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Gesture Controlled Robot using Arduino

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Abstract: ***A Gesture Controlled Car is a robot that can be controlled with a simple human touch. The user only needs to wear a touch device where the sensor is installed. The sensor will record the movement of the hand in a certain direction that will lead to the movement of the robot in the right places. The robot and the touch device are connected wirelessly with radio waves. The user can communicate with the robot in a very friendly way due to wireless communication. We can control the car using accelerometer sensors that are connected to our hand glove. Sensors are designed to replace the remote control commonly used to drive a car. It will allow the user to control the forward, backward, left and right, while using the same accelerometer sensor to control the car's steering wheel. The movement of the car is controlled by the separation method. The machine involves rotating both front and rear wheels on the left or right side to move the non-clockwise side and another pair around the clock causing the car to rotate with its axis without going forward or backward. The main advantage of this machine is that the car with this method can take sharp turns without difficulty. The design and use of a robotic control arm using a flex sensor is suggested. The robot arm is designed to consist of four moving fingers, each with three connectors, an opposing thumb, a round wrist, and an elbow. The robot arm is designed to mimic the movements of a human hand using a hand glove.***

Keywords: Robotic Arm, Flex Sensor, Wireless Module, Accelerometer.

I. INTRODUCTION

Robotics had become a trending and upmost technology in recent days. It is a topmost demanding technology in the field of science and will become the base for the future. Even Google is planning to produce worker robots. The mission and vision of robotic technology is to build the machines that can help humans in many fields. This paper presents a project named as Hand Gesture Robot. Here we had built a vehicle robot whose movements are controlled by human hand movement. The movement of our hands acts as a commands for the robot and moves in a particular direction.

Our motivation to work on this project had come from a disabled person who was driving his wheelchair by hand with a lot of difficulty. After being interacted with physical challenged people we decided to build a device should be helpful in outdoor and indoor as well. For the people who are physical challenged by their legs can drive two wheeler which has support but they can't drive a car without the help of another person. So here the robot is operated with the gesture of a human hand. This robot even helps to drive their chair without touching or pulling the wheels forward and backward

Even after the technology had been developed a lot, in real world still numerous people use ancient wheelchairs for their survival as the cost is high. So our main objective is to make a simple and cheaper device so that it could be mass produced and can be used by utmost people. This project can also be used in hospitals, shops, hotels, homes where contact-less delivery is necessary so that social distancing is strictly followed in this pandemic situation.

This Hand gesture controlled robot is a wireless operated robot and uses radio frequency waves for communication purpose. These robot contains two circuits, firstly a transmitter unit and another one a receiver unit. The hand gestures are converted into electrical signals by the accelerometer sensor and the Arduino Nano. Next, this signals are processes the incoming signals and sends it to the RF transmitter. At the receiving unit, these signals are received by the Radio Frequency receiver and then these signals are sent to the Arduino for decoding purpose. The Arduino after receiving the signals, activates the motors with the help of the motor driver. A RF pair is used for communication. These RF pair connected with Arduino and the motor driver is also connected to Arduino in order to run the robot.

The robot consist of Arduino Nano board, MPU6050 Sensor, HT-12E Encoder IC and an RF Transmitter at the transmitter side and RF Receiver, HT-12D Decoder IC, L293D Motor Driver IC and a robot chassis with four motors connected to wheels at the receiver side.

II. LITERATURE SURVEY

Different types of robots had been implemented using different technologies. Such as data glove, gesture to speech conversion, feature extraction. But all these need complex algorithms, remote, switches, joy sticks or single or multiple cameras to capture the hand movements. One of the most common technique is data glove method. So, here we are just using accelerometer, sensor to recognize the hand movement and a code for Arduino Uno.

Accelerometers are attached to the gloves as they are the sensors which are used to convert positional changes of hand into electrical signals. These accelerometer sensor sends the outputs based on the change in dimensions such as X-axis, Y-axis and Z-axis and orientation of the hand in free space. The sensor is fixed to the hand.

