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IoT Based Washroom Feedback System for Quality Monitoring

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Abstract: In the twenty-first century, technology advances at a rapid pace, although our primary responsibility remains cleanliness. We disseminate the message of cleanliness and hygiene in our environment. In public venues or restrooms, we must preserve hygiene or cleanliness. The government provides numerous facilities in cities to keep our surroundings clean. This approach focuses solely on how to maintain washroom hygiene. This effort educates the public about hygiene and the need of keeping the environment clean. As a result, the primary goal of this study is to create safe, sanitary, and disease-free restrooms. The authorities spend a significant amount of money and personnel to keep these public restrooms in good working order. Nonetheless, all of these efforts are in vain because there is no centralized system in place to oversee the cleanliness of public restrooms and track the quality of the cleaning provided by cleaners. As a result, a system that enables centralized monitoring of all toilets and an interface to the cleaner will be beneficial in resolving this issue. We attempted to address this problem by creating an IoT-based smart system. We've utilized sensors to detect unpleasant scents in the washroom, as well as sensors to measure water level in tanks and water leakage. Our algorithm estimates the cleanliness of toilets using sensor data.
Keywords: ESP2866 NodeMCU, Ultrasonic HC-SR04 Sensor, MQ-135 Odour Sensor, Water Sensor, Google FireBase, Website for Feedback, OpenCV, Python.

I. INTRODUCTION

IoT is a stand-alone technology. Surprisingly, the Internet of things is possible by the availability of other independent technologies that serve as essential IoT components. The following are the basic elements that make the internet of things a reality: Hardware: Giving physical items the ability to retrieve data and respond to commands by making them responsive. Data collection, storage, processing, manipulation, and instruction are all made possible by the software. The communication infrastructure, which includes protocols and technologies that allow two physical devices to exchange data, is the most important of all. People in our country do not have sufficient knowledge of how to use a restroom and do not understand how to maintain basic hygiene. Malaria, hepatitis, influenza, cholera, streptococcus, typhoid, and other diseases are caused by this. Swachh is a Hindi word that means "clean." The phrase 'Shithouse' then refers to a toilet. It explains how to use and maintain toilets cleanly and hygienically. The study is built on IoT concepts and uses various sensors such as a Water sensor, MQ-135 Air Monitoring sensor, Ultrasonic HC-SR04 sensor, and database. We are attempting to supply clean toilets and raise public awareness with these items. This paper's main goal is to keep our surroundings clean. This paper aids in the prevention of infections that might occur in public restrooms. This method aids in the creation of bacteria-free restrooms. As more people use public restrooms in areas like universities, schools, and offices, the bacteria level rises. According to a doctor nationwide medical survey, the number of people infected with urinary tract infections is over 8.3 million per year. The use of public restrooms in big metropolis areas is very high. The persons in charge of maintaining these restrooms are careless. This renders public restrooms unfit for use. There is currently no suitable structure or method for reporting complaints to the authorities. The Washroom Feedback System is designed to identify various sorts of uncleanliness in the toilets and alert the in-charge. The real-time data would be accessed via FireBase via a cloud service and would be continuously monitored with user feedback. The system is made up of various sensors that are put in washrooms and detect unpleasant odors, water flow, and low water levels in the tank as well as broken accessories in the washroom.

