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Automated Domestic Vacuum Cleaner Robot

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Abstract: Modern homes are moving to automation to provide convenience and reduce the time spent on household chores Vacuum cleaners make cleaning easier, but they are big, noisy, and bulky in everyday use.Therefore, vacuum cleaner technology needs to be improved to reduce these shortcomings. As of 2021, the Covid-19 pandemic continues, so keeping our living space clean and disinfecting is a top priority. People's workload is shifting from offline work in the office to online work at home, and the workload of many people has increased significantly, so some people may neglect to clean the environment. there is. In today's scenario, the whole family is busy with work and is supposed to clean the house. The cleaning robot helps you clean and disinfect the floor with the push of a switch. This also reduces the extra effort of housekeeping for cleaning purposes. Furthermore, we are enthusiastic about designing and developing an automatic cleaning robot "household automatic vacuum cleaner robot" that performs all cleaning and disinfection work with the push of a button.
Keywords: Vacuum cleaner, robot, remote control, autonomous cleaning, Arduino uno

I. INTRODUCTION

A. Overview

Robots are widely used in modern industrial manufacturing, home, entertainment and security sectors. Some robots are built and developed for a variety of applications to support humans as companions, janitor, or help with household chores. Robots are so popular and used all over the world that it is important to use them to overcome real-time problems. The major challenges facing the world in the current pandemic situation are hygiene and disinfection. The use of autonomous robot vacuums can help overcome this problem.

B. Automation

"Automation is the creation and application of technologies to produce and deliver goods and services with minimal human intervention. The implementation of automation technologies, techniques and processes improve the efficiency, reliability, and/or speed of many tasks that were previously performed by humans".

Autonomous models have two operating modes:

1) *Open loop:* In open-loop control, the control action from the controller is independent of the "process output".
2) *Closed loop (feedback):* In closed-loop control, the control action from the controller is dependent on the process output.

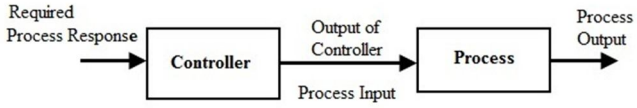


Figure 1 Open Loop Control System

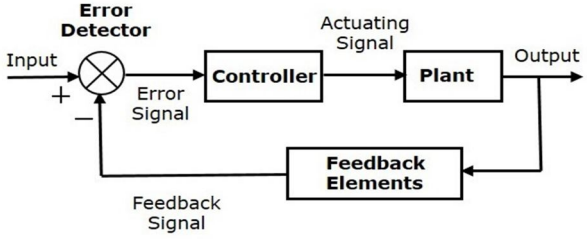


Figure 2 Closed Loop Control System

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C. Robotics

"Robot engineering is the crossroads of science, engineering, and technology that manufactures machines called robots that replace (or replicate) human behavior." Robotics involves the design, construction, operation, and deployment of robots. included. The purpose of robotics is to build machines that can help and support humans. Robotics is a fusion of mechanical engineering, electrical engineering, information engineering, mechatronics, electronic engineering, biological engineering, computer engineering, control engineering, software engineering and more. Robots are human alternatives that can mimic human behavior. Robots are used in real-time, multipurpose applications such as home automation. Also in dangerous environments such as radioactive environments, detection and deactivation of bomb scenarios, and human toxic manufacturing processes (space exploration, underwater, high temperature environments, biologically dangerous wastes and high levels of purification, etc.). You can use it. Contaminated waste), can be used). Robots can take any shape, but they tend to look like humans. This helps the robot accept certain replication actions performed by humans. Such replication behaviors are walking, lifting speaking, cognitive, or other humans.

II. LITERATURE SURVEY

1) Irawan, Yuda, Muhardi, Muhardi, Ordila, Rian, AND Diandra, Roni. “Automatic Floor Cleaning Robot Using Arduino and Ultrasonic Sensor” Journal of Robotics and Control (JRC). (July 2021)

This paper provides information on several components such as ultrasonic sensors, L298 motor shields, Arduino Uno microcontrollers, servos and DC motors. This tool works when the Arduino Uno microcontroller treats the ultrasonic sensor as a distance detector, the DC motor as a robot driver, and the DC motor is driven by the motor shield L298. When the ultrasonic sensor detects an obstacle in front, the robot automatically searches for a non-obstacle direction on the floor cleaning robot. The sensor distance value is determined when the distance measured by the ultrasonic sensor is less than 15 cm. Testing the distance values of the ultrasonic sensor revealed various conditions that occurred. At distances over 15 cm, you will reach the state of a prototype cleaning robot for road floor cleaning. 15cm stopped the condition of the prototype road floor cleaning robot.

