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Driving Assistance System for Security and Safety

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Abstract: The increase in the number of vehicles increases the number of accidents. India ranks first in the world by 11% where a greater number of accidents occur followed by China and the USA. Most road accidents occur due to human errors. The Advanced Driver Assistant System is developed to Automate, Adapt and increase the safety of the vehicle and driver and also to ensure better driving. The safety features in this system are designed and developed to avoid collision by using technologies that give an indication or alert to the driver regarding problems, implementing safe grounds, and controlling the vehicle if necessary. In recent years Ultrasonic sensor-based systems and the rear-view camera-based system is been used by different car manufacturers which are available only on higher-end vehicles. In the proposed system we calculate the frontal road width by capturing an image using a Vehicle Frontal Camera(VFC) and processing it for proper judgment of space available for the vehicle to pass, with that surround space detection is achieved by using LIDAR and detection of unattended pets/child inside the vehicle by using IR proximity sensors and identification of pets/objects under the vehicle using Chassis level camera when parked in a remote location or cities to avoid loss of life of animals and to avoid the damage caused to the vehicle.
Keywords: Adaptive driver assistance systems, Frontal-road width, vehicle frontal camera, Chassis level camera.

I. INTRODUCTION

Vehicles outfitted with sensors enable their operators to be more aware of their environment. It is now more common to see cameras and sensors on automobiles.IR cameras and automotive Radars are also being included in higher-end automobiles for increased perception around the vehicle [1]. These are useful for enhancing driver awareness and some systems provide driver feedback through displays. Certain aspects in the automobile are becoming automated every year where the risk for the driver is getting reduced due to advancements in technology. Over the years, various researchers and manufacturers have been working on developing systems that provide intelligent onboard applications [2] for vehicles. These systems, which are known as Adaptive DAS [3], are designed to help drivers avoid accidents and make driving safer. They have been deployed to alleviate increasing problems like accidents and make intelligent decisions in critical situations [4]. Machine vision, which is one of the very essential aspects of Adaptive DAS, is mainly designed to perform road recognition and road following [5]. Forward collision warning systems have not been widely applied in the present system because they did not reach up-to expectations due to practical constraints [6]. One of the toughest problems that most beginners and up to some extent even others face in driving is spatial awareness. In the present world, the only solution for this problem is their appropriate judgment. For reverse parking, we can make use of reverse cameras which come with Line of Sight. In this system, we have used a vehicle frontal camera instead of radar or lidars for precision and it also provides visibility. Here we calculate the distance between two obstacles, and the calculated distance is compared with the vehicle width which is known priorly. During summer many pets come and reside under the vehicle to avoid scorching sunlight. Many times, these pets are not identified by the driver due to the busy lifestyle in cities where the animal under the vehicle gets run over by the vehicle and even some damage happens to the vehicle also. To avoid these objects under the vehicle are identified using a camera before cranking the engine and if any pets/objects are found under the vehicle an indication is given to the driver regarding the presence of an obstacle.

According to an Italian study Advanced Emergency Braking Collusion Avoiding system reduces rear-end collisions by 45% based on event data recorded from a sample of 1.5 million vehicles in 2017 and 1.8 million in 2018 [7]. Collision avoidance system is motivated from their potential for enhancing the safety in vehicles [8 Surround Space Detection and Collision Avoidance systems, which use cameras and radars, are being used in higher-end automobile manufacturers such as BMW and Audi. We use LIDAR in our system for surround space detection and collision detection to determine whether any vehicle is present in the vehicle's immediate vicinity and whether any vehicle is approaching from the opposite lane during lane switching. Today cars are equipped with central locking, which can only be unlocked with a remote or key from outside the vehicle. When a driver locks the vehicle unintentionally when pets or children are left inside, it poses a serious threat to their safety because most vehicles have up-modular windows, which raise all of the windows and cut off the supply of air. To address this issue, we have developed a system that uses an infrared proximity sensor to detect the presence of anyone inside the car after it has been locked. If the device detects any movement, the driver is notified via a buzzer.

