iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.45140

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Automatic Wall Painter Using Raspberry PI

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Abstract: ***This project describes development of Automatic Wall Painting Robot in real time which helps to achieve low-cost painting efficiently. It would offer the opportunity to reduce or eliminate human exposure to difficult and hazardous environments, avoids Human efforts, saves human life in risky painting like high rise buildings, which would solve most of the problems connected with safety when many activities occur at the same time. It will suit for all types of walls. The system performs the painting process using image captured by the pi camera. The painting area is calculated, and information is transferred to the spray gun. The whole process in painting is controlled by controlling circuit/Raspberrypi module. Raspberry pi module will control the DC motors, pully, paint spraying gun and connecting shaft. The pully will help in extending and retracting raises the connecting shaft and lowers it, respectively. The spray gun handle is mounted to the connection shaft, while the air compressor is set on the top platform and is turned ON/OFF at the bidding of the raspberry pi module.***
Keywords: Building Automation; Robotics; Wall Painting; Human Safety; Raspberry Pi, Pulse Width Modulation

I. INTRODUCTION

The system thus proposed below, is expected to solve the major challenge that a paint robot may face on how to implement a design on a given wall. Also, the techniques employed by the system are expected to provide much better paint finishing when working on walls with varying roughness. The system has two degrees of freedom, along the z-axis and either the x or the y-axis. The system is expected to improve the overall cost factors of the painting job. On the contrary, the time factor of the paint application when compared to the humans working on the same depends greatly on the type of paint operation to be performed. If the paint is to applied just as a single paint over the complete wall, the system is expected to perform faster when compared to the human labor, but as far as, implementing complex designs are concerned, the time factor is expected to be higher because of the various curve planning, along which the paint operation is to be performed. In current era we have multiple technologies to increase the robotic painting automation in various industries. Embedded system design is a used for many types of product design by implementing the software and hardware with input and output devices along with microprocessors. The main idea of this automation is to provide exterior wall painting automatically with the help of robot. The main idea to make the robot to move easily along the walls and apply paint smoothly. The advanced robots are accurate and deliver the results with exact thicknesses. Many creators have an idea of inventing robots which will create works of art, instead

of usual painting it makes them more creative. Others have probe for ways to form the robots economical and used for commercial purpose in places like interior painting. Automation and robotics have entered various pasture of the construction industry, and painting work. The traditional painting of the wall buildings which is carried out using platform has proved to be expensive. It is very unsafe to involve working preferable heights. The main objectives of the paper are painting chemical can cause severe damage to lever to save human life these robots are preferred, Paint the wall automatic in perfect manner, to avoid accident of human while doing external wall painting robot, to provide user friendly control application, Normal painting by human is causing severe accident while doing external wall painting to avoid accident painting robot is used.

II. LITERATURE SURVEY

A. Automated Exterior Wall Painting Robot Using Raspberry Pi

The author proposed a robot that can be program to move around using simple Python commands. Developed a exterior building wall painting robot to paint the wall efficiently. It can be used to cover the wall uniformly and reduce the painting cost of wall. It takes only the initial cost to manufacturing. This type of robot used to save the human life for the injuries to paint the higher position in apartments and buildings. The paint having some poisonous some metal it lead some disorder like the respiratory problem and some skin problems. In our robotto paint the square fit in 2 minutes. But it is only the demo to use brush module for a future to use the sprayer mechanism to paint the wall to reduce the time and paint the wall efficiently and precisely. The main purpose of this robot is used to save human life while doing external wall painting.

B. Monocular Vision Based Parameter Estimation for Mobile Robotic Painting

In this paper human efforts are replaced by automated robot painting to advance the efficiency and to reduce the painting cost. Here they used a single camera and four laser sensors to sense the range. The position between the robot and the painting surface is identified through a single image distance calculation .As per developed model, the wall plane equation and the position of the paint-start point were achieved by robot manipulator. The parameter estimation about less than 10mm and medians of error less than 6mm and they are comparing the results of accuracy to the existing method. The future scope is based on to improve the measurement accuracy.

C. RoboPainter - A detailed robot design for interior wall painting

The author has devised an interior wall painting robot called Robot Painter. The robot contains 6 DOF (Degrees of Freedom) Robotic arm mechanism mounted on a 2 DOF differential moving platform. The end joint is attached to a spray mechanism that paints the wall and the overall system and has capability to self-localize and navigate itself near the walls using 10 ultrasonic sensors. The author has presented detailed analysis of the CAD drawings of the same.

