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IOT Based Gas Level Detection and Automatic Booking through GSM based Message Alert System

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Abstract: LPG is a common fuel for cooking worldwide due to its affordability, accessibility, and efficiency. This paper explores an IoT-based system designed to monitor and display the LPG level in household cylinders while also enabling automatic cylinder ordering and gas leakage detection. The system utilizes an HX711 load sensor connected to an Arduino to measure the real-time LPG level. A GSM module sends SMS alerts to users and automatically places an order for a new cylinder by dialing a pre-registered booking number when the gas level drops below 1000 grams. Additionally, an MQ-2 gas sensor detects leaks, enhancing house hold safety. The current LPG level is continuously displayed on an LCD, allowing users to track usage from the date of installation. By providing timely notifications, the system helps prevent issues such as last-minute ordering delays. Furthermore, gas leak detection ensures a safer cooking environment by reducing the risk of accidents caused by leaks.
Keywords: LPG, IoT, Gas Leakage Detection, Automatic LPG Booking, Arduino, GSM Module, Load Sensor.

I. INTRODUCTION

LPG cylinders play a vital role in our daily lives. One of the primary uses of LPG is to replace chlorofluorocarbons, which are harmful to the ozone layer. Although LPG is one of the most commonly used fuels, it has an explosive range of 1.8% to 9.5% gas concentration in air. LPG cylinders are categorized into three types based on the weight of the gas they contain: domestic, commercial, and industrial. The domestic LPG cylinder typically holds 14.2 kg of LPG, while the commercial and industrial cylinders contain 19 kg and 35 kg of LPG, respectively. As the demand for LPG increases, users are required to pre-book their cylinder at least a month in advance. However, many users face challenges in determining how much LPG is left in the cylinder, which often causes inconvenience. In such cases, an efficient method for monitoring LPG levels is needed so that users can be informed about the remaining gas. This paper discusses a system designed to detect both gas leakage and LPG levels in cylinders, as well as automatically place orders for new cylinders. The sensors used in this system have high sensitivity and fast response times. The gas sensor can detect various gases, including cigarette smoke. When gas is detected, the sensor sends the output to a microcontroller, triggering an alarm. If the LPG level, measured using a load sensor, falls critically low, the system alerts the user and automatically places an order for a new cylinder. The main goal of this system is to address issues such as delays and the need for pre-booking, ensuring a smoother LPG cylinder booking experience for consumers.

This paper proposes a new method to estimate the The suggested system for gas level detection and automatic booking was analyzed comprehensively to evaluate its performance, reliability, safety, and user experience. These aspects were assessed based on experimental testing and simulations, demonstrating the system's effectiveness in addressing real- world challenges in gas cylinder management. Results are validated with respect to a personal pulse monitoring device. The paper approach was arranged as follows: Section II describes the literature survey, Section III System design analysis, Section IV explains the system requirements, Section V discusses System Architecture, Section VI Methodology, Section VII and VIII results and finally conclusion is presented.

II. LITERATURE SURVEY

Most industrial fires are trig- gered by gas leaks, which can have devastating effects on equipment, human lives (leading to injuries and fatalities),and the environment. The current gas leak detectors typically rely on on-site alarms to alert people in the vicinity. In response, this concept introduces a gas leakage detector that not only triggers an on-site alarm but also sends SMS alerts to concerned individuals, providing an additional layer of safety. The presence of dangerous gases, such as LPG, Methane, and Benzene, is detected by this detector. LPG and Methane gases can catch fire, resulting in explosions. If inhaled in high enough concentrations, benzene is a carcinogen that can harm workers' health [1-4]. Every minor task on this globe is automated by the cyberspace of belongings, making our lives easier. The internet of things is now being used for security purposes as well.

