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IOT Based Smart Door System

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Abstract: Internet of things is the communication of anything with any other things. The door plays an important role in home security. So, providing a secured door system for houses has become a vital research. The goal is to implement a home security system by integrating smart phone and IOT. IOT is used remotely to view the activity and get a notification when there is a presence of a nearby object. Here, Raspberry Pi, camera etc. are utilized to provide an alarming system that has the ability to notify the owner.
Keywords: Raspberry Pi, PiNoIR camera, Servo Motor, Blynk App, LED.

I. INTRODUCTION

Securing homes has become one of the concerning issues. Today homes are being more vulnerable for several threats especially being burgled. For this manner home security is needed. Home security implicitly means a secured mechanism for the door. So the idea of Smart door lock system has been proposed. This is one of the most popular home security systems. With this system, only the authorized individuals can gain the permission to access the doors. Thus one can monitor his/her house from anywhere.

II. RELATED WORKS

In [1], three modules have been included namely: Human Detection Module, ZigBee Module and Door lock Module. Initially the visitor of the house is detected by the Human Detection module.

Then ZigBee module checks if the visitor has a valid ZigBee tag(ID). If the tag is valid, the Door lock module operates a motor to open the door. If the tag is invalid, the door remains locked. With this system, no cabling is required as it is a wireless system. But ZigBee is short-ranged compared to most other wireless technologies like WiFi. In [3], a visual device is used that monitors the area in standby mode.

If motion is detected, pictures will be taken and notification is prompted for the owner. The owner of the house then takes necessary action like alerting neighbours/seeking police help etc. in case of a suspicion. Here , GSM(Global System for Mobile Communication) is used with support for international roaming. This system offers only a one-way communication.

In [2], three modules have been proposed namely:

ZigBee Module, Door lock Module and Sensor Module. ZigBee module enables wireless communication. A digital door lock module is an equipment that uses the digital information such as a secret code, finger prints etc. as a method for authentication instead of the legacy key system. Sensor module monitors environmental condition like temperature and reports the same to the system. Any abnormality in these attributes indicates the owner that something is terribly wrong.

This system requires knowledge of the owner to operate ZigBee compliant devices. Also power supply is individual to sensor nodes which is a overhead.

In [4], NFC(Near Field Communication) technology has been used. Whenever a person waits at the door, the owner who is present at the nearby location is notified and appropriate action is performed.

NFC is a perfect source of convenience and is mainly used for real time applications. Major risk to NFC is computer hacking or phone hacking. NFC is an expensive Technology compared to other Technologies. Also it is short-ranged and is not suitable for remote access.

of detailed experiments for face detection dataset has been presented. This has three key contributions. The first is the introduction of a new image representation called the “Integral Image”.

The second is a learning algorithm, based on AdaBoost.

The third is a method for combining more complex classifiers in a “cascade” which allows background regions of the image to be quickly discarded .

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III. PROPOSED METHOD

A. Block Diagram

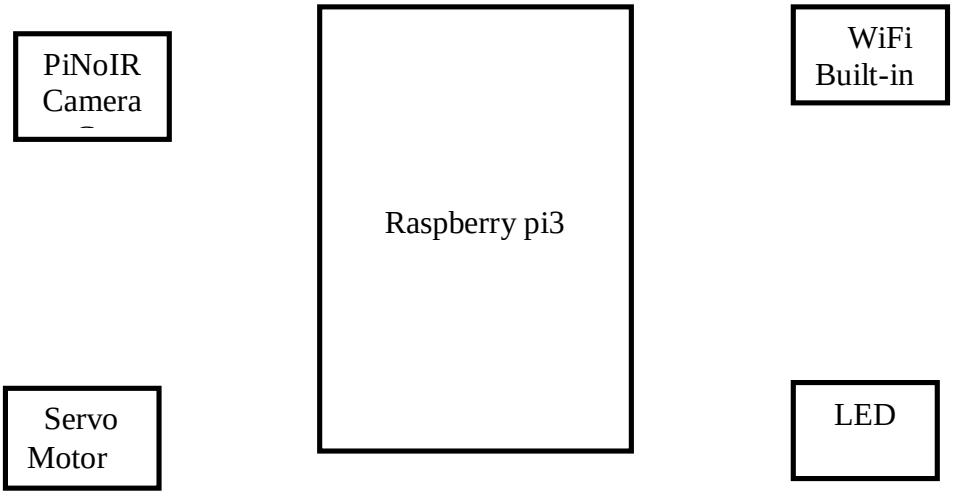

Fig. 1 The Block Diagram

As shown in Fig.1, the block diagram consists of Raspberry Pi3, Camera module, LED, Servo motor. Raspberry Pi3 has built-in WiFi module. This makes the connectivity easier.