II. REVIEW OF LITERATURE

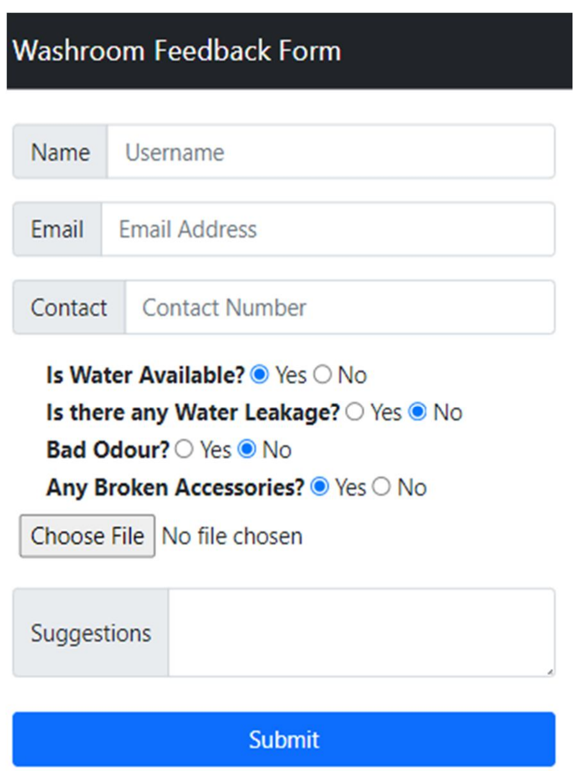
W.Sherine Mary, S.Muthukumar et.al [1]. This paper examines the many facts that suggest that poor sanitation is a contributing factor in the development of a variety of life-threatening diseases. Consider the cleanliness of public restrooms, as these are the sites where infections can be caught. Customers will be dissatisfied if washrooms are not cleaned regularly in railway stations, Bus stations, malls, and other public venues, and this has an impact on the company. We developed an automated sensor-based system that monitors washroom cleanliness by measuring the air inside the washroom, taking into account the multiple good effects of cleaning washrooms constantly in public spaces. The air inside the washroom might reveal numerous components of gases present, allowing you to determine whether or not the washroom is clean. A text alert is issued to the cleaning personnel in the public place if the values surpass the threshold value.

All of the previously reviewed papers have worked on constructing smart washrooms using various sorts of sensors such as methane and ammonia gas sensors, infrared sensors, and Bluetooth low energy beacon technology. Sensors in the Internet of Things are beneficial in lowering the rate of health issues.

III. SOFTWARE DETAIL

A. Web Application

One of the most crucial aspects of the project is the Web Application. The web application will be a simple user interface for collecting critical feedback from users of our smart washroom system. There will be a front-end and a back-end to the web application. A simple feedback form with elements such as name, email, phone, asking questions related to water availability, water leakage, bad odor, and photo of any broken accessories will make up the front end. HTML, CSS, JavaScript, and Bootstrap will be used to create the front end. The backend portion will be activated once the user has submitted the form. The project's back end will be written in Python, with Firebase as the database. The sensor will take measurements at regular intervals and send the information to the cloud. The back end will use the pyrebase module in python to retrieve data from the Firebase Realtime Database and double-check the user's complaint. If the application detects lower washroom standards, it will immediately notify the janitor or any higher authority through the SMS service offered by Twilio, who will take appropriate action. The Firebase Realtime Database is a cloud-based database with JSON-based data storage. Every linked client receives real-time data synchronization. When we construct cross-platform applications with our iOS and JavaScript SDKs, all of our clients share a single Realtime Database instance and receive automatic updates with the most recent data. The Firebase Realtime Database is a NoSQL database that allows us to store and sync data in real-time across our users. It's a large JSON object that developers can work on within real-time. The Firebase database gives the application with the current value of the data as well as modifications to that data via a single API. Our consumers may view their data from any device thanks to real-time syncing. It doesn't matter if it's on the web or a mobile device. Our users can collaborate with one another thanks to the Realtime Database. It includes mobile and web SDKs, allowing us to develop our app without the use of servers. When our users go offline, the Real-time Database SDKs serve and save changes using the device's local cache. When the device is connected to the internet, the local data is automatically synchronized. All offline and online services can be provided via a real-time database. Accessibility via a client device, scaling over numerous databases, and many other features are included



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B. OpenCV

OpenCV (Open Source Computer Vision Library) is a programming library geared mostly toward real-time computer vision. It was created by Intel and then sponsored by Willow Garage and Itseez (which was later acquired by Intel). Under the open-source Apache 2 Licence, the library is cross-platform and free to use. OpenCV has included GPU acceleration for real-time activities since 2011. The following are some of the areas where OpenCV can be used: Face recognition software; Recognition of gestures Recognizing motion; Detection of objects. Although OpenCV is designed in C++ and has a C++ interface as its primary interface, it also has a less thorough but still significant older C interface. The C++ interface displays all of the recent breakthroughs and algorithms. Python, Java, and MATLAB/OCTAVE all have bindings. The online documentation contains the API for these interfaces. Wrappers for a variety of programming languages have been created to encourage greater use. OpenCV.js is a JavaScript binding for a subset of OpenCV functionalities that can be utilized on online platforms.

