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Advanced Surveillance Robot

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Abstract - In the current context of increased surveillance and security, more sophisticatedly advanced and technologically innovative surveillance systems are needed. The detection or tracking of human in highly restricted areas is a difficult task,the robust detection of humans in real-home environments is also a challenging task, mainly because of variable illumination conditions. Our idea relies on the use of thermal infrared (IR) cameras placed on a robotic vehicle. Thermal imaging can successfully penetrate environments such as smoke, light fog, snow, rain and extreme darkness. They are also capable of scanning broad areas and are a good choice to use aboard aircrafts or in satellite devices. To automate the system, a dedicated image processing approach is required, which is used in the project. Along with video surveillance we have also provided additional features which include land mine detection. Sniffer dogs are still being used as a reliable source for identification of explosive, they do prove to be best but they need to be highly trained and made familiar with all possible explosives which is an extremely difficult task. Thus an automated mine detection system has also been integrated in the project. To make the complete system more sophisticated the robot will be GPS controlled and for defense purpose a gas spraying mechanism has also been provided.
Keywords –IR sensor, PIR module, CCTV, GSM, GPS, LPC2148 etc.

I. INTRODUCTION

Traditionally, autonomous robots have been developed for applications requiring little interaction with humans. However, in recent years significant progress has been achieved in the field of robotics, whose goal is to perform unique and dedicated tasks in variable environments. Service robots are expected to perform some useful tasks such as helping people in need, serving in offices and homes, surveillance tasks, child care, etc. In this context, people detection by a mobile robot is important because it can help to improve the human robot interaction, perform safety path planning, locating lost people, identifying gestures and activities, imitating people, and so on[1].

In our project “ADVANCE SURVILLENCE ROBOT” we propose to design a system thatwill provide a high end video surveillance in comparison to the traditional system’s that are or have been implemented today. And instead of just limiting our system to surveillance alone we have provided add on defence features and have made increased our surveillance area by designing our robot mobile.

II. LITERATURE SURVEY

When we think of surveillance the most popular system that we come across are those that use CCTV cameras, or cameras based on CCD or CMOS technologies. The human detection and identification process that are being applied in these approaches do not segment the body silhouette from the background. Selective body part based detection techniques, are generally designed for detecting certain human body parts such as face, hands, head curve, or torso. Different cues are used to detect body parts, for example laser range- finder are used to detect legs or skin colour to detect hands, arms and faces. Although people recognition using static cameras has been a major interest in computer vision, some of these works cannot be directly applied to a mobile robot which has to deal with moving people in cluttered environments. There are four main problems that need to be solved for people detection with mobile robots: real robust object segmentation, time response, incomplete or unreliable information cues, and the integration of spatial-temporal information. A metal detector is mainly a device that detects metal through the use of a coil that generates an electromagnetic field. The performance of a metal detector are determined by several factors; including the scanning speed of the robot Prodding is a technique in which, a sharp stick is inserted into the ground to examine the existence of a buried object but the chances of accidents are extremely high in this method. Thus in order to reduce risks; several attempts have been considered to mechanize prodding. Insertion of ultrasonic waves to measure the stiffness of the soil and to examine the material used in landmines is a widely used methodology. Remote sensing is the third method in which electromagnetic induction sensors and ground penetrating radar are used for mine detection. Remote sensing is considered to be significantly appropriate for robotics applications because it is safer in comparison to other techniques [2].

III. BLOCK DIAGRAM

In below Fig.1 shown the overall basic representation of our surveillance system. There are many blocks shown in the figure which are interconnected to each other. Let’s see each block one by one as follows:

A. Navigation Control Unit

This is the main important unit of this system. There is basically four blocks are present in this unit.

1) *IR Sensor Control Circuit*: The Infra-Red (IR) range sensor is used to detect the obstacles in way of the robot. IR sensors continuously emits the light to look for sudden shift in 'Doppler effect' frequency that a moving target will cause a reflected signal. These IR sensor are mainly used to controlled the movement of robot on field. Because of this we can able to control the robot wirelessly. This is one of the advantages of system.

In our system we have used three IR sensors at left side, right side and front side to control robot movement. If IR sensor detect any obstacle in front side then, robot will immediately stop and according to given instruction robot will take action.