2) “Design and Manufacturing of Automatic Classroom Vacuum Cleaning Robot” by Aniket A Somwanshi; Sanjay B Matekar. Publisher - International Journal of Engineering Research & Technology (IJERT). (October 2019)

Robotic electromechanical equipment automates work processes in many areas such as industrial power plants, military applications, household chores, and agricultural applications. Robots are a reliable means of carrying objects and cleaning areas in areas where human intervention is fairly impossible or dangerous. Impact on human health, such as B. nuclear power plants, chemical plants. This document describes a design prototype of an automated classroom vacuum cleaner robot (using user interface elements to power control electronic devices used in office / consumer environments). This paper also summarizes wheel design, chassis design, navigation motor calculations, and center search for vacuum design in vacuum cleaner implementations. In the robot design, different types of wheels were tested. The wheels under consideration are origami wheels, truck wheels, and pruning shears wheels. The origami wheels were adaptable in shape and size. The Impeller was mainly used in tank robots, but it did not serve its purpose. Ropper wheels are the wheels used in the robots they created and have been derived according to their requirements. Pruning shears have been observed to be easier and more economical to manufacture. Ropper wheels are manufactured and tested. The three diagonal ropper wheels had the problem of continuous fluctuations. To overcome this problem, five tilted wheels were tested. As a result, it was found that the fluctuation gradually decreased. 7-speed wheels have been manufactured and tested. The results of this wheel test showed a significant reduction in impact, so a 7-knob wheel was selected. The chassis was designed according to the required movement and carrying load. The choice of vacuum cleaner was based on Bernoulli's principle. Bernoulli means that if the fluid flows horizontally so that the gravitational potential energy does not change, a decrease in fluid pressure is associated with an increase in fluid velocity.

3) “Design and Development of Automatic Cleaning and Mopping Robot” by P.S. Aditya; R. Tejas; V. Sai Varun; B. N. Prashanth. IOP Conference. (2019)

This paper reports on "how to minimize the cost of robots". The design process for creating a cleaning robot was explained at the beginning of the treatise. The procedure for this is to determine how to perform the cleaning and wiping process, then determine the mechanical structure of the chassis, then select and purchase the appropriate electronics, and finally all the parts. Assemble, test and calibrate the robot. The work of the robots they build follows a set trajectory, starting at one end of the room and finally completing the cleaning of the entire room. Upon reaching the other end of the room, the robot turns and follows a path perpendicular to the previous path. The robot changes its route when it encounters an obstacle. The movement technique used for robots is simple snake movement.

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The manufactured robot facilitated both mop and vacuum cleaner mechanisms. It may work in both manual and automatic modes. They took different approaches to building the robot and chose to power the robot with lead-acid batteries to reduce the cost of the robot. The IR sensor used in most existing cleaning robots has been replaced by a more accurate ultrasonic sensor. Push switch, i. H. Limit switches were preferred over other non-contact sensors to increase the efficiency of the robot. The robot can cover about 90-92% of the area that way, and the rest can be cleaned with a mobile phone that can connect to the robot via Bluetooth.

4) "Vision-Based Dirt Detection and Adaptive Tiling Scheme for Selective Area Coverage" by Balakrishnan Ramalingam; Prabakaran Veerajagadheswar; Muhammad Ilyas;Mohan Rajesh Elara; Arunmozhi Manimuthu. Publisher-Hindawi. (December 2018)

This paper provides information on visual stain detection algorithms and adaptive tile-based area coverage schemes for reconfigurable morphological robots. A three-layer filter framework was used to detect visual stains, including edge detection, periodic pattern detection filters, and noise filters.