Another type is Vision based technique which involves using cameras in it which capture image of hands and then decode the image and performs instruction corresponds to it. Here this may contain a single camera or multiple cameras are used based on the application and accuracy. This technique is a hybrid of vision based method. It has three steps, the first step is to identify the hand region in the image. The second step is the feature extraction, which comprises of finding centroid and major axis of magenta region. The last step is building classifier by learning vector quantization method.

One of the other easy techniques is using a joystick to control the robot as the joystick is an input device but it provides better control and it is easy to use and handle. It is similar to the accelerometer, it sends the signals based on the change in dimensions of the sensor whereas, this module sends the signals based on the change in the dimensions of the joystick.

III. BLOCK DIAGRAM

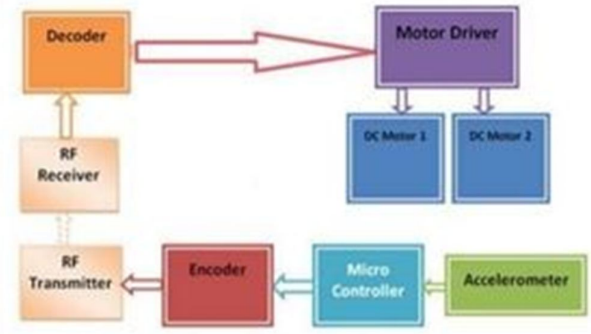

Figure 3.1. Block diagram

Components Required

- Arduino Nano/Uno
- 434MHz RF Transmitter
- HT-12E Encoder IC
- MPU6050 Accelerometer/Gyroscope Sensor
- L293D Motor Driver IC
- HT-12D Decoder IC
- 434 MHz RF Receiver
- 4 Geared Motors with Wheels
- Robot Chassis

A. RF Transmitter

The transmitter is ASK Hybrid transmitter module which provides frequency stability by using the saw resonator. It uses 434MHz frequency waves to transmit the data hence knows ass the RF transmitter. The transmitted is received by the same frequency receiver knows as RF receiver. It used for high accuracy and for shorter distance. The cost is low and high efficiency but the only disadvantage is low range.

B. RF Receiver

As this receiver operating frequency is at radio frequency i.e., 434MHz it is named as RF receiver. It is an Amplitude Shift Keying super heterodyne receiver and consists of PLL synthesizer and crystal oscillator in it to provide frequency stability. These receivers works with 434 RF transmitter. Both these transmitter and receiver combines and form a single RF transducer module.

C. Encoder IC

Here the encoder IC we use is HT-12E Encoder IC, it named so as it has the capability of pairing with 212 series of decoders to use in the remote control systems. This encoder is used for interfacing with RF module. It receives 12bit parallel data inputs encodes it and converts it into serial output for transmission through RF transmitter.

D. Decoder IC

HT-12D is a 12 bit decoder which has the capable of pairing with 212 series of encoders and used for interfacing with RF module. The main advantage of this is its low power consumption and has high noise resistance.

E. MPU6050 Accelerometer/Gyroscope Sensor

Accelerometer is an electronic sensor which measures the vibrations and acceleration of motion of an object. The change in acceleration produces electrical signals.

Gyroscope is a device that can measure the tilt and orientation of an object. Conversation of angular moment is the working principle for this sensor.

F. Motor Driver IC

It is a 16 pin IC. The main advantage of this motor is it consists to two DC motors and have capable of running those two motors independently. The main reason of using this motor drive is as it has capable of driving the motors in both clockwise and anti-clockwise directions.

G. Arduino-Uno

The Arduino-Uno ATmega328 is the most famous and commonly used microcontroller board in numerous applications, this had become the base of many applications as the features in the Arduino-Uno results in high flexibility and greater accuracy with the less cost. It has 16 digital pins, this 16 digital pins are emerged input and output pins.

Depending upon the application those are used as input and output respectively (of which 6 pins can be used as PWM outputs) and 6 digital pins as the analog inputs. It contains everything that needed to support the microcontroller to function with greater accuracy. To switch it ON, simply connect it to a personal computer /laptop with a USB cable or else supply the power with an AC-DC adapter/battery.