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II. SYSTEM OVERVIEW

Fig. 1 represents the block diagram of the proposed system. The microcontroller used in this system is Raspberry pi 3B+ which has a BCM2837B0 1.4GHz 64-bit processor having 1 GB RAM (Quad-core A53 processor). This board uses 3.3V to trigger and it also has 5V pins for external hardware connections. The inputs for this system are the video captured by the cameras or an image or a video and sensor data from LIDAR and IR proximity sensors.

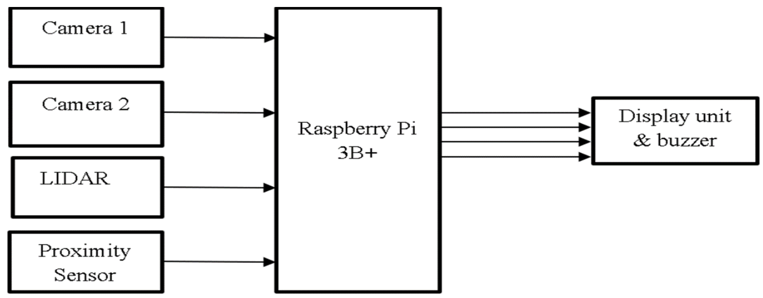

Fig.1. Block Diagram of the proposed system

The camera used in this system is the Raspbian Pi camera module which has a 5MP resolution with a horizontal FOV of 62.20^0 and a vertical FOV of 48.80^0 with a focal length of 3.04mm. Both the cameras are capable of capturing images at a resolution of 2592*1944 pixels for still image mode and 1080p for video mode. The cameras are connected to the Raspberry Pi board through a 15-way ribbon cable which uses Camera Serial Interface (CSI) for communication. The LIDAR used is the VL53L0X LIDAR module which is capable of measuring/indicating objects within the 2-meter range having 25^0 FOV with five operating modes. This LIDAR module is connected to the board through wires and data is sent and received through I2C protocol.IR proximity sensor a line-of-sight communication sensor that can detect any changes in surrounding up-to70cms is connected to a GPIO pin on the board and data is transferred through a data pin connected to the board. For indication purposes, we have used a 3.3 V buzzer which has two pins that are ground and input pin which is connected to ground and GPIO pin on the board respectively.

III. ALGORITHMS FOR DRIVER ASSISTANCE SYSTEM (DAS)

A. Frontal road width Calculation

The camera used in this experiment is a raspberry pi camera module of 5MP, which is capable of capturing 30 frames per second (fps). This system is triggered when the push button is pressed which is connected to the GPIO 15 pin (10th pin) of Raspberry Pi. Fig. 2 represents the flow of the system. The triggering of the system will enable the camera to capture an image. The captured image is of 2592*1944-pixel resolution. After the conversion to grey scale, the region of interest is marked to avoid unwanted processing which makes the system slower. After the ROI is calculated, a rectangular mask is created to show ROI. The calculated ROI part is then blurred to remove noise using Gaussian blur. The width and height of the ROI are known after masking. The total area is calculated using the width and height by formula (Area=width*height). Here the minimum area taken is 4000 and the maximum is 6000 which can be modified.

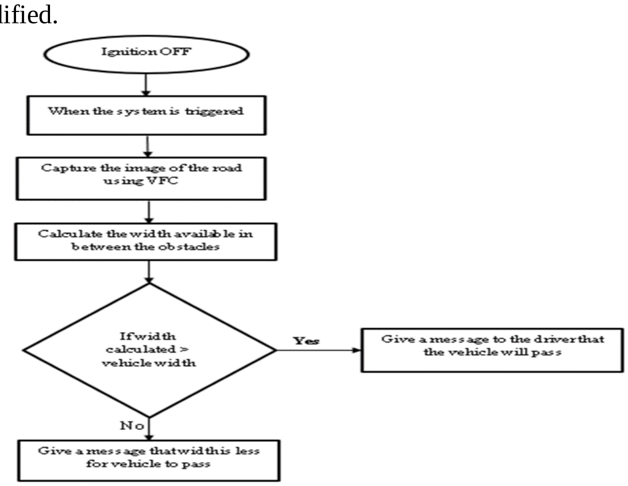

Fig.2. flowchart for Frontal Road width calculation

After that, the points x and y are found, and further, the coordinates (x1, y1) and (x2, y2) of two obstacles are found and distance is calculated using the distance= $\sqrt[2]{(x2-x1)^2-(y2-y1)^2}$ formula and is multiplied by 0.03. The functions for distance calculation, Region of Interest calculation, and lane width calculation are written separately and are invoked according to the sequence. At last, the calculated width is compared with the predefined width of the vehicle which is known before deciding whether the vehicle will pass through the available space. If the calculated width is more than the predefined width, a message is printed on the screen that the vehicle will pass through the available width and vice-versa.