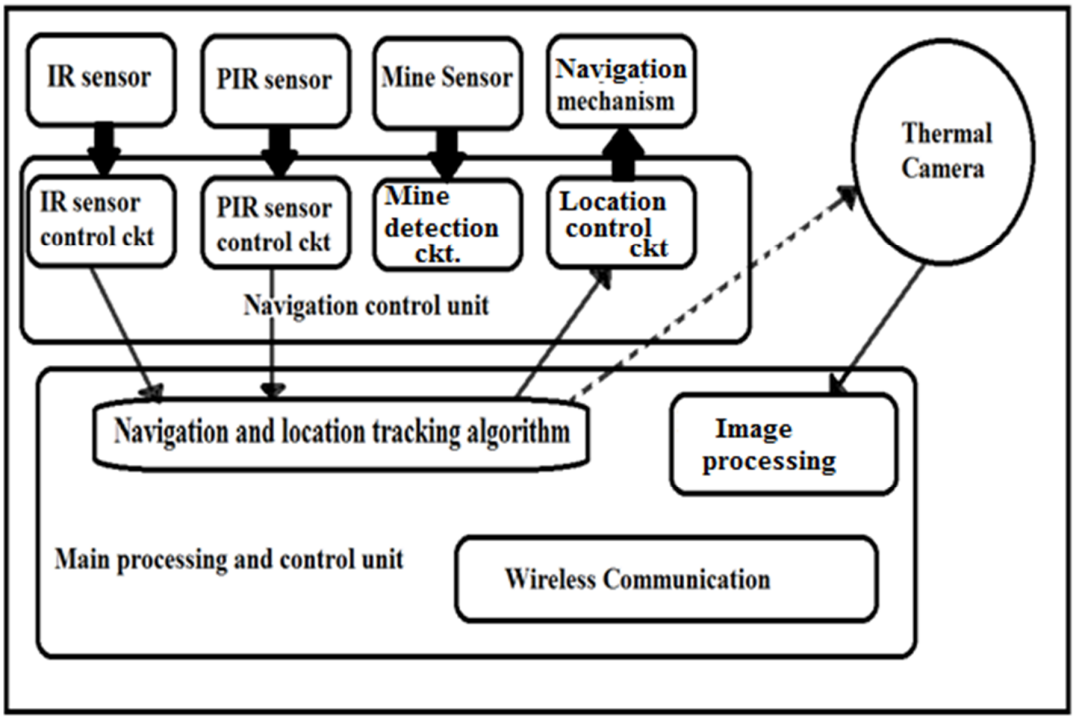

FIG. 1BLOCK DIAGRAM OF OVERALL SURVEILLANCE SYSTEM

2) *PIR Sensor Control Circuit*: Passive Infra-Red(PIR)sensors are used in security purpose and are basically heat radiation detectors, they senses the motion by capturing the heat that is radiated by any living source, this is done with help of photo-diode that are sensitive to heat radiations.This heat element is what triggers the PIR and helps in detecting a human presence. They are small in size, easy to handle and operates efficiently.Owing to these reasons they are widely used in industries and at home locations [3]. In this particular project the PIR will play an important role as whenever a human presence is identified by the PIR the camera will be turned on and the live feed will be sent to the authorised person.

3) *Mine Detection Circuit*: The mine detector is basically a metal detector that assists in finding underground mines. A colpitt's oscillator is the circuit that will act as a mine detector or mine sensor. When the landmine is detected by the mine sensor the LED that has been interfaced in the circuit will glow, indicating that a mine has been detected. This circuit then informs the controller about the detected landmine and also informs about its location. In the colpitt's oscillator circuit the inductor coil L and two capacitors C1 and C2 forms tank circuit. When the piece of metal (Generally Iron) comes very close to the centre of the coil, the value L changes and the voltage at the base of the third transistor rapidly increases and the 4^{th} transistor base, receives high voltage setting the transistor goes into saturation (As a switch) and activates LED and buzzer. But when metal piece is taken away from the coil, the base of third transistor does not get any voltage and hence remains OFF and there by switching off the 4^{th}transistor.The output of the colpitt's oscillator is a very good since wave is observed of the emitter of the second transistor (seen on CRO). At the base of the third transistor DC voltage is seen. This mine detector circuit is one of the main circuit of surveillance system [4].