The main issue today is the discharge of gas from pipelines. The primary mental goal of this research is to identify gas leaks in the pipeline. Again and again, gas detection sensors will be utilized to inspect the pipelines. If there is a leak in the pipeline, it will be detected, and information such as the name of the gas, its pressure rate, and the location of the leak will be sent to mobile phones, laptops, and other IOT devices. The precise location of the gas leak will be determined via GPS [5-7]. This author's presents the design and implementation of a smart cooking stove equipped with safety features. The research also introduces an energy harvesting system that captures heat from cooking aiming to enhance the efficiency of traditional stoves. This is achieved through the use of a heat-absorbing body coupled with a thermoelectric Cooler (TEC) module. The Seebeck effect is utilized to absorb heat and generate power via the TEC module. An IoT server has been used to develop a sensor-based safety feature that may detect gas leaks and warn the user through mobile SMS [8-11]. Meanwhile, the gas level in the system is continuously monitored, and it also notifies there level and branches about where the new LPG cylinder needs to be delivered. The radio frequency module, which comprises of a transmitter and receiver kit, is used to make it easier for the user to operate. It also has the advantage of providing the same information, in addition to being simple to use. The temperature sensor is also employed to detect anomalies caused by the surrounding environment. A key limitation of this system is that it utilizes a CPU instead of a dedicated controller, and it lacks user security features [12-14].

III. ANALYSIS

Accuracy of Gas Level Measurement The system employs a load cell sensor to monitor the weight of the gas cylinder, enabling it to calculate the remaining gas level. During testing, the sensor demonstrated an accuracy of ±2% when compared to a calibrated digital weighing scale, which is sufficient for domestic applications. Calibration was performed to account for environmental factors such as temperature and humidity. However, discrepancies were observed if the cylinder was placed on an uneven surface, leading to slightly incorrect readings. This limitation highlights the need for a stable and level base to ensure reliable performance. Overall, the system offers a high degree of precision, making it suitable for real- time monitoring.

Latency analysis focused on the time required to detect low gas levels and initiate the booking process. The system's IoT module transmitted data to the cloud server within 1 second on average, while the gas supplier's API response time was approximately 2 seconds. This resulted in a total end-to-end latency of 3 seconds. Such performance is efficient for non- critical applications like gas refill booking, ensuring users are promptly notified when their cylinder requires replacement. The low latency also enhances the user experience by minimizing delays in processing. The system incorporates a gas leakage detection feature, which uses a gas sensor to identify leaks and immediately alert users via notifications or alarms. This feature significantly enhances household safety by ensuring timely responses to potentially hazardous situations. Furthermore, the inclusion of real-time alerts for low gas levels ensures that users are aware of their cylinder's status, reducing the risk of running out of gas unexpectedly. These safety mechanisms make the system more than just a convenience tool, positioning it as a critical component for home safety.

The user experience was evaluated through the system's ease of use, accessibility, and notification efficiency. Users receive real-time updates on their smart phones through a mobile app or web dashboard, ensuring seamless integration into daily life. The automatic booking feature, triggered when gas levels drop below a predefined threshold, eliminates the need for manual booking, saving users time and effort. Feedback from test participants highlighted the system's user-friendly design and its ability to enhance convenience in managing gas refills. Scalability is an essential factor for IoT-based systems. The proposed system is designed to support integration with multiple gas cylinders, making it suitable for industrial or commercial applications. The software architecture can be easily expanded to accommodate additional sensors and users, ensuring its utility in larger-scaled employments. Flexibility in API integration also enables the system to work with a wide range of gas suppliers, although this requires customization based on each supplier's technical infrastructure. This adaptability increases the systems potential for wide spread adoption across diverse user groups. Despite its advantages, the system faces several challenges. Network connectivity issues, particularly in rural or remote areas with limited Wi-Fi access, can hinder performance. While the system is designed to operate efficiently under stable network conditions, interruptions in connectivity can lead to delayed notifications and booking processes. Addition- ally, integrating the system with multiple gas suppliers' APIs presents a significant challenge. Variations in API protocols and authentication mechanisms require considerable effort for customization and testing.

IV. SYSTEM REQUIREMENT

The proposed gas level detection and automatic booking system utilizes a combination of hardware and software components to develop a smooth and efficient solution for managing gas refills.