B. Surround Space Detection System

The contour of a threat vehicle can be identified whenever the threat vehicle comes in the described radius. Here in this experiment, we use LIDAR technology to detect suspect vehicles, so that collisions can be avoided. The LIDAR module used here is VL53L0X LIDAR which has a measuring range of up to 2 meters. It has five pins on board which are a 3.3v power supply, Ground pin, followed by serial data, and Serial clock pin for I2C communication. If more than one sensor is used at once we need to keep X_SHUT on the active low state for the proper working of all the lidar modules used. Once the vehicle is on, the LIDAR will be continuously monitoring if any vehicle or objects pass within the range.

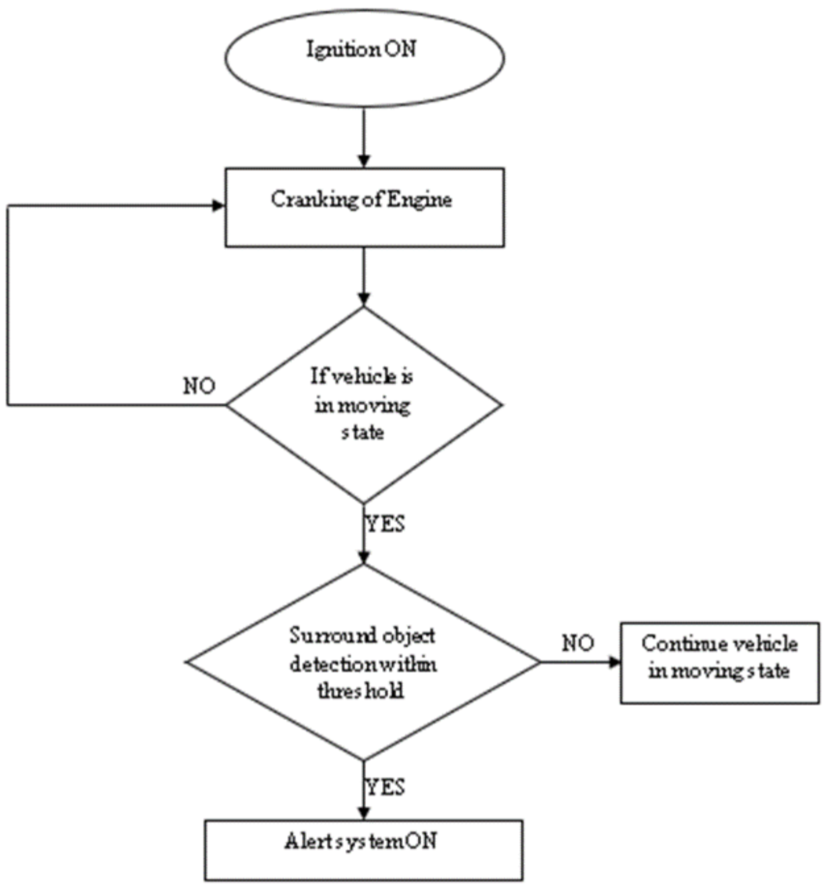

Fig.3. flowchart for Surround space detection

The LIDAR will be continuously sending laser beams from the virtual cavity surface. If any obstacles/object comes within the striking range of the laser beam, it strikes the object and bounces back to the sensor module. The distance is calculated based on Time-of-Flight measurement (time taken by beam to traverse from source and hit the destination and bounce back to the source). If the distance calculated is within the described range, an alert is given to the driver through a buzzer which indicates some obstacle is very close to the vehicle. Surround space detection for three sides is achieved using the LIDAR module.