The periodic step pattern detection filter filters out the background of the image on the floor, leaving only the dirty areas. Self-filtering techniques are used to calculate the appropriate filtering function for detecting and identifying ground pattern frequencies. The Edge Detection and Enhancement step performs edge detection and enhancement on the ground image with the background subtracted. The final part here is denoising and dirt analysis, which uses a median filter to remove the noise that was present in the previous stage. Tetromino composed of quad polyomino is used. A detailed description of the tetromino tiling algorithm and adaptive tiling schemes for segmented dirt area coverage plans is fully described in this document. Some of the things being discussed are tetromino tiling theory, adaptive tetromino tiling algorithms, and comparisons with totromino. Two experiments were performed to validate the visual-based adaptive and selective area coverage scheme in their study. The first experiment was performed to validate the stain detection algorithm using the actual image of the stain and the image collected from the stain database, and the final experiment was adaptive tying using the generated stain map. It was to validate the scheme. The robustness of the visual stain detection algorithm was assessed by measuring the stain detection rate on different surfaces, including different types of multimedia content for the MU. The goal is ultimately to maximize the delivery capacity of the system. Simulation results show that CSF offers the best performance in terms of hit rate and system delivery capacity.

5) "Development of a vacuum cleaner robot" by T.B. Asafa; T.M. Afonja; E.A. Olaniyan; H.O. Alade. Publisher-Mechanical Engineering Department, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria. (December 2018)

In this paper they explained before prototyping, you need to consider the layout of the robot's electrical components, how it interacts effectively with real objects, movement restrictions, and many other important factors. It takes time to do the calculations and designs ourselves in a trial-and-error way, but this document was helpful in this because it covered model design, constraints, cleaning areas, and interactions. .. Prototyping was easy thanks to this treatise during design, circuit layout and speech performance evaluation.

The basis of building an automated cleaning robot consists of several blocks, such as navigation, collision detection, and a vacuum cleaner. Each type of block and their interactions must be synchronized for the robot to function properly without error. Thanks to the detailed description of the report, chassis design, limited space circuitry, navigation, and vacuum have been simplified with challenges, recommended changes and improvements, estimated costs and code expectations.

6) "Lessons Learned from Robotic Vacuum Cleaners Entering in the Home Ecosystem" by F Vaussarda; J Fink; V Bauwens; P Retornaz; D Hamel; P dilllenbourg; F Mondada. Publisher – Research Gate. (October 2014)

This paper highlights how to effectively overcome these mistakes by addressing and learning from previous robot vacuum mistakes and making the necessary changes to the robot's design.

The report also documents the efficient use and management of energy with optimized distribution within the system by analyzing the energy crises that may occur in future generations. This article deals with various navigation techniques that can be used on a cleaning robot to use the energy in the system efficiently. Based on your design rating, you can choose the best navigation method to use. Therefore, the main aspects covered in this article are: Power Management: Describes the effective operation of the system and switching between active and inactive components to extend the battery life of the device. Navigation Techniques: Circulates the power consumption and accuracy of several types of navigation used and each type of navigation technique.

III. OBJECTIVES

1) To design and implement an omni-directional, D-Shaped autonomous robot using wireless sensors, bumpers, ultrasonic sensors, Arduino uno & ESP8266.
2) To design an energy efficient model that consumes least energy possible without compromising the features of a vacuuming robot.
3) To design a cost effective yet a powerful and rechargeable battery vacuum cleaner robot.
4) To design a robot capable of performing both sanitization and vacuuming.

IV. HARDWARE AND SOFTWARE COMPONENTS

A. *Arduino Uno Board*

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.



Figure 3 Arduino UNO

B. *H-bridge L298 Dual Motor Driver*

The L298 is an integrated monolithic circuit in a 15-lead Multi-watt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver de-signed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the in-put signals.

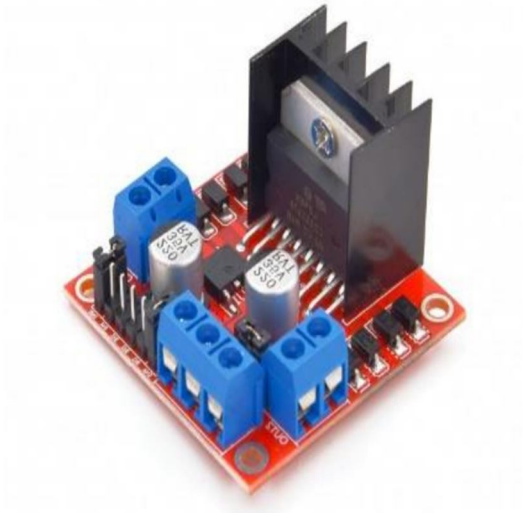


Figure 4 H-Bridge for Motor and Sensor power distribution

C. Sharp Distance Sensor

Sharp Distance Sensor is an IR Sensor; it works by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED, which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light.