The hardware setup includes the Arduino Uno, which acts as the central processing unit for the system. The ArduinoUno is a microcontroller board equipped with 14 digital I/O pins and 6 analog inputs, offering enough capacity to handle the sensors and communication modules. It is widely used due to its ease of use and compatibility with various sensors, making it an ideal choice for this project. For displaying the gas levels and system status, the system incorporates a 16x2 LCD display. This LCD provides users with real-time information about the remaining gas levels in the cylinder and alerts for any system errors or warnings, such as low gas or a detected gas leak. The GSM module is another critical hardware component. This module, such as the SIM800L or SIM900, allows the system to send SMS alerts to users when their gas levels are low or when a booking has been confirmed. This ensures that the user is notified instantly, even in areas where internet connectivity might be unavailable. The gas sensor, such as the MQ-2 or MQ-5, is used to detect any leakage of gases like propane, methane, or butane. This is an important safety feature that triggers alarms and sends notifications to users to take immediate action if a dangerous situation arises. The Wi-Fi module ESP8266 plays a crucial role in enabling the system's IoT capabilities. It allows the system to connect to the internet, enabling remote monitoring of the gas levels and enabling communication with cloud platforms for booking management and notifications. The ESP8266 module supports both HTTP and MQTT protocols, ensuring reliable communication with cloud services or external APIs for automatic refill booking. Finally, the load sensor, specifically the HX711 load cell, measures the weight of the gas cylinder and calculates the remaining gas level. This sensor's accuracy is crucial for providing reliable data to trigger refill orders in time before the gas runs out. In terms of software, the Arduino IDE is used as the primary development environment to write and upload the code to the Arduino Uno. The simplicity of the IDE makes it accessible for both beginners and experienced developers, allowing them to easily program the system. The software is written in Embedded C/C++, which is ideal for programming embedded systems like the Arduino. The use of these languages allows the system to interact efficiently with sensors, process data, and manage communication with external devices. Additionally, the software manages the logic for detecting gas levels, sending notifications, and triggering the refill booking process. By combining these hardware and software components, the LPG monitoring and automated refill booking system operates efficiently and safely. The sensors and modules work together to provide real-time gas level information, detect potential hazards like gas leaks, and automatically book a refill when needed, all while offering a simple user interface through the LCD and GSM notifications. This combination of IoT technologies provides a convenient, automated, and safe solution for managing gas refills.

V. SYSTEM ARCHITECTURE

The LPG level tracking and automatic reservation system operates based on an integrated architecture that involves multiple hardware and software components interacting seamlessly. This section breaks down the system architecture into key subsections: overview, component interaction and data flow, system integration, logical flow and decision making, and power management. The block diagram of the system shown in figure 1 and corresponding schematic diagram was shown in figure2.

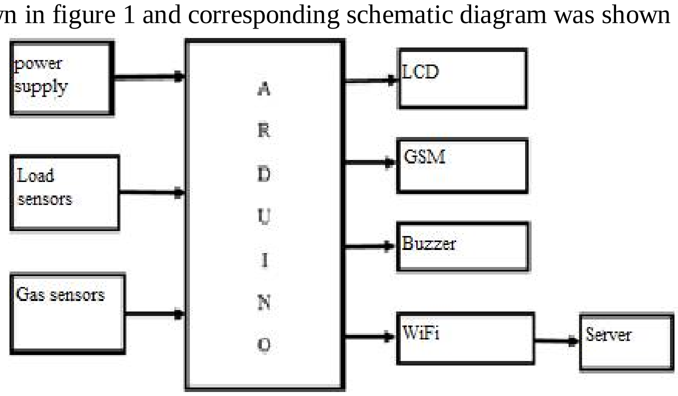

Figure 1: Block diagram

A. *Overview of Software Architecture*

The gas cylinder level detection and auto-booking solution is designed to monitor the gas levels in a cylinder, detect any gasleaks, and automate the process of refilling the gas. It is based on IoT technology, ensuring real-time monitoring, safety alerts, and seamless refill booking. The system uses sensors to detect gas levels and leaks, processes data using a microcontroller (ArduinoUno), communicates over Wi-Fi and GSM for notifications, and integrates with cloud services for refill booking. The architecture focuses on ensuring that the system is reliable, efficient, and easy to use while maintaining safety standards.