D. Autonomous Wall Painting Robot

They proposes a complete area coverage planning module for the modified hTrihex, a honeycomb-shaped tiling robot, based on the deep reinforcement learning technique. This framework simultaneously generates the tiling shapes and the trajectory with minimum overall cost. In this regard, a convolutional neural network (CNN) with long short term memory (LSTM) layer was trained using the actor-critic experience replay (ACER) reinforcement learning algorithm. The simulation results obtained from the current implementation were compared against the results that were generated through traditional tiling theory models that included zigzag, spiral, and greedy search schemes. The model presented in the current paper was also compared against other methods where this problem was considered as a traveling salesman problem (TSP) solved through genetic algorithm (GA) and ant colony optimization (ACO) approaches. Our proposed scheme generates a path with a minimized cost at a lesser time.

E. Paint-Robot - FPGA Based Wall Painting Service Robot Prototype

The authors have shown the successful working of a suspension type mechanism to paint, called Paint-robot.The system runs on FPGA logic board and uses stepper motor to control the location of a DCV that paints the wall. The system is tested with MATLAB simulation and the authors have compared the simulation tests with the practical results, which are shown to be positive towards their intended goal.

III.DESIGN AND METHODOLOGY

One of the most important features of the project is designing the system. The design part provides all the different elements of the system such as architecture and components. System design solves the problem by splitting the components of the complex system into smaller components and will perform and operate on each individual component. Embedded systems are computer systems designed to carry out certain tasks that are integrated with hardware. In this project embedded system interfaces sensors and module to micro-controller and connects different components to make it as a complete usable product. The overall system consists of Raspberry as a heart of the system is interfaced with IR Sensor, L293D – Motor driver and DC motor. If we set the condition the ultrasonic value is within the limit of some present value means it automatically follows the wall without any human intervention. If it is greater means it automatically changes its path. It is a real time build for more application based on object follower based on distance with the help of image processing technique. The power supply unit is used to supply the power to the system, the pi camera checks for the readings of the IR sensor to find the range between the wall and the robot. If the wall is away from the robot as the pi camera detects it and sends the signal to the motor driver, which controls the motor speed and direction. The software within the pi determines the path towards the wall and sends the signal to the spray paint assembly which in turns starts spraying the paint to the wall. The alarm and indicators give the feedback indicating that the wall is too far away from the robot and need physical attention to guide the robot towards the wall. The pi camera is connected to the Raspberry pi module, with the help of this camera web capture the image of the object and we check whether it is a wall or obstacle. If the captured image is an obstacle we take 90-degree turn and make a path to avoid the obstacle. If the captured object is a wall then the program moves to the next step. The next step of the code is to check the wall is painted with the specified color or not. For color identification, we have used hsv techniques Next step is to detect colour of wall , we set the specified color as painted region so it finds region to be painted with hsv algorithm in open CV.