4) *Location Control Circuit*: Here in the Fig.1 the block of location control circuit is mainly associated with the mine detection. For providing exact location of detected mine to controller we used the GSM module in our system. The Global system for Mobile Communication (GSM: originally from Group Special mobile) is the most popular standard for mobile in the world. GSM is cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. The ubiquity of GSM standard makes international roaming very common between mobile phone operator, enabling subscriber to use their phone in many parts of the world[5]. This is the truly international, proven standard. The advanced data service with security feature is already available for customer. Installation process is also so much convenient for user. [5] The network behind the GSM system seen by the customer is large and complicated in order to provide all of the services that are required; they are divided into a number of sections: The base station sub-system (the base station and their controller). The network and switching subsystem (the part of the network most similar to a fix network). This is sometimes also just called the core network.The GPRS Core Network (the optical part which allows packets based internet connection).

B. Thermal Camera

A thermo graphic camera also known an infrared or thermal imaging camera is a device that forms an image using infrared radiation in contrast to the normal camera that use visible light technique to form images. Instead of the 750 nanometre range an infrared cameras operate in wavelengths as long as 14,000 nm (14 µm). Infrared was discovered by Sir William Herschel as a form of radiation beyond red light.

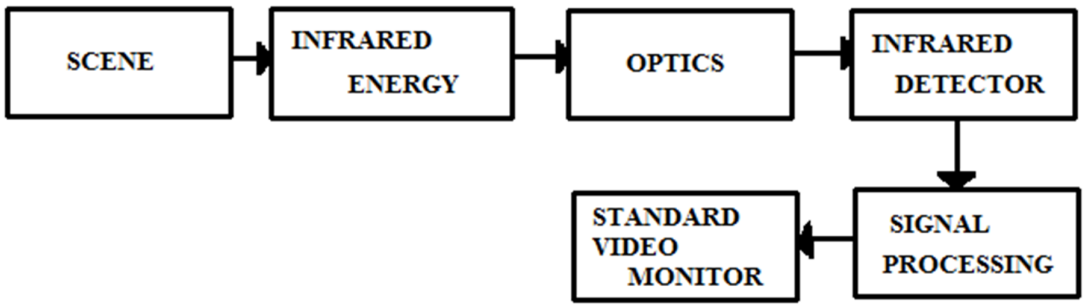

FIG.2 BLOCK DIAGRAM OF THERMAL CAMERA WORKING

Here's how thermal imaging works:
A specially designed lens focuses the infrared energy emitted by all of the objects living and non-living in view.
This focused light is then scanned by an of infrared-detector elements, these detector elements create a detailed temperature pattern known asthermo graphic image. It obtains the temperature information to form the thermo gram.
The thermo gramimage created by the detector elements is translated into electric impulses.
These impulses are then sent to a signal-processing unit, a circuit board with a dedicated chip translates this information from the elements into data for the display.
The display information generated by the signal processing unit is sent to the display device, where the image or video is displayed in various colour palates depending upon the intensity of heat received.

C. Main Processing And Control Unit

In the surveillance system the main processing block play a vital role as it transfers data from robot to controller. This block is mainly used to control the robot via navigation and location tracking algorithm. The controller tracks each and every movement of robot from control room only, by using the GPS module. The controller that will be synchronising all the actions of the robot is the ARM cortex LPC2148,the LPC series microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded support, that helps in combining the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface with a unique accelerator architecture that enables a 32-bit code execution with maximum clock rate [6]. The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides reliable location and time information in all weather and times and everywhere around the Earth. Maintained by the United States government it is freely accessible by anyone with a GPS receiver.

When robot detects the mine, the RF receiver stops receiving data and it stops at that moment the GPS module is initiated. It provides reliable latitudes and longitude information by using the GPS antenna to the controller. This location is found by using the GPS satellites.The GPS module is interfaced with the controller by using serial communication IC Max 232. The output of the controller IC consists of 9 pin D connector, to which GPS is interfaced. This data is displayed on the LCD. By using the switching IC 4066, the GSM module is initiated. This data is then sent to the controller wirelessly. A message is sent to a mobile phone, this message is sent to a number which is stored in the GSM mobile. The GSM is connected to the main circuit using another DB9 connector. This information of that location is sent to the GSM module using a MAX 232 IC. It is a serial communication integrated circuit. The MAX 232 IC is interfaced with the controller which contains the program to drive the entire circuit.