Users that use IoT-based smart washroom systems for quality control will use the feedback form to upload images of any damaged taps, doors, mirrors, or other washroom accessories. Through OpenCV, the backend will automatically check reports of broken accessories using the ORB Algorithm. ORB Algorithm is used for image matching. When a user uploads a broken accessory image, it is checked against the orb image matching program, and if the findings are positive, an SMS is sent immediately.

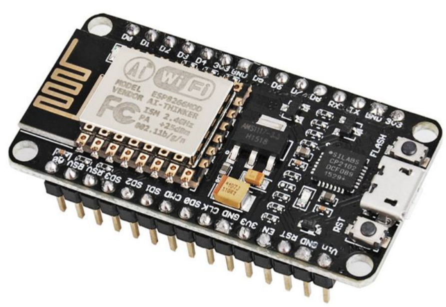
IV. HARDWARE DETAIL

A. ESP8266 NODE-MCU

Espressif developed the ESP8266 Wi-Fi enabled system on chip (SoC) module. It's primarily used to create embedded IoT (Internet of Things) applications. ESP8266 features 2.4 GHz Wi-Fi (802.11 b/g/n, WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I2C) serial communication protocol, analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI) serial communication protocol, I2S (Inter-IC Sound) interfaces with DMA (Direct Memory Access) (sharing pins with GPIO), UART (on (PWM). The ESP8266 module is a low-cost wireless transceiver that can be utilized in end-point IoT applications.

The microcontroller must use a series of AT commands to connect with the ESP8266 module. The ESP8266-01 module is connected to the microcontroller via UART at a specific Baud rate.

1) The ESP-01 has eight pins (2 GPIO pins) - An antenna on a PCB. (as depicted in the diagram above)
2) The U-FL antenna connector on the ESP-02 has 8 pins (3 GPIO pins).
3) The ESP-03 has 14 pins (7 GPIO pins) Antenna is made of ceramic.
4) The ESP-04 has 14 pins (7 GPIO pins) and no ant.



B. Ultrasonic Sensor (HC - SCR -04)

We have used 2 ultrasonic sensors in our project. Sensor for ultrasonic waves The HC-SR04 is a distance measuring sensor. It releases a 40 000 Hz (40kHz) ultrasonic that travels through the air and bounces back to the module if it comes into contact with an object or impediment. You may compute the distance by taking into account the travel time and the sound's speed. VCC (1), TRIG (2), ECHO (3), and GND are the configuration pins of the HC-SR04 (4).

We need to put the Trigger Pin in a High State for 10 seconds to create the ultrasound. This will generate an 8-cycle sonic burst that will travel at the speed of sound and be received by the Echo Pin. The Echo Pin will output the sound wave's travel time in microseconds. For example, if the item is 20 cm away from the sensor and the sound speed is 340 m/s (0.034 cm/s), the sound wave must travel for approximately 588 microseconds. The number you'll obtain from the Echo pin, though, will be double that because the sound wave must travel forward and backward. To calculate the distance in cm, multiply the received travel time value from the echo pin by 0.034 and divide by two.