There are 9 main components of Arduino UNO board which are as follows:

- USB connector
- Power port
- Microcontroller
- Analog input pins
- Digital pins
- Reset switch
- Crystal oscillator
- USB interface chip
- TX and RX LED’s

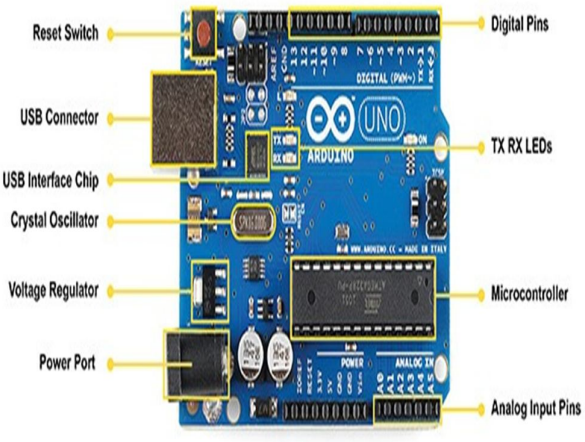

Figure 3.5 Pin diagram of Arduino-Uno AtMega328

H. Jumper wires and Connecting cables

1) A jumper wire is an electrical wire which simply acts as a connector which passes electricity or current though it. It even have a group of wires in some cables such as optical fibre.

2) We can connect the ends of the jumper wires or connecting wires with a connector or pin. It is also known as jump, jumper wire, jumper cable, DuPont wire or cable.

3) Individual jumper wires are fitted by inserting their end connectors (pins) into the slots that are provided in the breadboards, microcontrollers, etc.

4) They are male to male connectors, female to male or male to female connectors, female to female connectors are the 3 types of jumper wires available in the market.

5) These don't have any specify colour, they are available in different colours.
6) The main advantage of this jumper wires are without soldering, this wire connects two points of same or different devices.
7) Jumper wires are flexible and cheaper.
8) There are different types of connectors. Some of those common connectors are:
9) Solid tips, Crocodile clips, Banana connectors, Registered jack (RJNN), RCA connectors, RF connectors, RF jumper cables

Circuit

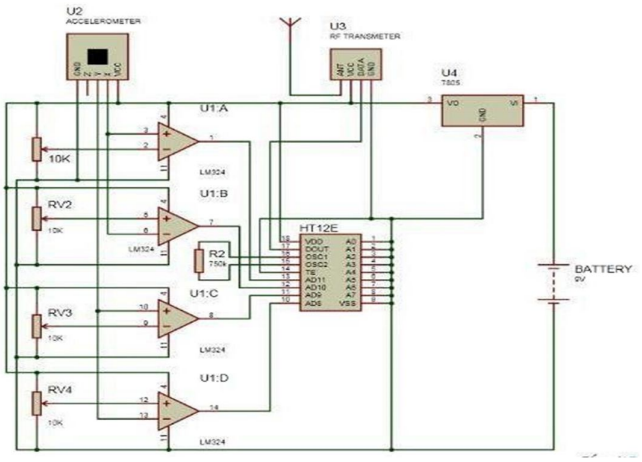

Figure.3.6 Circuit diagram for transmitter section

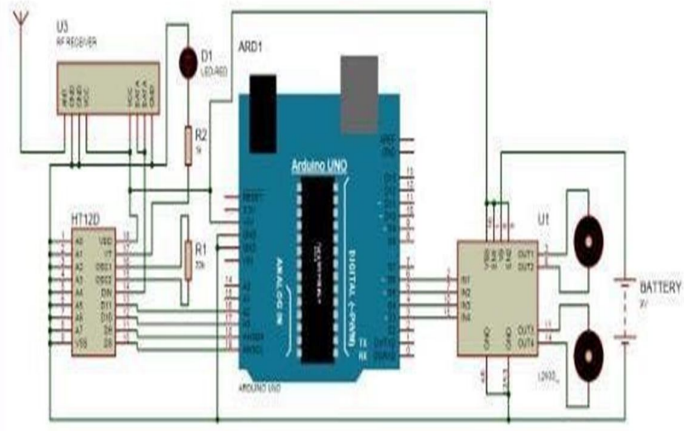

Figure.3.7 Circuit diagram for receiver section

IV. WORKING

A. Hand Gesture Robot Circuit

If we take glance over it, firstly the hand gestures of human are analyzed and then converted into electrical signals by the MPU6050 accelerometer sensor. This electrical signals are send to the Arduino Nano for processing of the incoming signals and then sends it to the RF transmitter. RF transmitter transmits this signals to the receiver. At the receiving side, these signals are received by the RF receiver which further sent to the Arduino Uno for decoding. The Arduino after receiving the signals, activates the motors via the motor driver.

