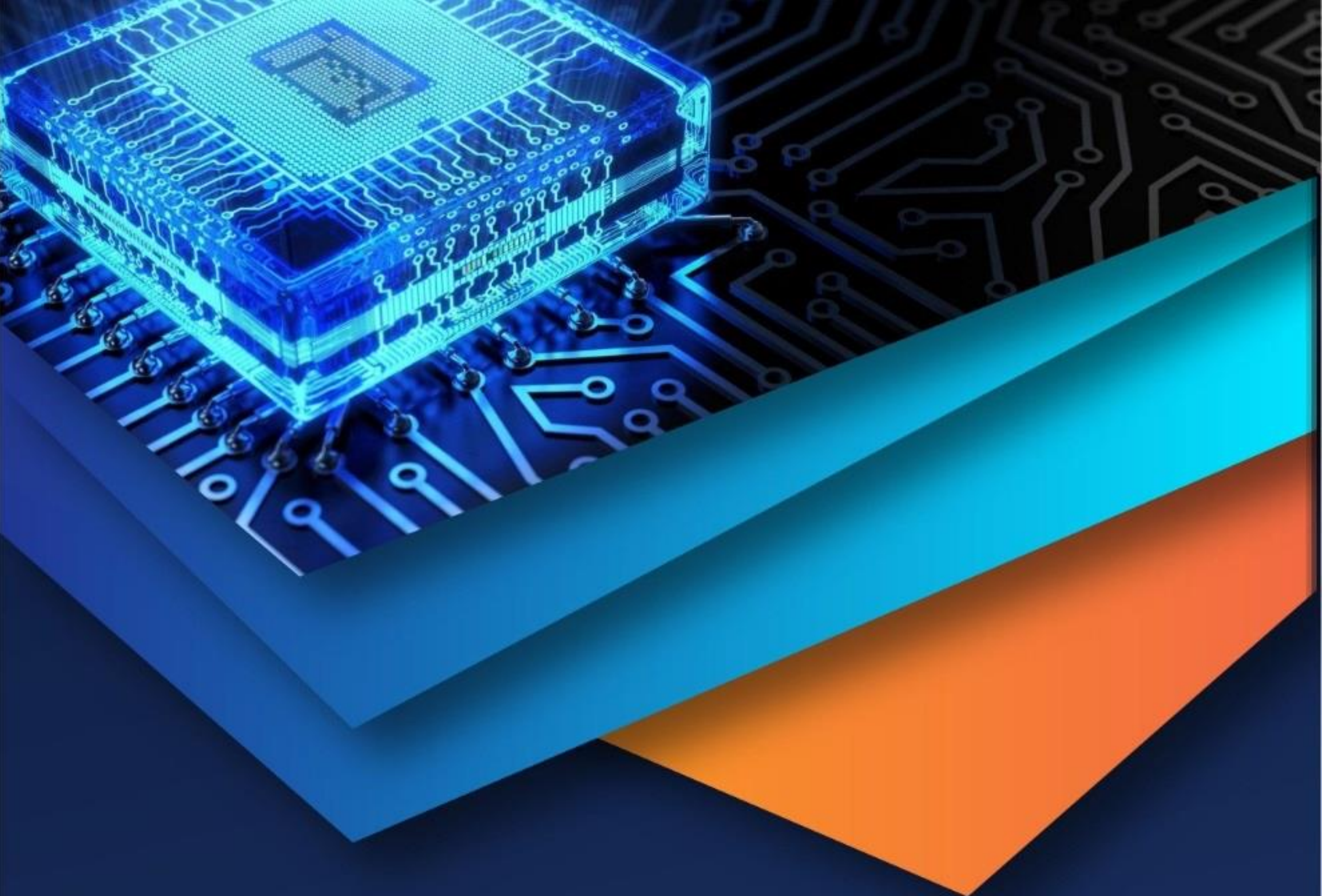

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