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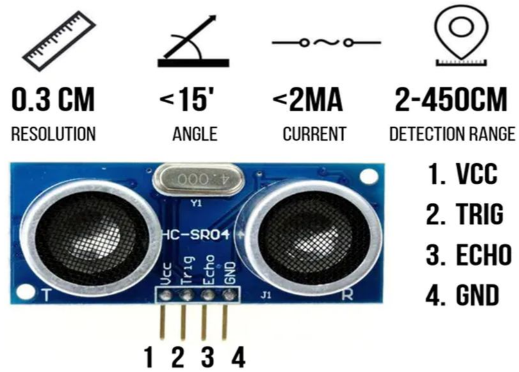
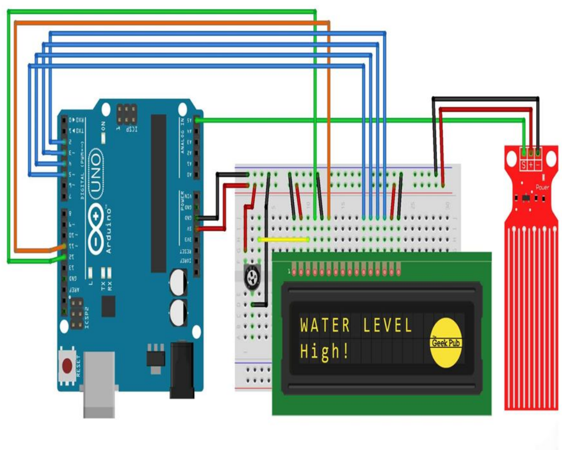
To begin writing the programming code, we must first define the Trigger Pin and Echo Pin on the Arduino board. EchoPin is connected to D2 in this project, while TrigPin is connected to D3. Then create variables for distance (int) and duration (duration) (long).



C. Water Sensor

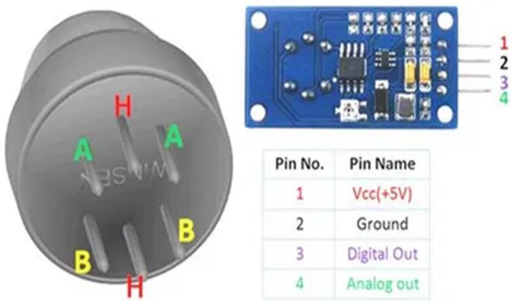
We have used 4 water sensors in our project. The water sensor brick is designed to detect water and can be used to monitor rain, water level, and even liquid leaks. A leak, spill, flood, or rain can all be detected by connecting a water sensor to an Arduino. It is capable of detecting the presence, level, volume, and/or absence of water. While this sensor might be used to remind you to water your plants, there is a Grove sensor that can do the job better. When water is detected, the sensor's array of exposed traces reads LOW. In the diagram below, we'll connect the water sensor to Arduino's Digital Pin 8 and use the helpful LED to indicate when the water sensor comes into contact with a source of water. S, Vout(+), and GND are the three terminals of a water sensor (-).



D. MQ 135 Odour Sensor

The MQ-135 Gas is used in air quality control equipment and is suitable for detecting or measuring NH3, NOx, Alcohol, Benzene, Smoke, and CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. If you need to measure the gases in PPM the analog pin needs to be used. The analog pin is TTL driven and works on 5V and so can be used with the most common microcontrollers. If you are looking for a sensor to detect or measure common air quality gases such as CO2, Smoke, NH3, NOx, alcohol, and Benzene then this sensor might be the right choice for you. You can either use the digital pin or the analog pin to do this. Simply power the module with 5V and you should notice the power LED on the module glow when no gas is detected the output LED will remain turned off meaning the digital output pin will be 0V. Remember that these sensors have to be kept on for pre-heating time (mentioned in the features above) before you can work with them. Now, introduce the sensor to the gas you want to detect and you should see the output LED go high along with the digital pin, if not use the potentiometer until the output gets high. Now every time your sensor gets introduced to this gas at this particular concentration the digital pin will go high (5V) else it will remain low (0V).

You can also use the analog pin to achieve the same thing. Read the analog values (0-5V) using a microcontroller, this value will be directly proportional to the concentration of the gas which the sensor detects. You can experiment with these values and check how the sensor reacts to different concentrations of gas and develop your program accordingly. MQ-135 gas sensor applies SnO2 which has higher resistance in the clear air as a gas-sensing material.