IV. HARDWARE IMPLEMENTATION

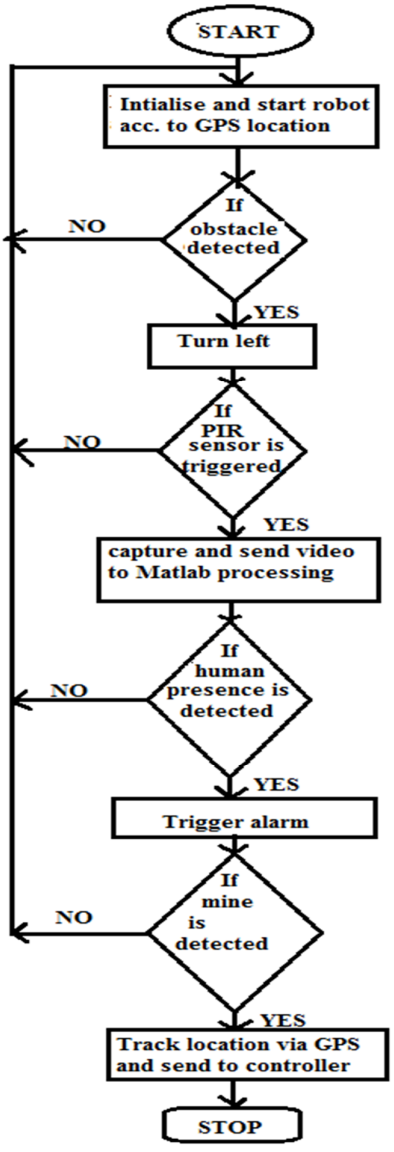

FIG.3 FLOW CHART OF DEVELOPED SYSTEM

When the robot is allotted the area to be screened it starts moving in the mentioned direction, if any obstacle is detected the robot will adjust its path with the help of IR sensors and controller command.If the PIR sensor is triggered the robot will stop and send the captured video to the controlling database where the live feed will be processed to identify weather the PIR was actually triggered because of human or not.If yesthen the commanded action will be taken. Similarly, if a mine is detected in the robots path it will trigger an alarm and send its location to the authorised person.

V. SOFTWARE IMPLEMENTATION

A. *Image Processing*

The major and important part of our project is the thermal camera and the video being captured by it. In order to identify a human presence we need to process the live video, for this purpose the MATLAB software is being used. MATLAB is one of the most efficient software for image processing and is simpler in implementation. There are numerous processes that can be performed in image processing, but our field of interest are the once shown in figure below.

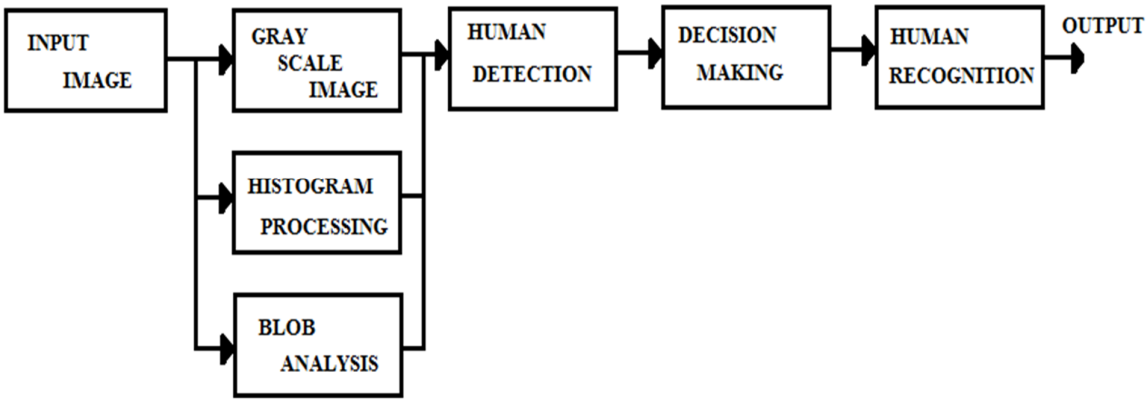

FIG. 4 BLOCK DIAGRAM OF HUMAN DETECTION FRAMEWORK

In above Fig.3 the process of human detection is shown. First the video captured from thermal camera is given to Matlab where the image processing begins. This input image is first converted to a grey scale image so as to simplify further processes. Then histogram is applied to the obtained image. Processes such as erosion, segmentation and blob detection are performed on the image. After completion of all these processes the final human detection algorithm is applied [7].