Figure 5 Sharp Distance Sensor

D. Li-Po Battery

Lithium polymer battery is one of the core components, which powers the whole Automation, choosing a proper battery, which is robust and long lasting, is important, so Li-Po battery were the perfect type of battery, which is easily rechargeable and easy to integrate with the circuit.



Figure 6 Li-Po Rechargeable Battery Pack.

E. ESP 8266

The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. The ESP8285 is an ESP8266 with 1 MB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

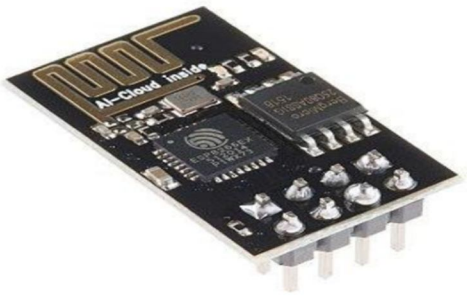


Figure 7 ESP8266 Wi-Fi Module

F. Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

Figure 8 Arduino IDE

V. METHODOLOGY

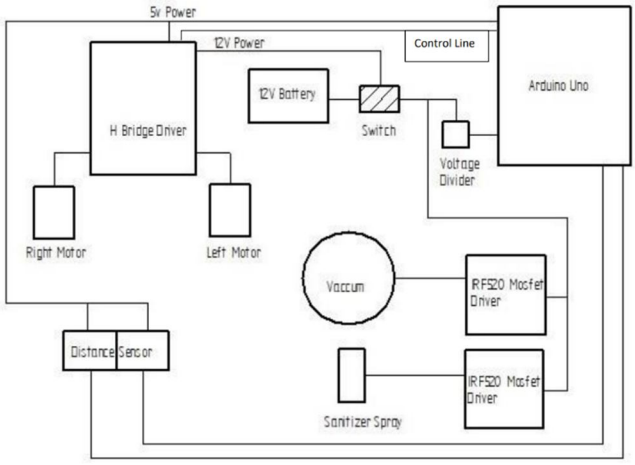


Figure 9 Block Diagram of Automated Domestic Vacuum Cleaner Robot

The proposed system incorporates an automatic sanitization and vacuuming system. The entire system is divided into four subsystems.

Making of Chassis: The suitable dimensions of the chassis have to be set according to the requirements of the average domestic environment. The base of the robot is set accordingly. The finalization of the positions of the front wheels and guide wheel are made and the precise expected cuttings will be made on the base of chasse for the same. The implementation of the guide wheel is used for the stability of the robot.

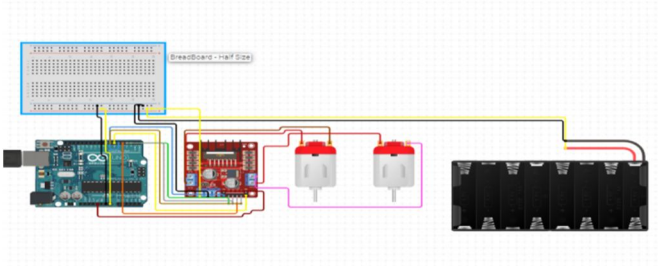


Figure 10 Movement Testing of Wheels

Interfacing the Sharp distance sensor & Push buttons: These sensors and buttons will be placed on the front face of the chasse. It facilitates with the collision detection and alternate withinside the movement of wheels.