1) *Raspberry Pi3:* The Raspberry Pi is a credit card sized computer which is a 1.2GHz 64-bit quad-core ARM Cortex A53 processor. It has 1GB RAM and additional memory is provided by using a micro SD card. It has 4 USB ports, 40 GPIO pins. A Full HDMI port is used to connect to a display. Version 3 of RaspberryPi is 10 times faster than version 1 and 80% faster than version 2.
2) *ServoMotor:* It is a closed loop servo mechanism that uses position feedback to control its motion and final position. It requires 100mA current, 3.0-7.2V voltage. Its speed is 53-62 RPM. Motor is paired with some type of encoder to provide position and speed feedback.
3) *PiNoIR Camera:* It is Raspberry Pi's NO INFRARED camera. It is 8 MP CMOS camera. It is capable of capturing still images as well as HD video .Stil image's resolution is 2592*1944 and Video's resolution is 1080 p at 30 FPS. This has got night vision capabilities because it is a no infrared camera.
4) *LED:* LED is placed outside the door to indicate whether door has been locked/unlocked. If the LED glows, it indicates that door has been unlocked and the visitor can enter the house , otherwise it indicates that the visitor is not supposed to enter the house.

B. Software Requirements

The software requirements for the project are : Raspbian OS, Blynk app, openCV library.

1) *Raspbian OS:* It is a computer operating system for Raspberry Pi. It is a Unix-like operating system. It is free and open sourced. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers.
2) *Blynk app*: It is a platform with ios and Android applications to control Arduino, RaspberryPi etc. over internet. It provides a digital dashboard to build GUI(Graphical User Interface) for projects. Blynk app enables communication of mobile with Raspberry Pi. It has three components namely: Blynk app, Blynk server and Blynk libraries. Blynk app generates a unique authorization token for every project.
3) *OpenCV library:* OpenCV stands for Open source software library for Computer Vision. It was released under BSD(Berkeley Software Distribution) license and hence it is free for academics and commercial purposes. It has C, C++, Python, Java interfaces. It supports windows, Linux, Mac, Android etc.
operating systems. It has more than 2500 ptimized algorithms to detect, recognize faces, identify objects, track camera movements etc.and it is preferable over MATLAB.

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IV. OPERATION OF THE SYSTEM

A. System Structure

The actual working of the system starts by capturing the image of the visitor at the door by the PiNoIR camera. Then, this image is sent for processing to the RaspberryPi. In this, the face in the image is detected with the help of Haar's Cascading algorithm. This image is sent to the owner through Email. The owner after seeing the image sends his choice through Blynk App. This app is virtually linked to the RaspberryPi. Thus RaspberryPi receives the owner's choice and then rotates servo motor to either lock/unlock the door. The system structure consists of three phases mainly : input phase, processing phase and output phase as shown in Fig. 2.

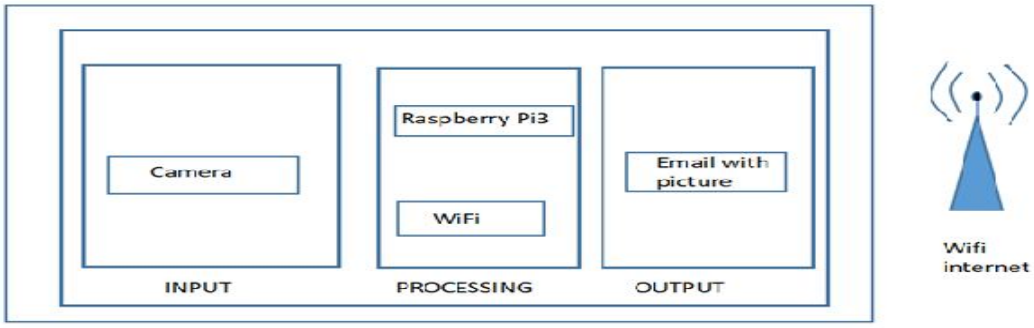

Fig. 1 The System Structure

1) *Input Phase:* In the Input phase, when the visitor arrives and stands at the door, the PiNoIR camera captures his/her image. This image is sent to the Raspberry Pi for processing.
2) *Processing Phase:* In the processing phase, the Raspberry pi processes the image using OpenCV. Upon successful detection of face in the image, the image is sent to the owner's Email. The owner then decides whether to grant/restrict access and passes the command to the Raspberry Pi.
3) *Output Phase:* In the output phase, the servo motor is either rotated/retained to lock/unlock the door based on the owner's choice. Also LED placed at the entrance light up so that the visitor can understand the owner's decision. (white=Don't enter, green=Enter). This phase also includes sending proper notifications to the owner like notifying about the online/offline status etc.

The following flowchart depicts the design methodology of the system.