The Fig.5 and Fig.6 shows the practical implementation of above mention matlab image processing technique.

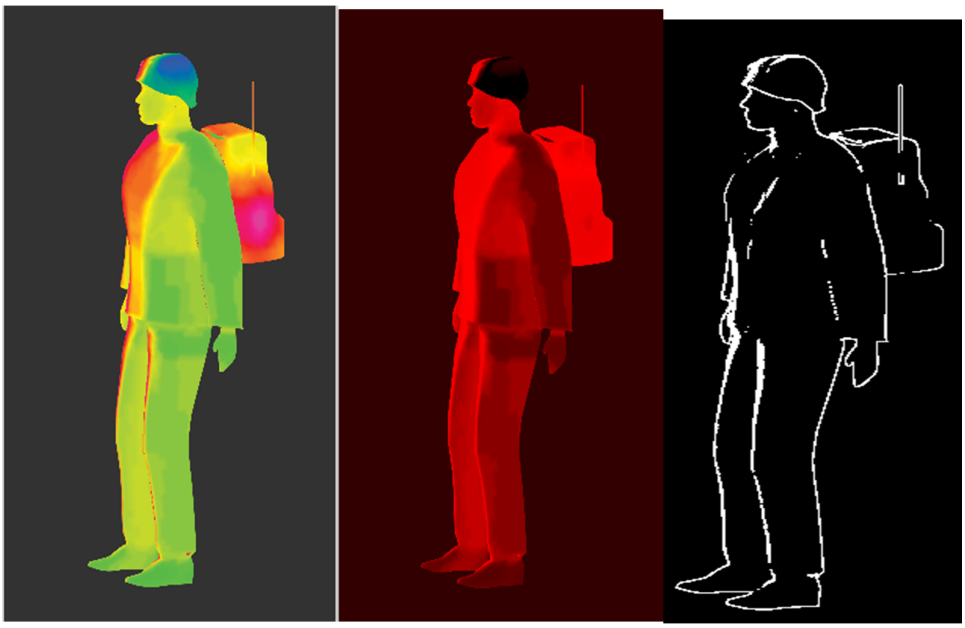

FIG.5 INITIAL INPUT IMAGE IN MATLAB

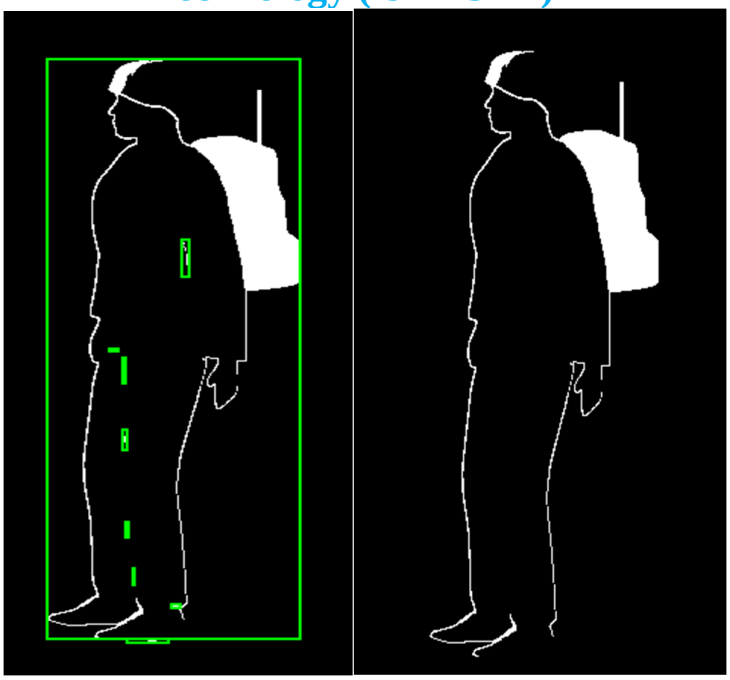

FIG.6 FINAL OUTPUT IMAGE IN MATLAB

VI. APPLICATIONS

The project that we have proposed to design has a very crucial role to play in surveillance field. It can be used at:
Highly restricted areas such as nuclear stations, R&D centre, defence arena etc.
It can be a best suited system that can be used in sanctuaries to prevent poaching activities
In areas which need high end night surveillance.
The system can also be used indoors to improve building security and provide high tech surveillance management by fining the people in hiding and identifying locations of hidden explosives.