Pin No.	Pin Name
1	Vcc(+5V)
2	Ground
3	Digital Out
4	Analog out

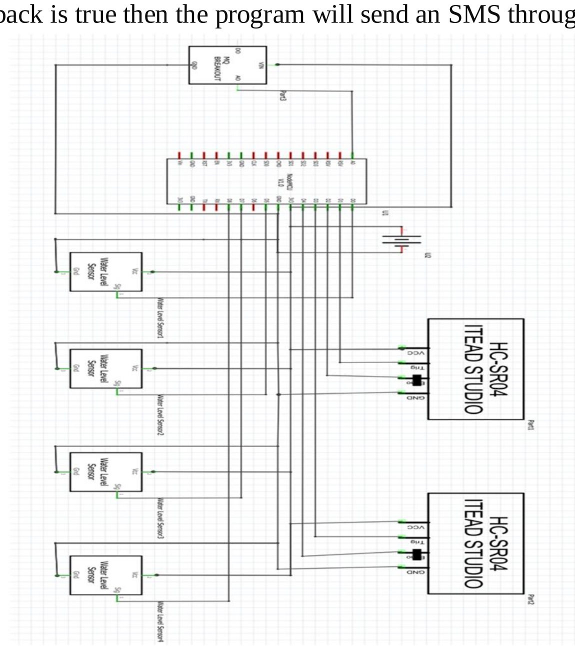
E. Relay Modules

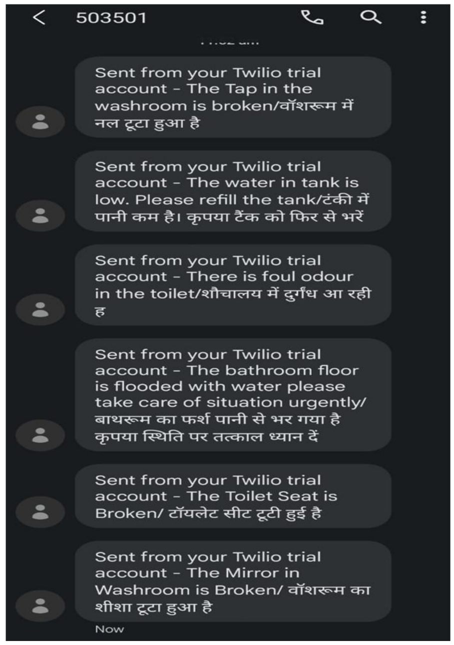
An electromagnet operates a power relay module, which is an electrical switch. A separate low-power signal from a microcontroller activates the electromagnet. The electromagnet pulls to open or close an electrical circuit when energized. We use a relay in association with a DC motor to pump the water to the upper tank from the lower tank whenever the water level indicator signals low in the upper tank.

V. FINAL WORKING AND CIRCUIT DIAGRAM

We have used Nodemcu as our main controller board. The main functions of Nodemcu are to collect data from analog and digital pins. The collected data from pins are sent to the online real-time database known as Google Firebase through ESP8266 Wifi Module which is integrated with Nodemcu. The Arduino IDE code is used for authentication of the board and is the main source for communication between Nodemcu and Firebase Database. We have used one MQ-135 Air Quality Gas Sensor for detecting Ammonia in Washroom, four water sensors for detecting water leakage in the washroom, and Two Ultrasonic sensors for monitoring the water level in the washroom water tank. This completes the Hardware section of our project.

The Software section includes a web application. The user who is unhappy with the cleaning services of the washroom can lodge feedback from our website, Once a user submits its feedback it is stored in another firebase database. The form takes details such as name, email, contact number, few washroom quality-related questions, and also user can submit an image of any broken accessories. We have developed a python program that will take data from both firebase databases and it cross-check the trueness of the feedback given by the user, if the feedback is true then the program will send an SMS through Twilio to the authorities.





VI. CONCLUSION

For quality control, we devised and constructed an Internet of Things-based Washroom feedback system. As previously said, this system consists of sensors that can be simply placed. All sensor readings and input from users of public restrooms were collected regularly using a web application. To collect and store all of the information, readings, and database for user input, a Firebase is used as a service. To quickly analyze data obtained on cleanliness, the water level in tanks, water leakage, bad odor detection, and washroom accessory maintenance. For this project, we will create a web application.

Our proposed technique will also aid in raising public awareness about good sanitation. As a result, by incorporating smart technology into current public restrooms, we can maintain hygiene and cleanliness, limiting the spread of new diseases caused by poor hygiene. Using hardware-based prototype modules with all automated sensors and new technology internet of things, we will deploy smarter technologies and raise public awareness about good hygiene as a result of this project. It makes use of the Internet of Things, a new technology that is rapidly gaining traction. Thus, by employing technology more intelligently, we may maintain cleanliness, which is second only to godliness. Keep it clean and stay safe.