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C. Detection of Unattended child/person Inside a Vehicle

This system is activated once the engine is off and when all the doors are locked by the driver which is indicated using a push button in this experiment. After 15 seconds of centre lock activation in the vehicle, the IR proximity sensor used in this system detects any movement inside the surrounding. IR proximity sensor module contents Emitter and detector where the emitter is an IR LED and the detector is an IR photodiode. The IR light emitted by the emitter falls on objects in the surroundings and is detected by the IR photodiode. The photo-diode is sensitive to IR light emitted by the IR emitter which is of the same wavelength. The IR emitter will be continuously emitting IR rays when these IR rays hit any object and are bounced back and it is detected by the IR photodiode. When the IR light falls on the photodiode, resistance and output voltage will change in proportion with the magnitude of IR light received. If the magnitude is varied compared to the emitted light, an indication is given to the driver through a buzzer place outside the vehicle which indicates the presence of children/pets inside a vehicle.

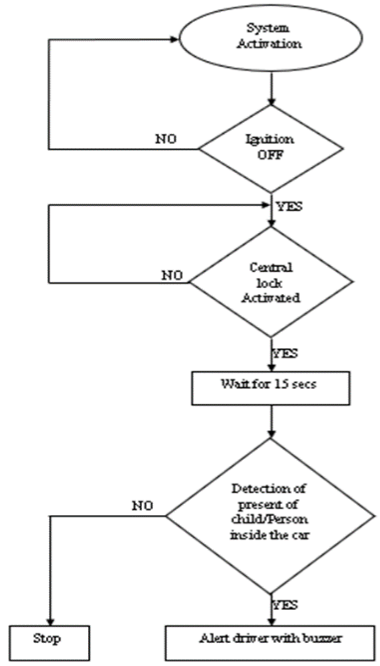

Fig.4. Flowchart for detection of unattended child/person inside the vehicle

D. Detection of Objects or Animals Under the Vehicle

This objective mainly aims in saving the precious lives of pets that rely upon shelter under the vehicle. The camera used to achieve this goal is the raspberry pi camera module of 5mp which is capable of capturing 30 frames per second.

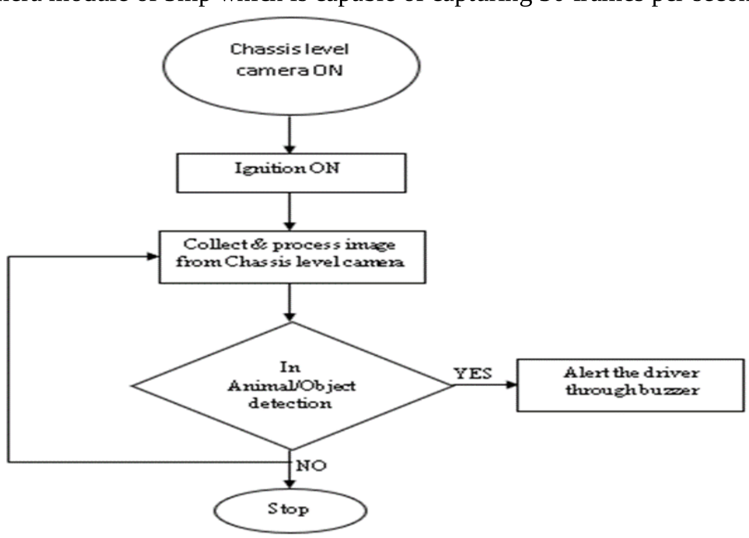

Fig.5. Flowchart for detection of objects/animals under the vehicle

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This system gets activated when the ignition of the vehicle goes off and the driver moves out of the vehicle. After the system gets activated, initially it captures an image using the chassis-level camera and makes it a default image. After that, for every 4 to 5 seconds an image is captured and compared frame to frame with the predefined image taken at the beginning. If any changes are found in the frame of the captured image and predefined image, the driver is alerted through a buzzer indicating the presence of animals/objects under the vehicle, and the objects identified are displayed through square boxes. In this system, we have used a machine learning algorithm where n number of background images of surface and n number of images of all possible obstacles like pets /sharp objects are considered as negative and positive images and are trained in an XML file for recognition of obstacles. More the number of images we consider and train higher will be the accuracy of the system.