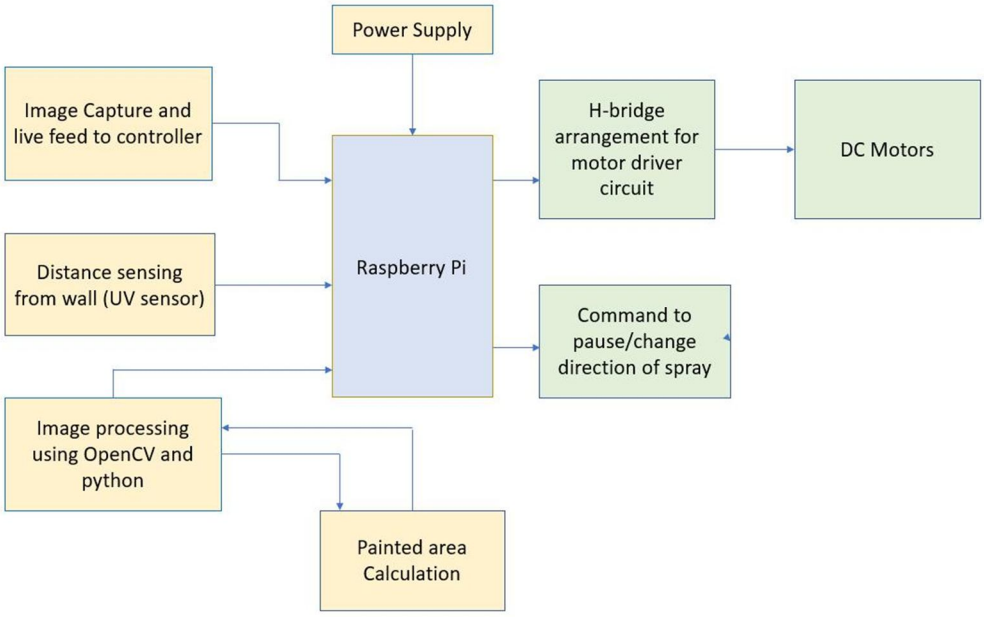

Fig1. Block diagram of the system

IV. COMPONENTS SPECIFICATION

A. ARM11 Raspberry Pi 3board

Pi is a credit-card sized computer that connects to a computer monitor or TV and uses input devices like keyboard and mouse. It is capable of performing various functionalities such as surveillance system, military applications, surfing internet, playing high definition videos, live games and to make databases.

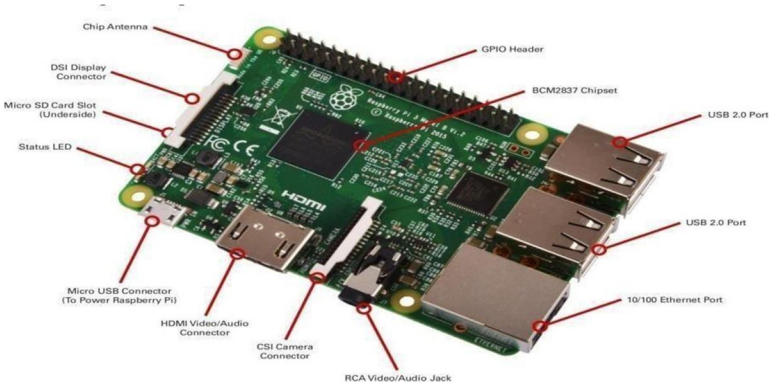

Fig 2. Specification of Raspberry pi

B. Processor / SOC (System on Chip)

The Raspberry Pi has a Broad-com BCM2835 System on Chip module. It has an ARM1176JZF-S processor. The Broad com SOC used in the Raspberry Pi is equivalent to a chip used in an old Smartphone (Android or iPhone). While operating at 700 MHz by default, the Raspberry Pi provides a real world performance roughly equivalent to the 0.041 GFLOPS. On the CPU Level the performance is like to a 300 MHz PentiumII of 1997- 1999, but the GPU, however, provides 1 G pixel/s, 1.5 G texel/s or 24 GFLOPS of general purpose compute and the graphics capabilities of the Raspberry Piare roughly equivalent to the level of performance of the Xbox of 2001. RaspberryPi chip operating at 700 MHz by default, will not become hot enough to need a heat sink or special cooling.

C. L293D: An H-Bridge

An H-Bridge is nothing but an electronic circuit. Using such a circuit, you can supply current in two directions. Thats it. The L293D is an H-Bridge with two possible outputs. Meaning, you can connect two things to it and you can control the direction of current flow in both. Lets say you have a DC motor, as in the diagram below:

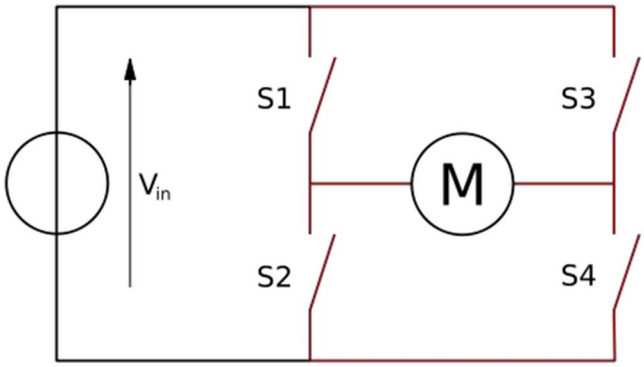

Fig 3. An H-Bridge in terms of switches

If you close both S1 and S2, you'll short circuit the entire thing. Same goes with S3 and S4. Such a condition, in technical terms, is called a shoot through. So we won't consider shoot throughs. Now, if you close switches S1 and S4, current flows through the motor from left to right. If you close S3 and S2, current flows from right to left. In these two conditions, the direction of rotation is different. This is exactly what's needed in most robotics projects using differential drive wheels. But having physical switches would be very inconvenient. You'd need more motors to close and open switches. And to control those motors you'd need even more switches. Ah well. You probably get the point. This is exactly what's needed in most robotics projects using differential drive wheels. But having physical switches would be very inconvenient. You'd need more motors to close and open switches. And to control those motors you'd need even more switches. Ah well. You probably get the point.