B. Component Interaction Dataflow

The system's components interact in a continuous loop of data collection, processing, and communication. Here's how the components work together:

Gas Sensor (MQ-2 or MQ-5): The gas sensor identifies the presence of combustible gases in the air. It continuously tracks the gas concentration in the environment and transmits the data to the Arduino for further processing. Load Sensor (HX711): The load sensor gauges the weight of the gas cylinder to assess the remaining gas. It transmits this information to the Arduino, which calculates the gas level based on the weight measurement.

Arduino Uno: The Arduino receives the data from both the gas and load sensors. It processes the data to calculate whether the gas level is low or if there is a gas leak. The Arduino also communicates with the GSM module and Wi-Fi module for notifications and cloud integration.

GSM Module (SIM800L/SIM900): When critical events like gas leakage or low gas levels are detected, the Arduino sends alerts via SMS to the user through the GSM module, ensuring immediate attention even if the user is offline. Wi-Fi Module (ESP8266): This enables the Arduino to connect to the internet, allowing communication with cloud platforms for live monitoring and automatic refill ordering.

C. System Integration

The system is designed to integrate multiple hardware and software components, creating a fully functional gas monitor- ing and refill booking system. Hardware Integration: The sensors (gas and load sensors), Arduino Uno, GSM, and Wi-Fi modules are physically con- nected through GPIO pins. The Arduino acts as the main controller, collecting data from the sensors and triggering actions based on predefined thresholds (e.g., low gas or gas leak). Software Integration: The Arduino software is programmed in Embedded C/C++ using the Arduino IDE. The software reads data from the sensors, processes it, and determines actions such as sending alerts or initiating a refill request.

D. Logical Flow and Decision Making

The system operates based on a logical flow that processes sensor data, makes decisions based on thresholds, and triggers actions accordingly.

1) Step1:Data Collection:

The load and gas sensors collect real-time data regarding the gas level and possible gas leaks. The gas sensor continuously monitors the environment, while the load sensor checks the cylinder's weight to estimate the gas level.

2) Step2: Decision Making:

The Arduino processes the data

If the gas level is lower than the defined threshold (e.g., 10% remaining), the system triggers an automatic refill order.

If the gas sensor detects a gas leak above a safety threshold, the system triggers an alert.

The Arduino compares sensor readings with these thresh- olds and makes decisions such as:

If gas is leaking, activate the alarm and send an SMS to the user.

If the gas level is low, initiate are fill booking.

3) Step3: Triggering Actions:

Based on the decision:

For Gas Leak: The system activates an audible alarm and sends an SMS to the user via the GSM module to notify them of the leak.

For Low Gas Level: The Arduino sends the data to the cloud platform via the ESP8266, which then triggers the refill order through SMS.

4) Step4 : User Notifications:

Once an action is triggered, the user receives an SMS alert for critical issues (like a gas leak or low gas), and the system updates the web dashboard or mobile app with real-time information about the gas level and refill booking status.

E. Power Management

Given that the system is expected to operate continuously, power management is a crucial aspect of its design. Low Power Consumption: The Arduino Uno and sensors are designed to operate on minimal power, ensuring that the system is energy-efficient.

The Wi-Fi module (ESP8266) and GSM module are only active when necessary, thus reducing energy consumption when not in use. Power Source: The system is powered by a 5V power supply (such as an adapter or rechargeable battery pack). The use ofa battery backup is recommended to ensure that the system remains operational during power outages. Power Saving Modes: The system could be optimized for power savings by using sleep modes. For example, when the system is idle (neither gas leak detected, nor e fill booking needed), the Arduino and sensors can enter a low-power sleep mode, reducing the overall power usage. Energy-Efficient Modules: The choice of low-power com- munication modules, like the ESP8266 Wi-Fi module and GSM module, ensures that the system remains energy- efficient, even when sending data to the cloud or receiving SMS alerts.