IV. RESULT ANALYSIS

For the first scenario, images are obtained at different locations i.e., on a highway and a rural road. The obstacles may be an automobile or any obstacle. The image is captured and obstacles are identified and the width between them is captured using FRWA. Fig 6 represents the region of interest for width calculation and Fig. 7 represents the illustration of frontal road width calculation.

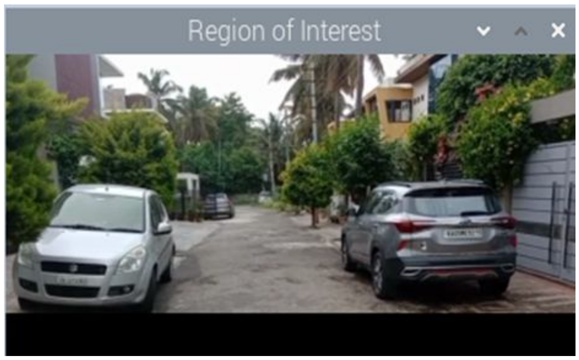

Fig.6. Region of Interest for width calculation

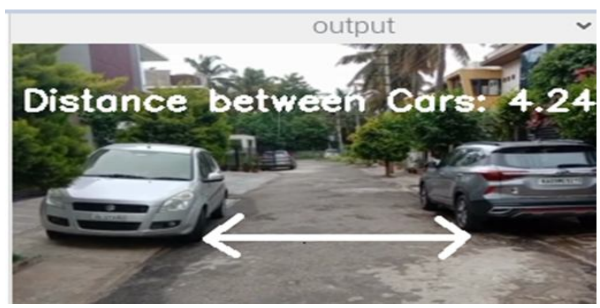

Fig.7. Illustration of frontal road width calculation

The LIDAR detects any movement with a specified target (2m) and indicates the driver if any obstacle is found. Here In this system, we have used HIGH_SPEED _MODE of Lidar which has a Time of Flight (TOF) of 20ms, and the targeted range for this mode is 1.2mts or 120cms. If the Lidar does not detect any obstacle within the range it displays as 8190mm / 819cm which indicates out of range. The above Fig. 8 and Fig. 9 represent the output of the surround space detection system which uses the VL53L0X Lidar module.