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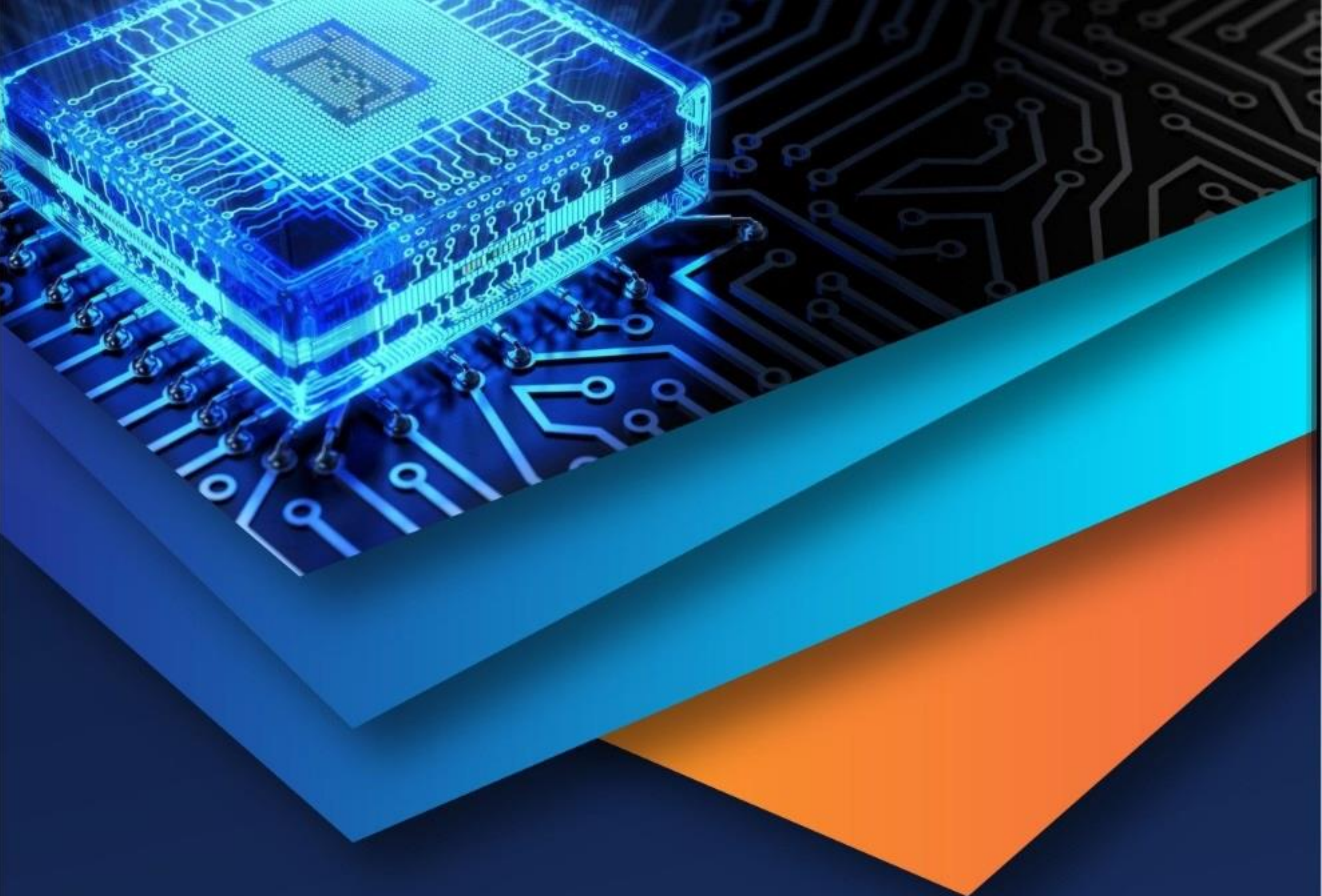

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