D. Regulator

A voltage regulator (also called a _regulator') with only three terminals appears to be a simple device, but it is in fact a very complex integrated circuit. It converts a varying input voltage into a constant _regulated 'output voltage. Voltage Regulators are available in a variety of outputs like 5V, 6V, 9V, 12V and 15V. The LM78XX series of voltage regulators are designed for positive input. For applications requiring negative input, the LM79XX series is used. Using a pair of voltage-divider resistors can increase the output voltage of a regulator circuit. It is not possible to obtain a voltage lower than the stated rating. You cannot use a 12V regulator to make a 5V power supply. Voltage regulators are very robust. These can withstand over-current draw due to short circuits and also over-heating. In both cases, the regulator will cut off before any damage occurs. The only way to destroy a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator almost instantly.

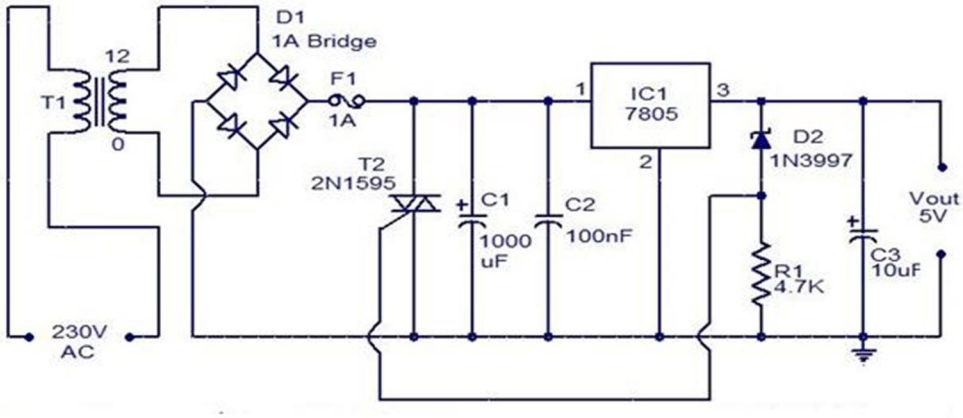

Fig 4. 5v power supply with over voltage protection.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

E. GPIO – General Purpose Input Output

General-purpose input/output (GPIO) is a generic pin on an integrated circuit whose behaviour, including whether it is an input or output pin, can be controlled by the user at run time. GPIO pins have no special purpose defined, and go unused by default. The idea is that sometimes the system designer building a full system that uses the chip might find it useful to have a handful of additional digital control lines, and having these available from the chip can save the hassle of having to arrange additional circuitry to provide them.

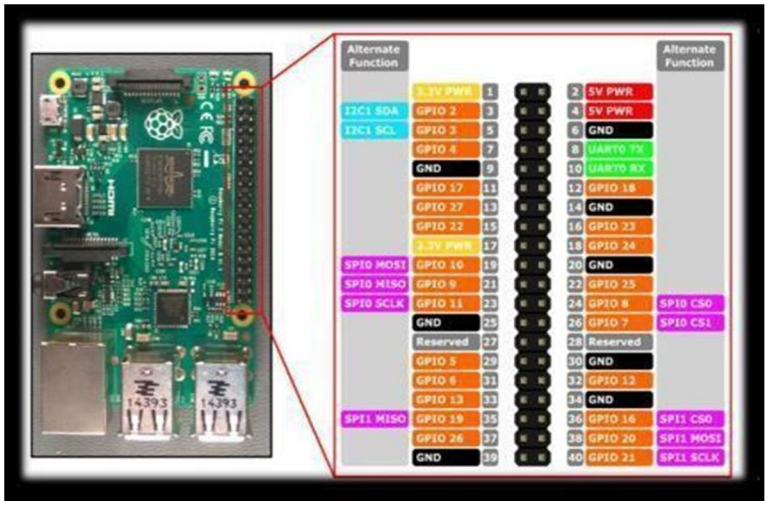

Fig 5. GPIO Pins

F. CSI Connector

CSI–Camera Serial Interface is a serial interface designed by MIPI (Mobile Industry Processor Interface) alliance aimed at interfacing digital cameras with a mobile processor. The RPi foundation provides a camera specially made for the Pi which can relate to the Pi using the CSI connector.