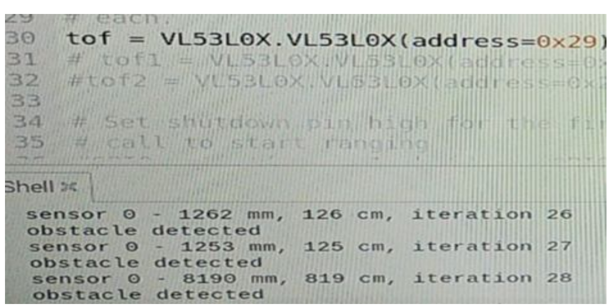

Fig.8. Result of Surround space detection

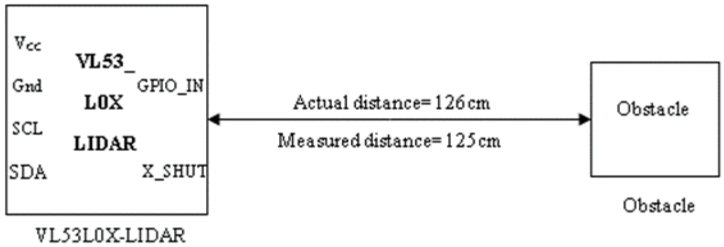

Fig.9. Representation of Lidar distance calculation

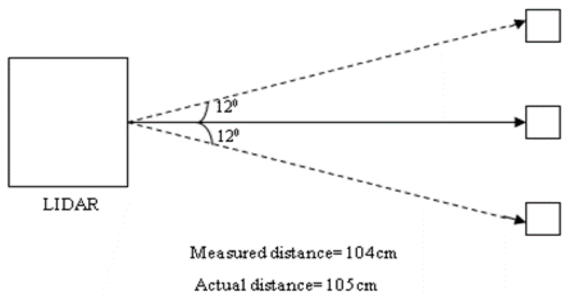

Fig.10. Representation of Lidar field of view

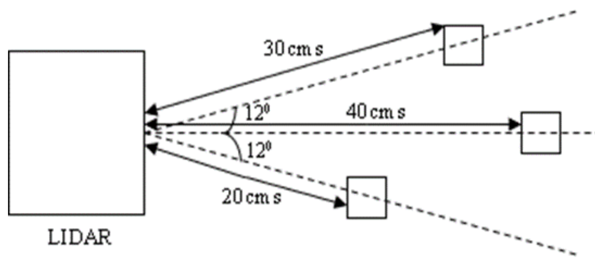

Fig.11. Representation of Lidar angle and range

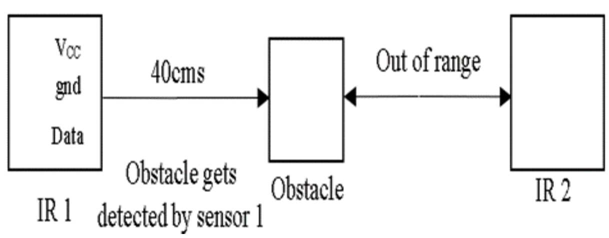

Fig.12. IR Proximity sensor range representation

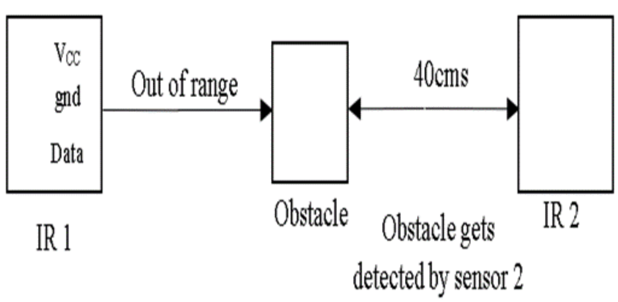

Fig.13. IR Proximity sensor range representation

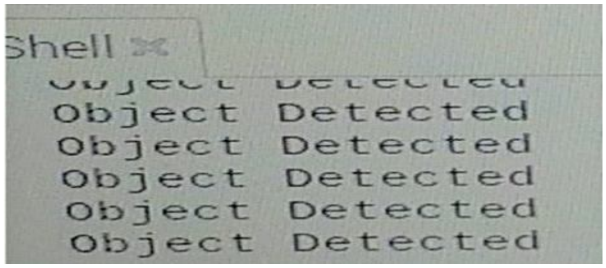

Fig.14. IR Proximity sensor range representation

Fig.15. Placement of sensor inside the vehicle

Fig. 14 shows the output of the IR proximity sensor which is used to detect any child/person inside the vehicle when locked from outside. Fig. 15 also shows the placement of two IR proximity sensors near the door handle. If any person/child is detected inside the vehicle, an indication is given to the driver through a buzzer placed outside the vehicle.

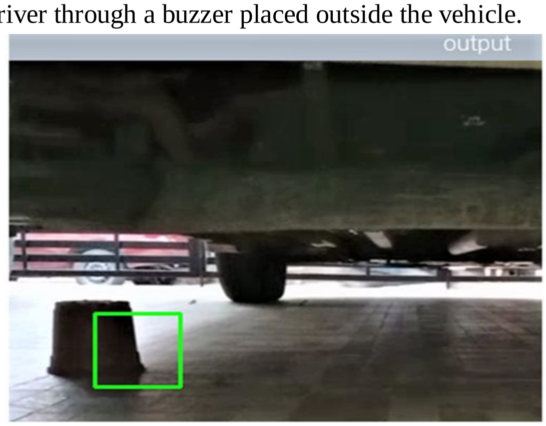

Fig.16. Illustration of object detection under the vehicle

Fig.17. Illustration of object detection under the vehicle

For the detection of animals/objects under the vehicle, for the experimental purpose, we have considered an object which is kept near the front and rear tires. The obstacles are identified when the system is activated and are marked by a square as illustrated in Fig. 16 and Fig. 17.