1)Transmission Circuit: The first part of the circuit is the Transmitter circuit consists of an MPU6050 accelerometer sensor, an Arduino Nano, a 434 MHz RF transmitter and a 9V battery. The 9V battery powers the Arduino whereas the sensor, the RF transmitter can be powered from the Arduino-Uno, the Arduino can accept voltages that ranges from 5V to 12V. Whereas the sensors have to be powered by a 5V supply. The components are placed and then the connections are given with respect to the circuit diagram. In order to reduce the cost, in the place of the battery we can even use the power bank instead.

2)Receiver Circuit: The second or last part of the circuit is Receiver circuit consists of an Arduino Uno, a 434MHz RF receiver module, L293D Motor Driver IC, HT-12D Decoder IC, 4 Geared Motors with Wheels. The battery power the motor driver, the motor driver powers the Arduino-Uno and the Arduino powers the RF receiver. All the components are

placed on a robot chassis and connections are made with respect to the circuit diagram. The accelerometer sensor sends the outputs based on the change in dimensions such as X-axis, Y-axis and Z-axis and orientation of the hand in free space. The sensor is fixed to the hand. Decoding is done by analyzing the position of hands and performs instruction corresponds to it.

3)Logic: The MPU6050 sensor has both devices inbuilt in it those are an accelerometer and a gyroscope. The actions based on the values are as follows:

If the value of acceleration along the x-axis is positive and within a specific range, then Arduino give the forward command, then the robot moves in the forward direction. If the value of acceleration along the x-axis is negative and within a specific range, then Arduino give the backward command, then the robot moves in the backward direction. Similarly, if the value of acceleration along the y-axis is positive and within a specific range then the robot turns Left direction. If the value of acceleration along y axis negative and within a specific range then the robot turns Right direction. And if none of the above cases is satisfied, then the robot will stop.

4)Trouble Shooting: If the motors don't run in the desired direction. Then find out motor behaviour in which way. Mostly, the wires of that motor have to be interchanged. If the received signal buffer contains some undesired values along with the message, then use the substring function to extract the message from it.

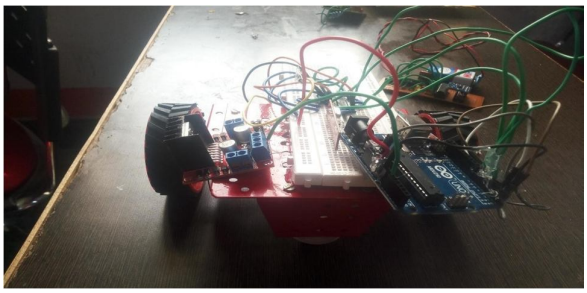

Figure.4.1 practical Hardware kit

V. RESULT

We achieved our objective without any hurdles i.e. the control of a robot using gestures. The robot is showing appropriate reactions at whatever point we move our hand. For controlling the robot remotely, Holtek's encoder-decoder pair (HT12E and HT12D) together with a 433MHz transmitter-receiver pair is used. HT12E and HT12D are CMOS ICs with working voltage going from 2.4V to 12V. Encoder HT12E has eight location and another four location/information lines. The informational index on these twelve lines (address and address/information lines) is sequentially communicated when send empower pin TE is taken low. The information yield shows up sequentially on DOUT pin.

The information is sent multiple times in progression. It comprises of contrasting lengths of positive-going heartbeats for '1' and '0,' the beat width for '0' being double the beat width for '1.' The recurrence of these heartbeats may lie somewhere in the range of 1.5 and 7 kHz relying upon the resistor esteem somewhere in the range of OSC1 and OSC2 PINS.

