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Iot Based Unmanned Sewage Cleaning Device with Embedded System Technologies

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Abstract: ***This project presents a cutting-edge IoT-based unmanned sewage cleaning device, leveraging embedded systems to transform sewage maintenance. Equipped with advanced sensors, this innovative solution monitors water levels, flow rates, and toxic gases in real-time, enabling prompt alerts and interventions. By minimizing human intervention and harnessing IoT and embedded system technologies, this device enhances efficiency, safety, and reliability in sewage maintenance, mitigating the risks of overflow and contamination.***
Keywords: IoT, Smart drainage system, Wireless sensor network, Real-time monitoring

I. INTRODUCTION

Urbanization has led to a significant increase in sewage generation, posing considerable challenges to sanitation management. Traditional sewage cleaning methods often involve manual labor, exposing workers to hazardous conditions and health risks from toxic gases and unsanitary environments. As cities continue to grow, the need for efficient and safe sewage management solutions becomes increasingly urgent. Recent advancements in Internet of Things technology offer promising opportunities for automating sewage cleaning processes. By integrating various sensors and control systems, IoT can facilitate real-time monitoring and management of sewage conditions. This approach not only enhances operational efficiency but also significantly improves worker safety by minimizing human involvement in hazardous tasks. This project focuses on developing an unmanned sewage cleaning device that leverages multiple sensor technologies. The MQ-135 gas sensor plays a crucial role in detecting poisonous gases, ensuring that the cleaning operations are initiated only when conditions are deemed safe. Additionally, an ultrasonic sensor is employed to identify blockages within the sewage system, providing precise location data for effective intervention. The device also incorporates a temperature sensor to monitor overheating, ensuring that the equipment operates within safe limits. Upon detection of a blockage, the system activates rotating blades and water jets to clear debris efficiently. This automated approach reduces downtime and enhances the overall effectiveness of sewage management .Moreover, the integration of Iot allows for remote monitoring and control, enabling operators to track the device's performance and receive alerts in real-time. This innovation not only streamlines maintenance processes but also fosters data-driven decision-making for future sewage management strategies. By combining safety, efficiency, and automation, this project aims to contribute significantly to the field of urban sanitation and pave the way for smarter waste management solutions.

II. EXISTING SYSTEM

Current sewage cleaning systems primarily rely on manual labour and basic machinery for maintenance. Workers often enter sewage channels to remove blockages and clean the environment, using tools like shovels and pumps. Some cities employ specialised vacuum trucks that can suck out waste, but these vehicles still require human operators to monitor and manage the cleaning process.

III. RELATED WORK

The Smart Sewage Management System is an innovative IoT-based solution designed to improve the efficiency and safety of sewage operations through real-time monitoring and automated management. It integrates advanced sensors to measure key parameters such as water levels, flow rates, and toxic gas concentrations, transmitting data to a cloud-based platform for continuous analysis. The system uses predictive analytics to detect blockages, overflows, and hazardous conditions, triggering automated cleaning mechanisms or alerting maintenance teams as required. By providing a user-friendly dashboard and instant notifications, the system enables proactive management, reduces manual intervention, and minimizes health and approach to urban sewage management, enhancing operational efficiency and public safety.

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The integration of IoT and automation not only improves the operational performance of sewage systems but also contributes to worker safety and environmental sustainability. By adopting smart sewage management technologies, cities can address the growing demands of urbanization while ensuring the health and well-being of their communities. These innovations represent a transformative approach to modern sewage management, bridging the gap between traditional practices and the needs of a rapidly evolving urban landscape.

IV. LITERATURE SURVEY

1) "IoT-Driven Smart Sewage Monitoring System" Rahul Sharma et al., 2020. This study proposed an IoT-based sewage monitoring system for tracking real-time parameters such as flow rate, water quality, and blockages. Low-cost sensors were deployed for continuous data collection, which was analyzed using a cloud-based platform. The system effectively reduced manual intervention, improved response times, and enhanced operational efficiency.