G. Relay

Fig 6 .12 Channel Relay

Trigger Voltage	5V DC
Trigger Current	70mA
Maximum AC	250/125V AC
Maximum DC	30/28V DC

V. MPLEMENTATION

In this section we have described how our idea is converted into real time. Our real time has been implemented into two parts i.e. Hardware implementation and Software implementation in Hardware implementation we described how circuit connection is made based on the block diagram and we have explained each component working in the real time. In Software implementation part we have explained the code which is essential for working. A 12V DC motor is fixed to the mainframe and connected to the driver IC where deriver IC helps in the movements of the DC motor. The motor is connected to the slider assembly for up-down movements. When slider motor moves in clockwise direction slider move in up when the slider moves in anti-clockwise direction slider move in the down direction. We have connected the twin between the motor as well as slider movement because they have to work simultaneously and both depend to each other i.e., whenever we need slider assembly to move up and down we make the motor to run. We have placed a small clamp in the mainframe which connects the lead rod to the mainframe. Lead rod is vertically mounted such that we can connect the slider assembly. The X-Y movement of the lead rod is maintained by the mainframe movement itself.The actuator of the system is triggered by a servo motor. Sparing the paint to the wall is done with the help of actuators with the raspberry pi assembly The pi camera is connected to the pin 22 of the Raspberry pi module, with the help of this camera we capture the image of the object and we check whether it is a wall . whether it is a wall . If the captured object is a wall then the program moves to the next step. The next step of the code is to check the wall is painted with the specified color or not. For color identification, we have used masking techniques. In this technique, we mask another color check for specified color is on the wall, if it is already present it will show that area as white and all other areas as black vice-versa. If all parts of the wall is white then the painting is already done on that particular wall and it will move to the next position. If the area is not painted it will start to paint the wall with the help of hardware working explained in the above paragraph. Wall painting robot is a simple device that carries the entire paint application set up from one end to other end of pipe and simultaneously applies a uniform spray coat of paint on the wall pipe. This machine easily solves the above problem which otherwise is really difficult without such aid. The machine needs compressed air supply for movement of the robot and painting operation.

1) *Base Frame:* The Primary base frame is the base element provided with castor wheels, The primary base is made of mild steel square tube and mild steel plate. It supports the entire assembly of the spray paint system.
2) *Vertical Motion System:* The vertical motion system comprises of the screw and nut, lifter screw held in two ball bearings and nut connected to the carrier. Rotation of screw is converted to translation of the spray paint system u or down Paint storage: Paint storage is done in a small tank of 0.8 to 1.2 liter capacity mounted on the structure. The compressed air is supplied through the chamber to carry the paint to the spray rotor end.
3) *Paint Application:* Paint application is done by means of a spray which is reciprocated in linear guide by crank and connecting rod mechanism opearated by motor. Frame with castor wheels: This is base of the machine which enables transportation of the set-up or when applied with motorized motion can enable automatic translation while wall painting.
4) *Pinion Shaft:* Pinion shaft is mounted at its square end on the worm gear box output side, where as the pinion is held on the other side of the pinion shaft.
5) *Main Shaft:* Main shaft is held at one end in ball bearing 6003zz in the main bearing housing which is welded to the base frame. Where as the side stand is welded at other end of shaft.
6) *Holder Bracket:* Holder bracket is an standard forged part which hinges the side stand at one end, and spring arrester pin-1 is welded at the other end. This pin holds one end of the helical tension spring. The holder bracket is welded to the boom.
7) *Base Frame:* Base frame comprises of the base plate, boom, motor plate and the gear box plate. These are support members that hold the assembly together.

VI.CONCLUSION

Development of an Autonomous wall painting robot uses simple components like a sensor, a driver circuit, and a DC motor. We can design a robot that performs a wall painting operation. The proposed Real time Project will be designed to automate the interior walls painting process, making it easier and more efficient. This design is simple and relatively easy to implement in comparison with the remainder of interior wall painting robots. Adding to that, the stability of its structure, and the fact that it can be built using any other material, judging by its availability, affordability, and following the needed specifications. A method has been developed for automatic spray painting of unknown parts. This machine is very useful for painting of any shape with very time period less. Accuracy of this machine is more as compared to manually painting . It also saves the labor cost and the total cost of painting the any jobs. The methods of painting and intends to enlighten readers and artists alike with knowledge of modern art techniques as well as forgotten techniques of the painting technology.