VI. METHODOLOGY

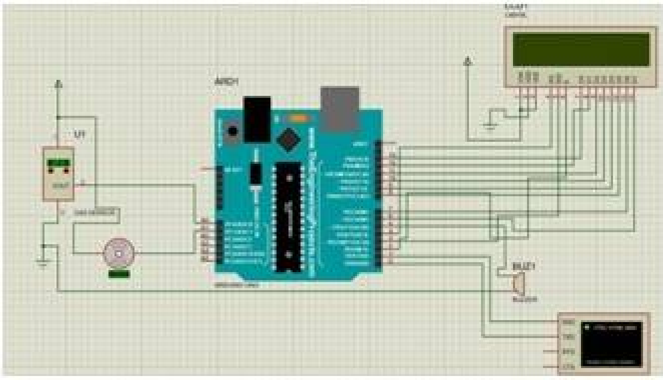

Figure 2: Schematic Diagram of System model

A. *System Design:*

The first step is selecting appropriate hardware components, including: Gas Sensor (MQ-2/MQ-5), For detecting the presence of flammable gases like methane, propane, or butane. Load Sensor (HX711), to track the weight of the gas cylinder, aiding in the determination of the remaining gas. ArduinoUno: The microcontroller that processes data from sensors and controls other components. Wi-Fi Module (ESP8266), For connecting the system to the internet and facilitating cloud communication.
GSM Module (SIM800L), to send SMS notifications for critical events like gas leakage or low gas levels. LCD Display: To display information about the system status.

B. *Data Collection and Processing*

Gas Detection: The gas sensor continuously monitors the air for any dangerous levels of gas. If a gas leak is detected, the sensor sends an alert to the Arduino Uno. Gas Level Measurement: The load sensor checks the weight of the gas cylinder. The Arduino processes this data to calculate the remaining gas in the cylinder based on predefined thresholds (900grams). The gas level and leakage detection hardware system model is shown in figure3.

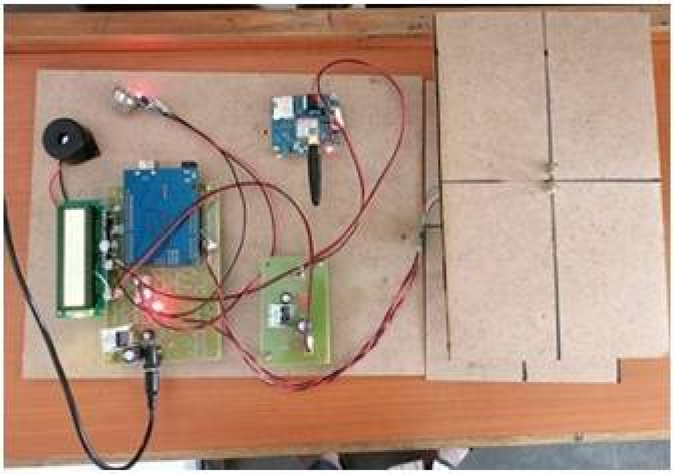

Figure 3: Gas Level and leakage detection hardware using Arduino Uno.

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C. Decision Making and Action Triggering

The Arduino Uno processes the sensor data. If the gas level goes beneath the preset limit (below the threshold), it triggers the automatic booking process by sending the data to the cloud through the ESP8266 Wi-Fi module. If a gas leak is detected, the system triggers an immediate alarm (audio or visual) and sends an SMS alert to the user via the GSM module.

D. Automatic Booking Process

If the gas level drops below a specified limit, the Wi-Fi module transmits the data to the cloud platform (e.g., AWS, Firebase). The cloud then communicates with a gas supplier's API to place an automatic refill order for the user. This action ensures that a refill is ordered before the gas runs out.