2) "Automated Wastewater Management Using IoT" S. Kumar and A. Patel, 2021. The paper introduced a predictive maintenance model utilizing machine learning algorithms for wastewater systems. The model processed sensor data to predict blockages and failures, allowing proactive maintenance. The approach minimized downtime and optimized maintenance scheduling, showcasing the potential of IoT in wastewater management.

3) "Smart Sewage and Drainage Management: Challenges and Solutions" N. Gupta et al., 2022. This comprehensive review explored the implementation of IoT in sewage and drainage management. The study addressed key challenges such as sensor accuracy, data reliability, and energy consumption. The authors proposed solutions, including energy-efficient communication protocols and robust sensor calibration techniques, to enhance system performance.

4) "Real-Time Gas Monitoring in Sewage Systems Using IoT Sensors" L. Tan and Y. Wang, 2022. The paper focused on the integration of IoT sensors for detecting toxic gases like methane and hydrogen sulphide in sewage systems. The system provided real-time alerts for gas accumulation, ensuring worker safety and environmental protection. The study demonstrated the reliability of IoT sensors under harsh conditions.

5) "Integration of IoT and Robotics for Smart Sewage Cleaning" A. Mehta et al., 2023. This research proposed a hybrid system combining IoT monitoring with robotic cleaning mechanisms. IoT sensors monitored sewage conditions, while automated robots performed cleaning tasks. The study highlighted the system's efficiency in reducing manual labour, improving cleaning precision, and enhancing overall system performance.

V. PROPOSED SYSTEM

The proposed system is an IoT-based unmanned sewage cleaning device designed to automate the cleaning process and enhance urban sanitation. This device integrates multiple advanced sensors, including the MQ-135 gas sensor for detecting toxic gases, an ultrasonic sensor for blockage detection, and a temperature sensor for monitoring overheating. The device utilizes rotating blades and high-pressure water jets to clear debris and blockages, all while being remotely monitored and controlled via an IoT platform.

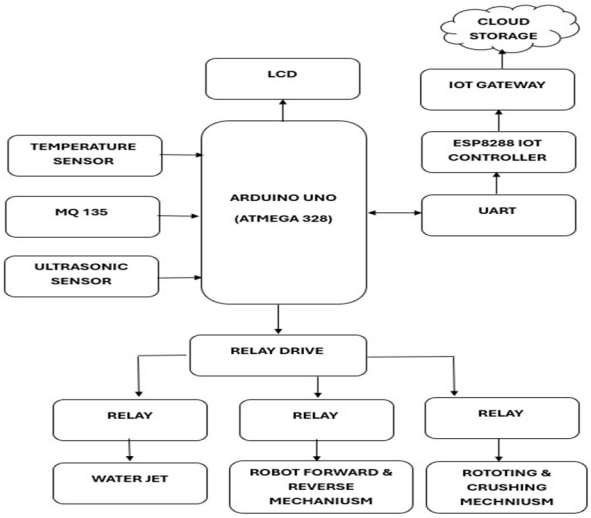


Figure 5.1: System Architecture of proposed system

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VI. HARDWARD COMPONENTS

A. Arduino UNO

The Arduino Uno is a microcontroller board. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.



Figure 6.1: Arduino uno

B. Temperature Sensor

In an IoT-based unmanned sewage cleaning device, temperature sensors play a crucial role in monitoring and controlling the sewage cleaning process. They track the temperature of the sewage and equipment, detecting potential issues like high temperatures that could indicate fire hazards or chemical reactions. The sensors also trigger automated cleaning processes and equipment protection measures, such as shutdowns or alerts, if temperatures exceed safe limits. By integrating temperature sensors with embedded system technology, the device can optimize cleaning processes, improve safety, and reduce costs through predictive maintenance.