V. CONCLUSION

In this paper, we have proposed a driving assistance system for security and safety which includes frontal road width calculation where it calculates the width between two obstacles in front of the vehicle, A Lidar based surround space detection system to avoid collisions, and A system to detect unattended child/person leftover in the vehicle using IR Proximity sensor and a system which detects objects/ animals under the vehicle to avoid damage to both vehicles and animals.

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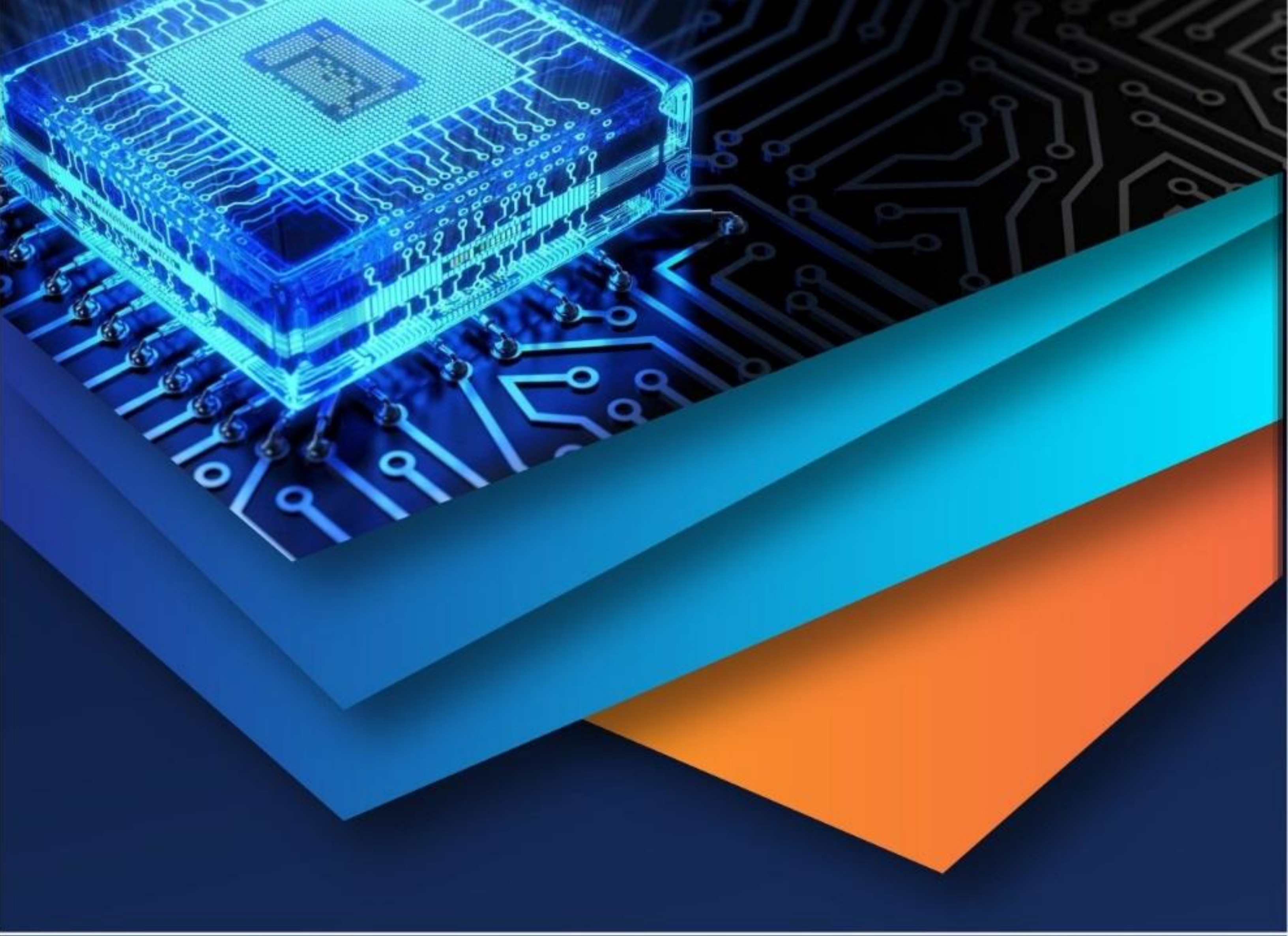

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