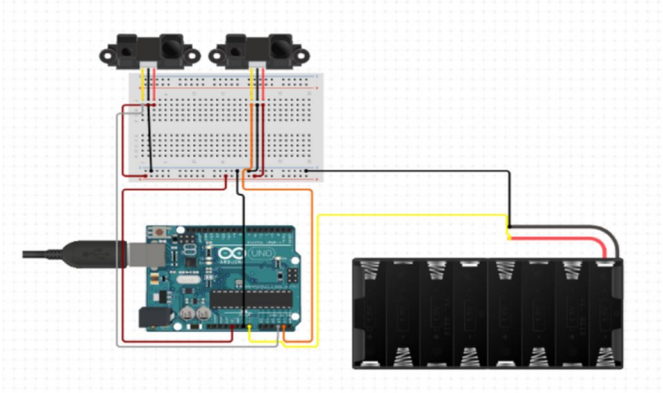


Figure 11 Operation of Sharp Distance Sensors

Assembly and Controlling: The powering wheels used for the robot for movement and rotation of the chasse are high rpm wheels, which are used to better understand the movement pattern of the system. The guide wheel is also placed which helps to stabilize the chasse when the load (circuit board, battery, fan, etc.) is added. Connections of the battery with the Arduino is been made. These are the basic design aspect made for the prototype of the system. The default connections of each individual component are to be tested for their working capacity.

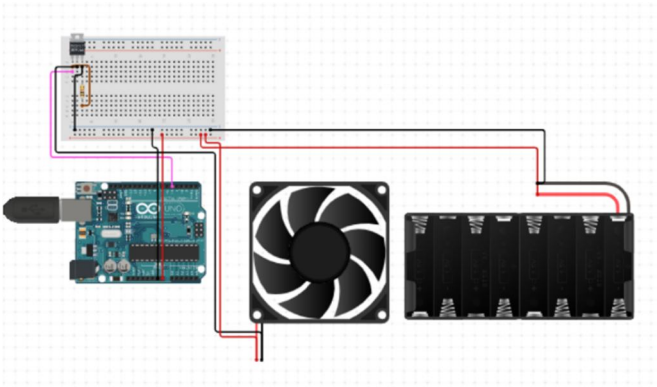


Figure 12 Interfacing of Vacuum Fans

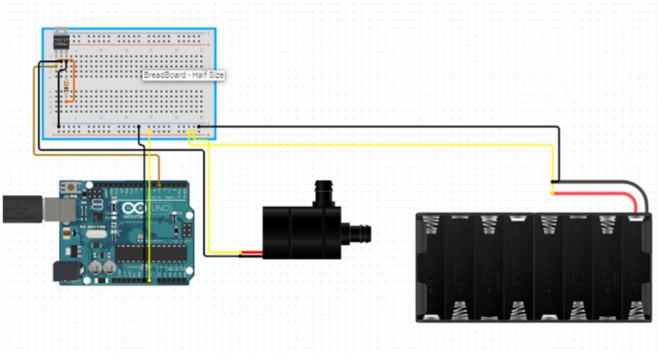


Figure 13 Interfacing of Pump

Software Requirements: Arduino IDE: The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

VI. OUTCOMES

Automated domestic vacuum cleaner robots show the result of developing autonomous mobile robots based on some new ideas that have emerged in this field over the last decade.

It is capable of performing both sanitizing and vacuuming. Our new design for the shape of vacuum robot is going to be D-shaped Chassis.

The shape of the Automated Domestic Vacuum Cleaner Robot is well suited for the application, especially for a task like cleaning along a wall, around legs and in corners.

The developed Automated Domestic Vacuum Cleaner Robot is capable of dealing with a real environment in real-time.

VII. RESULTS

1) Automated Domestic Vacuum Cleaner Robot detects the obstacles within its range accurately and navigates the space autonomously without any major collisions.

2) The suction fan used in the model collects majority of the dust present on the surface within its operating region.

3) The sanitizer spray operates throughout the navigation of the robot covering majority of the area in its vicinity.

4) The battery level indicator indicates the user whenever voltage is low for robot's operation.

5) The sharp distance sensors are accompanied by a long contact switch, which operates when the sharp distance sensor fails to detect the obstacle. It provides the backup signal for direction change after the collision.

6) The sanitizer spray used covers +10mm around the dimensions of the robot.

7) The battery used in the system gives runtime of 40-45 min. on full charge.

8) The design of Automated Domestic Vacuum Cleaner Robot is made to use least energy possible without compromising the features of a vacuuming robot, this makes it an energy efficient model.