E. User Notification and Interface

After the automatic booking is processed, the GSM module sends an SMS to the user, confirming the refill order. Additionally, the system updates the LCD display and the mobile app/web dash board with real-time data about the gas level and refill status, providing transparency and ensuring the user is informed.

F. Power Management

The system is designed to be energy-efficient. Power- saving techniques such as using sleep modes for the Arduino and communication modules (Wi-Fi/GSM) when inactive are implemented to reduce energy consumption, especially in battery-operated systems.

VII. RESULT

Real-Time Gas Monitoring: the system successfully provides continuous real-time monitoring of gas levels and leak detection using MQ-2/MQ-5 gas sensors and load sensors. This ensures that users are immediately alerted to low gas levels or potential gas leaks, improving safety and convenience. Automatic Refills: When the gas level falls under the established threshold, the system automatically places a refill order through cloud integration with the gas supplier's API. This eliminates manual monitoring and ordering, providing an efficient solution for gas management. User Alerts and Notifications: the GSM module sends SMS notifications to the user in case of critical events like gas leaks or low gas levels. This ensures the user is promptly informed, even if they are not actively monitoring the system. Cloud Integration: the system leverages cloud communication through the Wi-Fi module (ESP8266) to store and process data, allowing users to remotely monitor their gas levels. Cloud integration also enables automatic refill booking, providing a seamless user experience. Energy Efficiency: The system is designed with power management in mind. By utilizing low-power components and incorporating sleep modes for inactive periods, the system ensures minimal energy consumption, making it suitable for long-term operation on battery- powered devices. The demonstration of gas leakage and level system and corresponding message alert system is shown in figure 4 and 5.

Figure 4: Demonstration of Gas Leakage system Using Arduino Uno.

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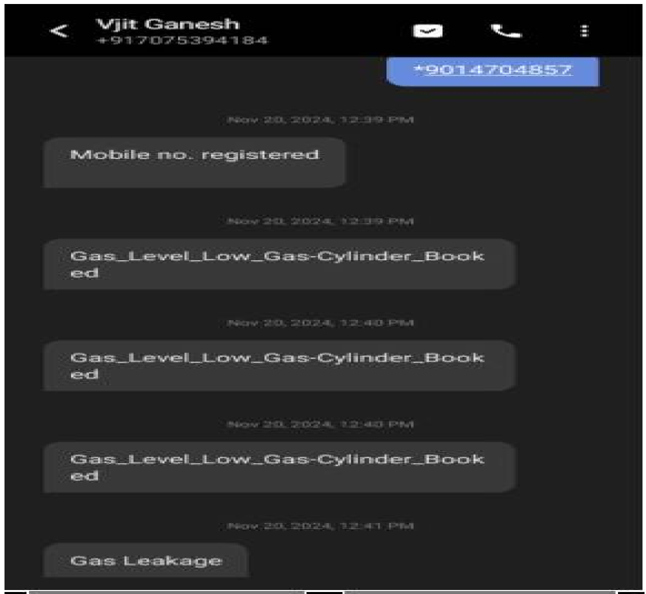

Figure 5: Message Alert Notification System Using IOT

VIII. CONCLUSION

This project consists of two sections transmitter section and receiver section. In this the automated booking of latest LPG cylinder is enforced. With the assistance of the gas device and cargo device ready to able to observe the amount of the gas and also the gas leak. And at last with the application of IoT, new LPG cylinder can be booked by the user. By this system, the Users can be aware of their gas level and it also avoids the prior and delay booking of the cylinder. And also, the components used here are commercially cheap when compared to other gas detectors. Hence this concept can also be widely used in the industries according to their requirements. Reduce human intervention: the system can reduce the need for manual intervention in booking and monitoring LPG cylinders. Save time the system can save time by automatically booking new cylinders when the gas level is low. Prevent gas leakage: the system can prevent gas leakage accidents by continuously monitoring the gas level and alerting the user if a leak is detected. Ensure safety: the system can ensure safety by stopping the flow of gas to the stove and switching on a fan to-let the leaked gas out. The system may also used in other settings, such as mines where gas sensors can detect harmful gas leakages.