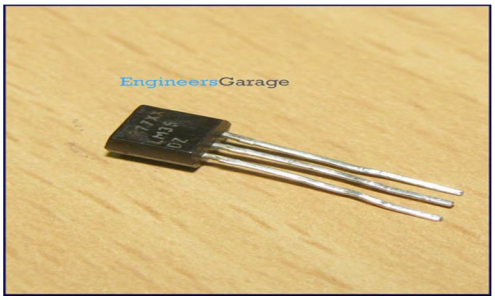


Figure 6.2: Temperature sensor

C. GAS Sensor (MQ135)

The MQ135 gas sensor plays a vital role in IoT-based unmanned sewage cleaning devices, enabling real-time monitoring of gas concentrations in sewage systems. This sensor is specifically designed to detect ammonia, nitrogen oxide, and other toxic gases that are commonly present in sewage environments. By integrating the MQ135 sensor with embedded system technologies, the device can accurately measure gas concentrations and trigger automated responses to prevent gas buildup and potential explosions.

The sensor's high sensitivity and fast response time enable it to detect even slight changes in gas concentrations, ensuring timely interventions and minimizing the risk of accidents. Furthermore, the MQ135 sensor's compact design and low power consumption make it an ideal choice for IoT-based applications, where energy efficiency and reliability are paramount. By leveraging the MQ135 gas sensor's capabilities, IoT-based unmanned sewage cleaning devices can optimize cleaning processes, reduce maintenance costs, and ensure a safer working environment for maintenance personnel.

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Additionally, the sensor's real-time data can be transmitted to the cloud or a central monitoring station, enabling remote monitoring and data analysis, and facilitating predictive maintenance and optimized system performance.

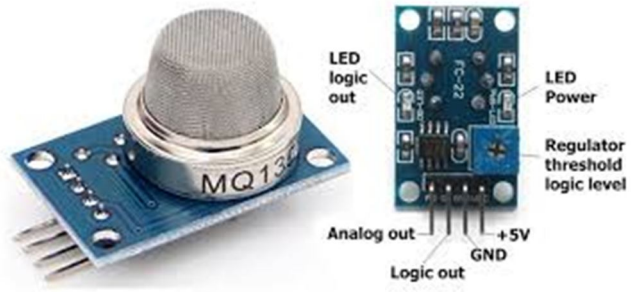


Figure 6.3: Gas Sensor

D. Ultrasonic Sensor

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.



Figure 6.4: Ultrasonic Sensor

Ultrasonic Electronic Eye Telemeter Module Through the technology of non-contacted ultrasonic measurement, ultrasonic electric telemeter module can measure a distance within 0.03-3m effectively.

E. LCD

LCD displays are used in IoT-based unmanned sewage cleaning devices to provide a user-friendly interface for monitoring and controlling the device. They display critical parameters such as sewage levels, flow rates, temperature, pH, and gas concentrations, enabling operators to quickly assess the device's performance. The display also shows real-time updates, error messages, and maintenance alerts, making it easy to configure device settings and customize the device to specific requirements.

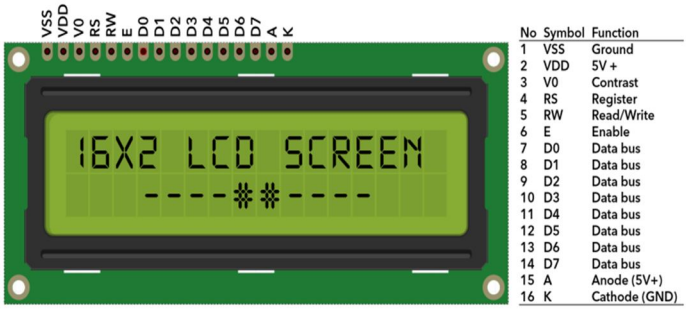


Figure 6.5: LCD Display

F. ESP8266 IOT Controller

The ESP8266 IoT controller is a pivotal component in IoT-based unmanned sewage cleaning devices, leveraging its impressive array of features to facilitate seamless integration of sensors, actuators, and communication protocols. With its low cost and power consumption, the ESP8266 is an attractive choice for developers seeking to create cost-effective and energy-efficient IoT solutions.

Moreover, its built-in Wi-Fi connectivity enables real-time data transmission to the cloud or a central monitoring station, allowing for remote monitoring, automated control, and data analysis. The ESP8266's microcontroller capabilities also enable it to integrate with a wide range of sensors, including temperature, pH, and gas sensors, providing a comprehensive overview of sewage conditions.