Our completed item can be found in the pictures below:

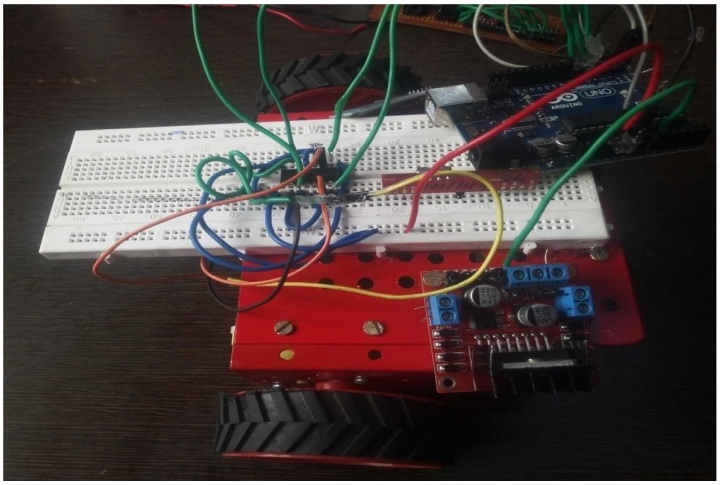

Figure.8.2 product after connections

Figure 8.3 transmitter part on hand glove

VI.APPLICATIONS

A. Gestures can be utilized to control collaborations for diversion purposes, for example, gaming to make the game player's experience more intuitive or vivid.
B. Through the utilization of motion acknowledgment, controller with the rush of a hand of different gadgets is conceivable.
C. Industrial application for trolley control, lift control, etc…
D. Military applications to control robotics.
E. Medical application for surgery purpose.
F. Construction application.
G. Plays a major role in helping very weak people in their daily life.
H. Can be used as an autonomous for physically challenged people.
I. General purpose device for better living.

VII. FUTURE SCOPE

A. The on board batteries consume a great deal of room and are additionally very weighty. We can either utilize some other force hotspot for the batteries or supplant the current DC Motors with ones which require less force.
B. The proposed framework is pertinent in dangerous climate where a camera can be joined to the robot and can be seen by the client who is in his station. This framework can likewise be utilized in clinical field where little robot are made that can help specialists for productive medical procedure tasks For more effective reaction, limit esteems can be utilized to identify motion and progressed highlights, for example, finger tallies that give distinctive useful orders can be utilized.
C. Entertainment applications – Most videogames today are played either on game control center, arcade units or PCs, what not require a mix of info gadgets. Motion acknowledgment can be utilized to genuinely drench a major parts in the game world like at no other time.
D. Automation frameworks – In homes, workplaces, transport vehicles and that's just the beginning, motion acknowledgment can be joined to significantly expand ease of use and lessen the assets important to make essential or optional information frameworks like controllers, vehicle theater setups with catches or comparative.

VIII. CONCLUSION

The purpose of project is to control a toy car using accelerometer sensors attached to a hand glove. The sensors are intended to replace the remote control that is generally used to run the car. It will allow us to control the forward and backward, and left and right movements, while using the same accelerometer sensor to control the throttle of the car. based on the hand movements. By using the above mentioned components the hardware was setup, thus resulting in the formation of a robot. In order to implement the experiment a Dell laptop was used, whose web camera acted as the input device for capturing the video. The software part was developed in Java for image processing wherein the hand gestures were analyzed to extract the actual direction. Eclipse Ide was used for developing the java code. The direction thus identified was send as characters to the robot with the help of Zigbee.
XBee S2 variant of Zigbee was utilized for appropriate correspondence. The final movement of the robot can be concluded as follows: At the beginning the robot was in a stop mode. As the hand moved from bottom to top, the robot moved in the forward direction. As the hand moved from top to bottom, the robot moved in the backward direction. As the hand was shown as an acute angle towards the left, the robot moved towards the left direction. As the hand was shown as an acute angle towards the right, the robot moved towards the right direction. As the hand is kept stationary with respect to the environment, the robot was in the stop mode.