VII. CONCLUSION

We have tried our level best to design a system that will complement the thermal surveillance system and will also efficiently handle the small defence mechanism perfectly that have been provided in the system design.The system is still in developing stage and hope to implement the system with equal success rate.

VIII. FUTURE SCOPE

The further development that we can do to this system is that we can try and find algorithms which will make the human detection more sophisticated and try processing it in even more faster rate.The system can be developed even more by adding even more defence mechanisms and various other type of exclusive sensor's to make it even more advanced.

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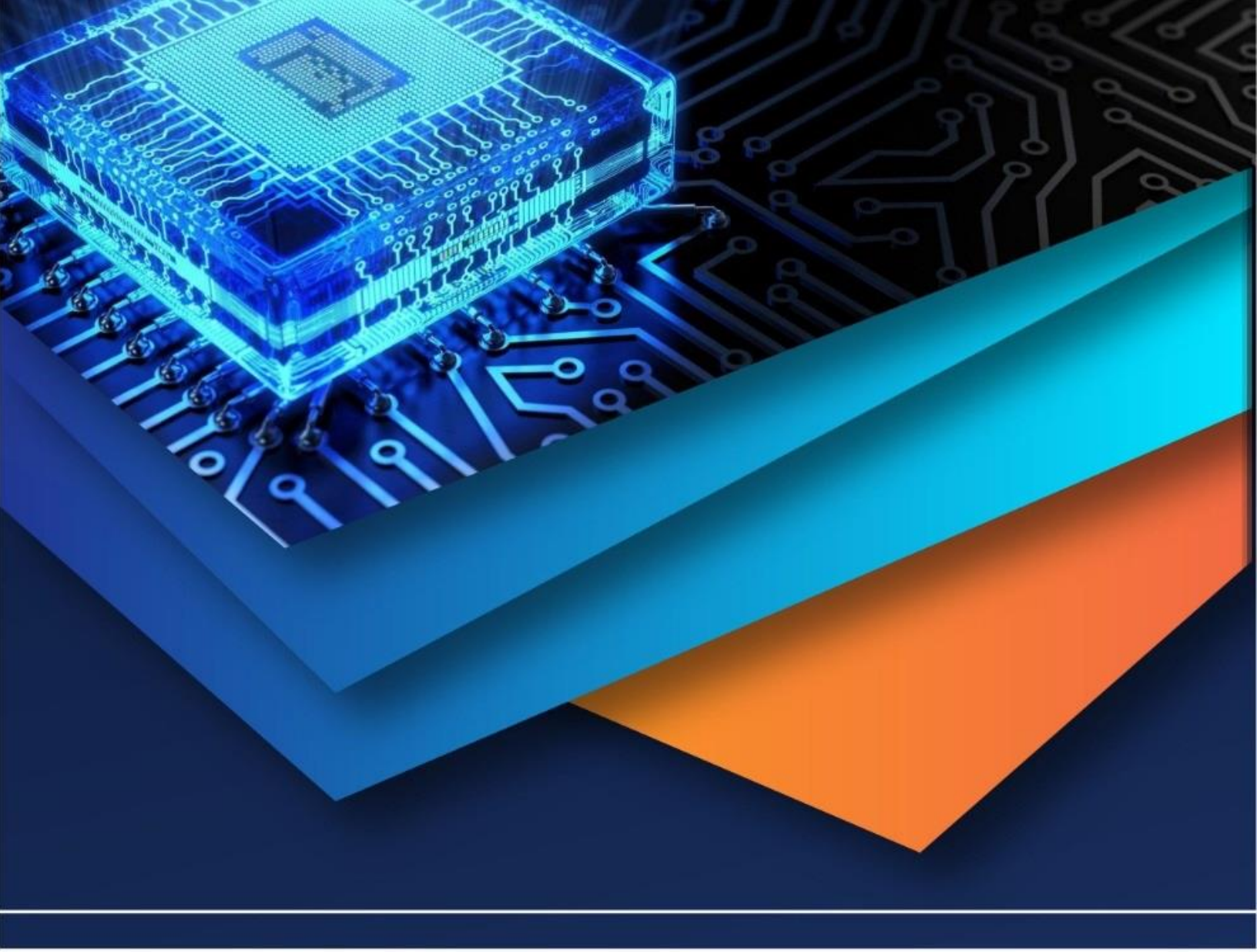

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