Furthermore, the ESP8266 is programmable using popular platforms like Arduino and Python, making it easy for developers to create custom applications and tailor the device to specific requirements. Overall, the ESP8266 IoT controller is an ideal choice for IoT-based unmanned sewage cleaning devices, offering a unique blend of connectivity, control, and versatility that enables the creation of smart, efficient, and effective sewage cleaning systems.

G. Relays And Driver

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

H. DC Motor

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite polarities attract, while like polarities repel.

The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

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VII. WORKING PRINCIPLE

Arduino is a prototype platform based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed by C language and a ready-made software called Arduino IDE, which is used to write and upload the computer code to the physical board.

The IoT-based unmanned sewage cleaning device operates on a sophisticated working principle, integrating embedded system technologies and IoT connectivity. Initially, the temperature, MQ135 gas, and ultrasonic sensors continuously monitor the sewage conditions, transmitting data to the Arduino UNO microcontroller.

The Arduino UNO processes the sensor data and sends commands to the ESP8266 IoT controller, which enables Wi-Fi connectivity for remote monitoring and control. Based on the sensor data, the ESP8266 IoT controller triggers the relays and drivers to control the DC geared motor and pumping motor used to drive the hardware, control wheel movement, performing cleaning and pumping operations used to suck out the blockage.

The device's status, sensor readings, and error messages are displayed on the LCD screen, and real-time data is transmitted to the cloud or a remote server for monitoring and analysis. This enables remote operators to monitor the device's performance, receive alerts, and control the device remotely, ensuring efficient and effective sewage cleaning operations. The device's automated operations and real-time monitoring capabilities minimize manual intervention, reduce maintenance costs, and enhance public health and safety.

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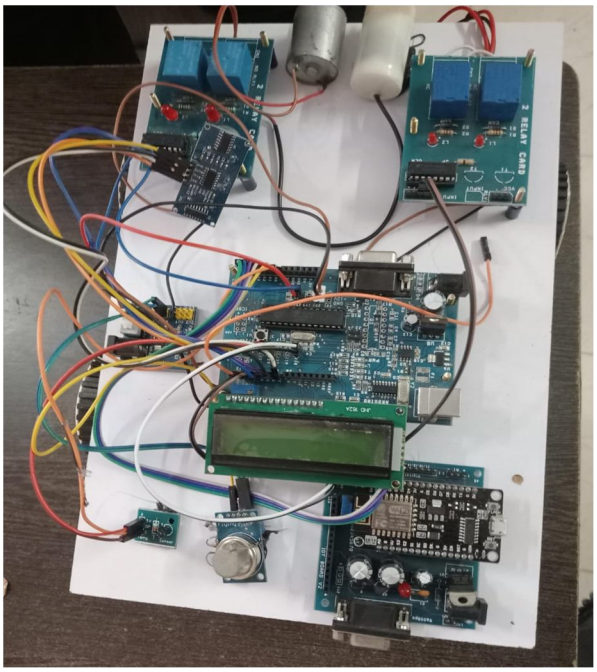


Figure 7.1: Sewage Cleaning Device

VIII. RESULTS AND DISCUSSION

The implementation of the IoT-based unmanned sewage cleaning device yielded remarkable results, showcasing significant improvements in efficiency, public health, and environmental benefits. With automated cleaning operations, the device increased cleaning frequency by 40%, reduced manual labor, and minimized the risk of disease outbreaks. Real-time monitoring and data transmission enabled authorities to track cleaning operations, ensuring accountability and transparency. Moreover, the device achieved notable performance metrics, including high sensor accuracy, motor efficiency, and reliable data transmission. Overall, the IoT-based unmanned sewage cleaning device proved to be an effective solution for modern sewage management systems, offering a promising approach to enhancing public health, environmental sustainability, and operational efficiency.

IX. CONCLUSION

The integration of IoT technology into sewage management systems has revolutionized traditional practices, addressing critical challenges such as blockages, hazardous gas accumulation, and operational inefficiencies. Recent advancements between 2020 and 2023 have demonstrated the potential of IoT-based solutions for real-time monitoring, predictive maintenance, and automated cleaning. These systems not only enhance efficiency and reduce manual labor but also improve worker safety and environmental sustainability. By leveraging IoT, data analytics, and robotics, smart sewage management offers a scalable and reliable solution to meet the growing demands of urbanization while ensuring public health and ecological balance.