From the experiment, about 80% of the implementation worked according; the remaining was less due to background interference which is a negative marking to the implementation. Hand Gesture Controlled Robot System gives a more natural way of controlling devices. The command for the robot to navigate in specific direction in the environment is based on technique of hand gestures provided by the user. Without using any external hardware support for gesture input unlike specified existing system, user can control a robot from his software station.

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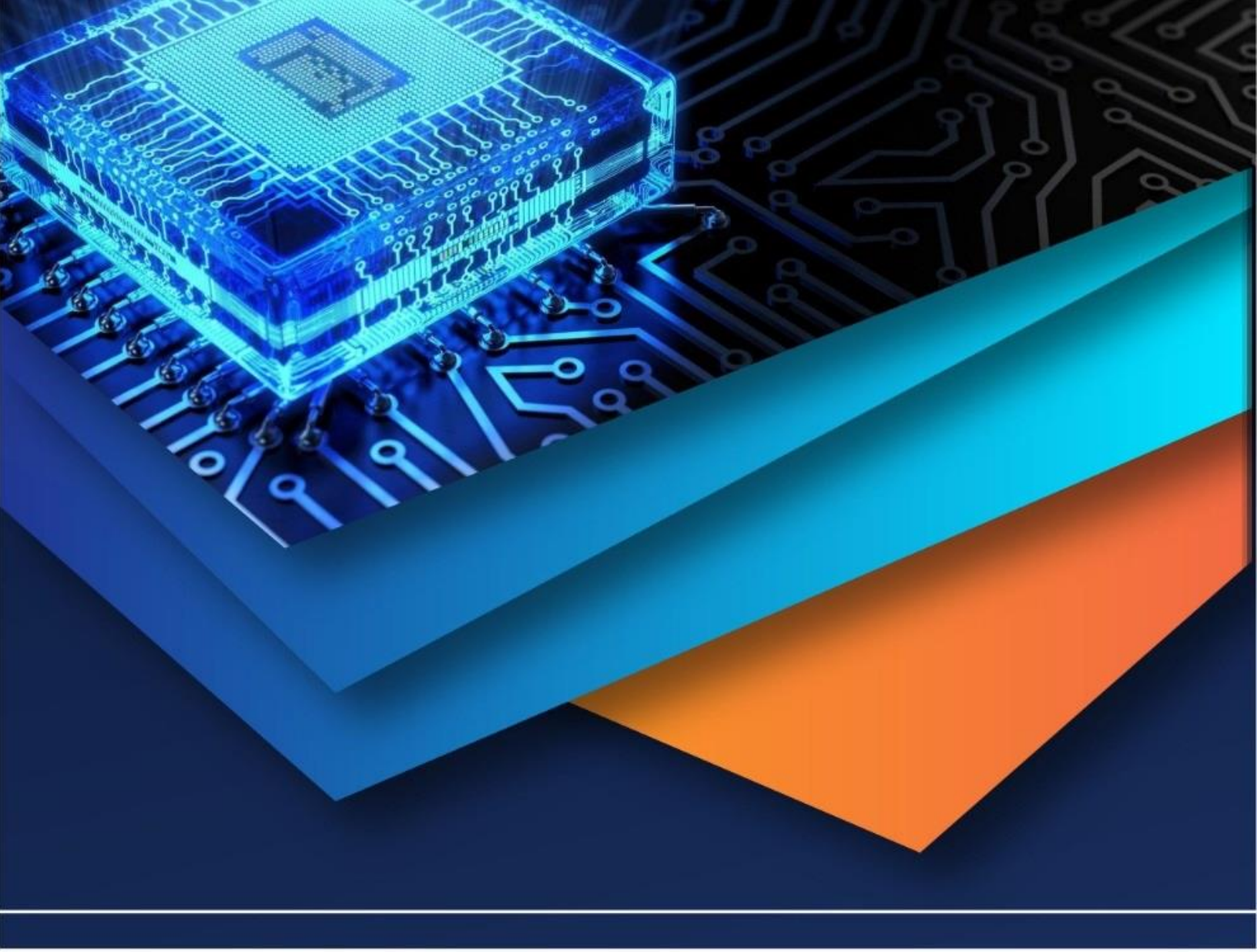

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