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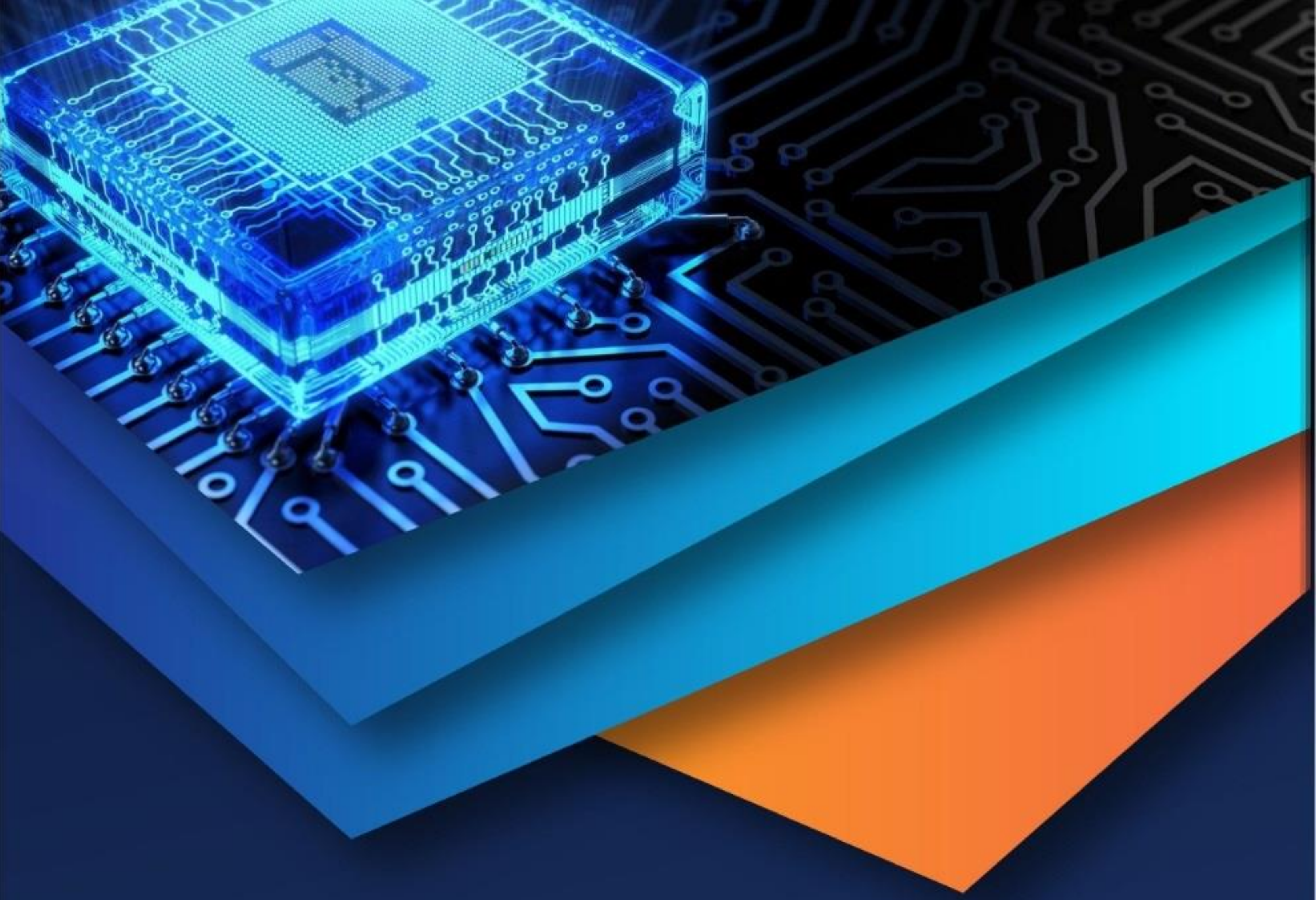

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