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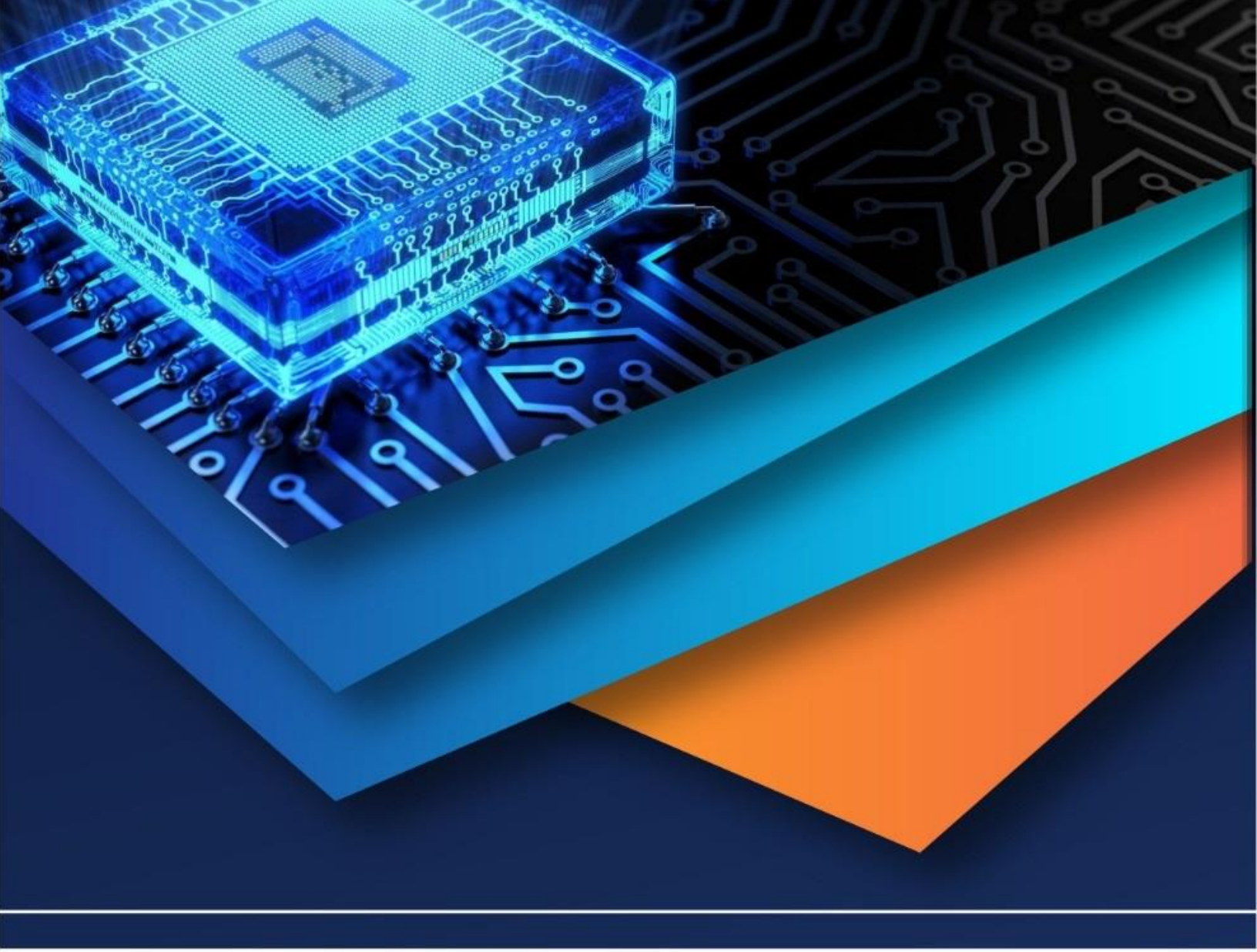
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