By using the automatic painting machine it is clear that the human efforts are reduces as well as the cost of labor also reduces. Automatic Painting machine can also print the huge building easily and safely without any hazards to human being and labors.

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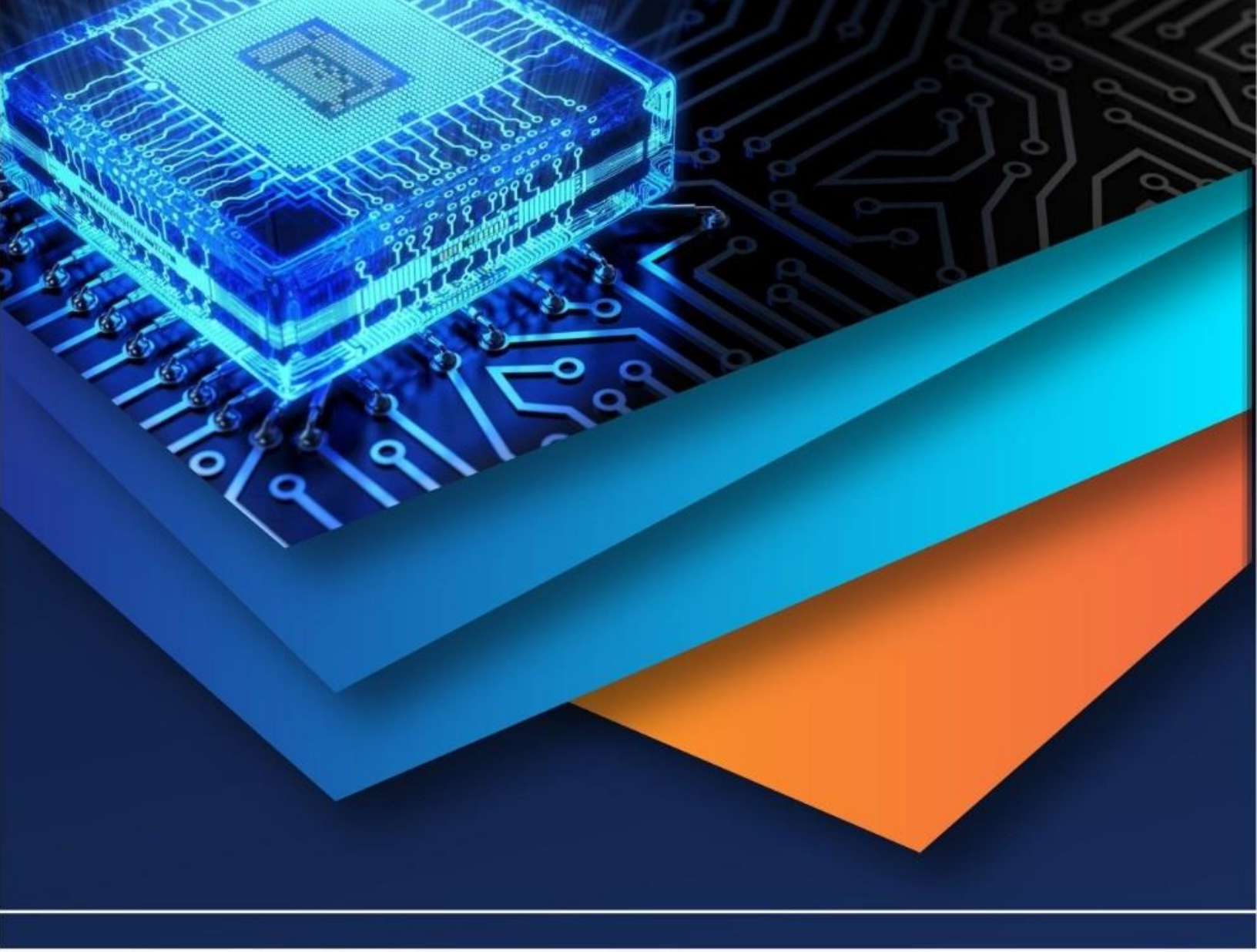

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