VIII. CONCLUSION

Households are becoming more and more automated, resulting in greater convenience and less time spent on household chores. Vacuum cleaners have made cleaning your home easier, but they can be noisy and cumbersome for regular use. This robot shows the result of developing an autonomous mobile robot based on some new ideas that have emerged in this field over the last decade. Both disinfection and vacuum cleaners are possible. The shape of the robot is especially suitable for tasks such as along walls, around legs, and cleaning corners. In addition, the sharp distance sensor allows the front panel to detect obstacles that allow the robot to travel unobstructed paths. The developed robot can process the real environment in real time. The combination of the robot's shape, its sharp distance sensor system, and its algorithms work together to enable the task of cleaning and disinfecting unfamiliar, unstructured environments. You can outline the environment consisting of walls and corners in a reasonable amount of time. The turn and wheel speed are adjusted.

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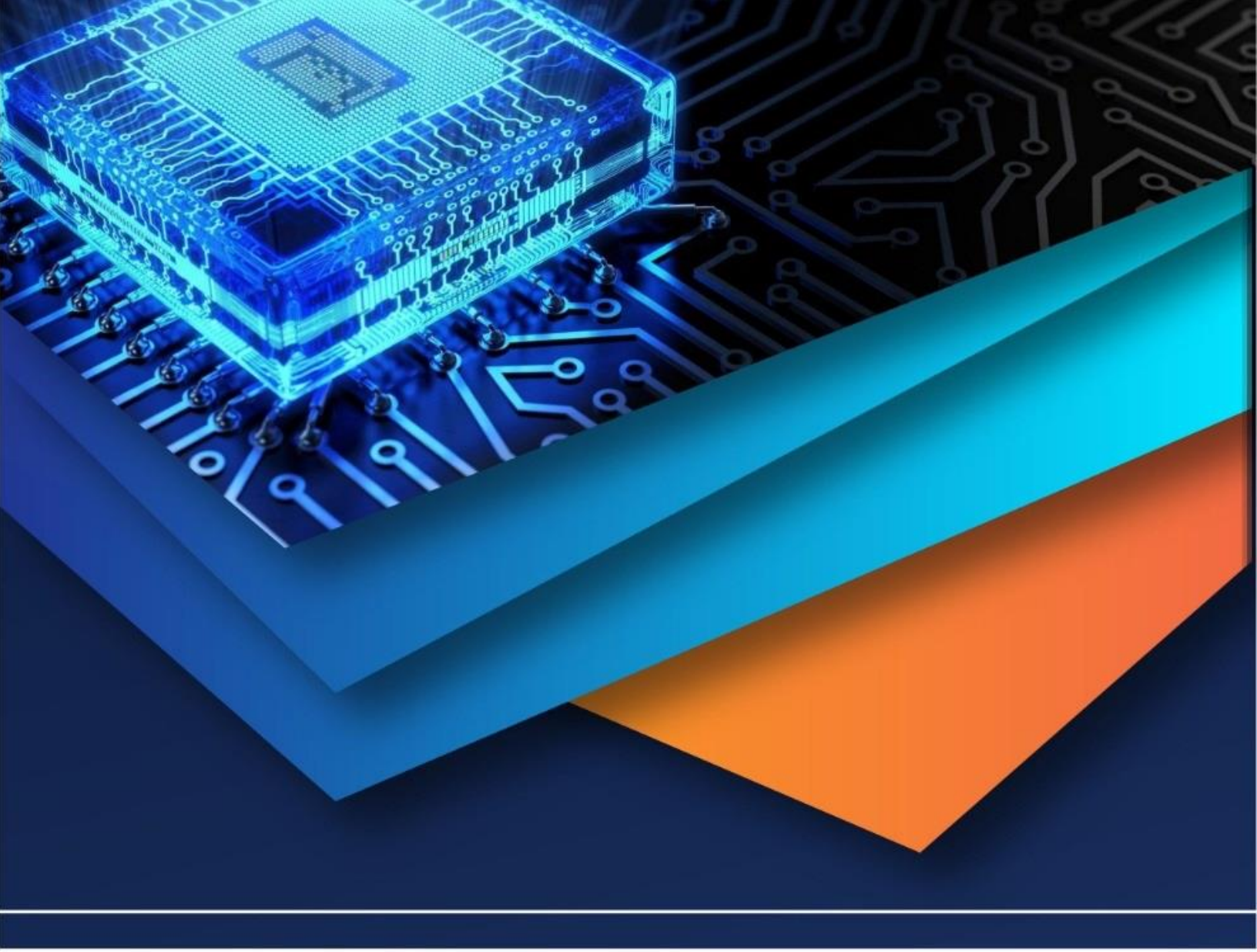
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