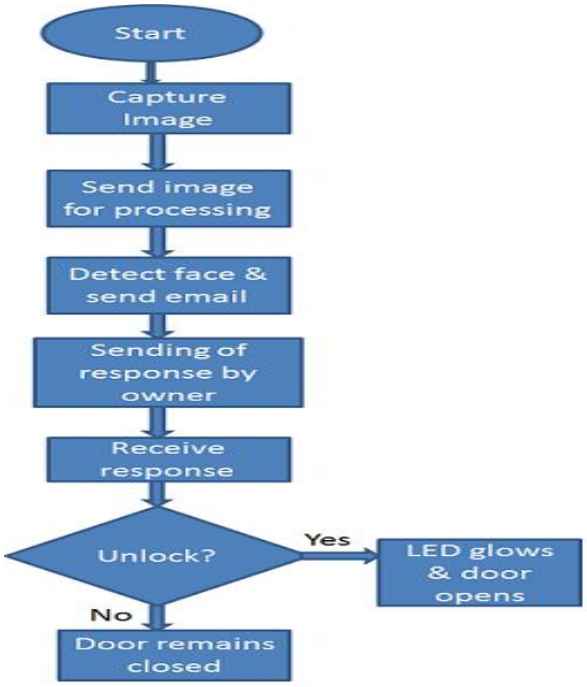

Fig. 2 Flowchart for design methodology

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B. Algorithm for Face Detection

Face detection is a computer technology being used in a variety of applications that identifies human faces in digital images. In this system, the face in the image is detected and highlighted using Haar Cascading Algorithm. Object Detection using Haar feature-based cascade classifiers is an effective object detection method, as in [5]. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. Positive images are the images with faces and negative images are the images without faces. Initially, the algorithm needs a lot of positive images and negative images to train the classifier. Then we need to extract features from it. For this, haar features shown in Fig.4 are used. Haar Features are used to match the regularities in human faces that share similar properties. A few properties common to human faces are: (i) The eye region is darker than the upper-cheeks. (ii) The nose bridge region is brighter than the eyes etc. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

Haar's face detection algorithm is a Cascade of Classifiers because instead of applying all the 6000 features on a window, group the features into different stages of classifiers and apply one-by-one. If a window fails the first stage, discard it. We don't consider remaining features on it. If it passes, apply the second stage of features and continue the process. The window which passes all stages is a face region.

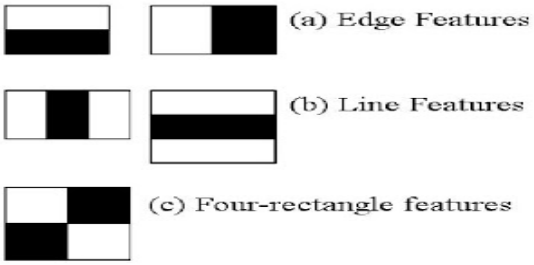

Fig. 4 Haar Features

OpenCV comes with a trainer as well as detector. If you want to train your own classifier for any object, you can use OpenCV to create one. OpenCV already contains many pre-trained classifiers for face, eyes, smile etc. Those XML files are stored in opencv/data/haarcascades/ folder. For face detection in OpenCV, the following steps must be followed:

Firstly, load the required XML classifiers. Then load the input image in grayscale mode.

Now we find the faces in the image. If faces are found, it returns the positions of detected faces as Rect(x,y,w,h). Once we get these locations, we can create a ROI for the face .

The output of the algorithm is an image with the face highlighted. This is then sent to the owner's Email.

V. RESULTS

The following image Fig.5 shows the console for sending of an Email. Error in sending occurs if there is a problem with internet connectivity. If no problem is found, sending occurs successfully.

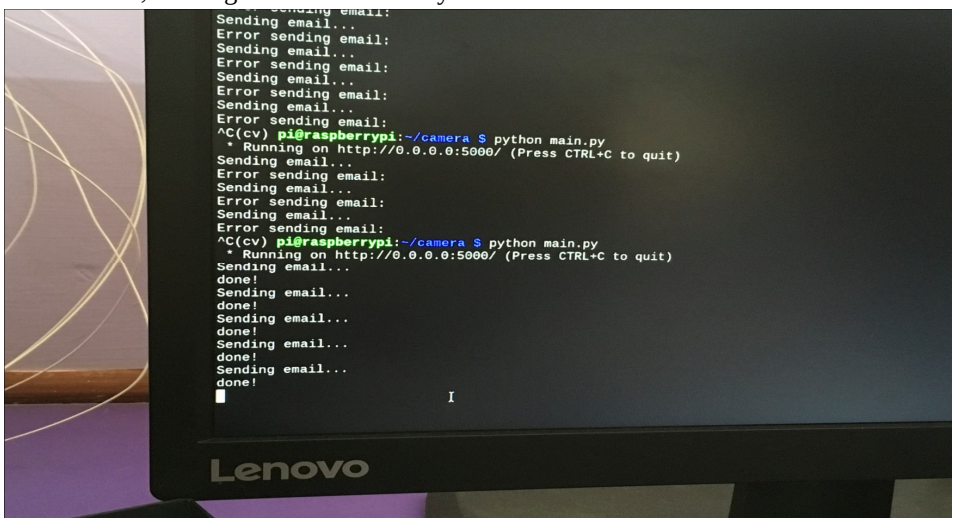

Fig. 5 Console for sending Email

The below image Fig. 6 shows the image received by the owner through Email . Here, the region of the face is highlighted.

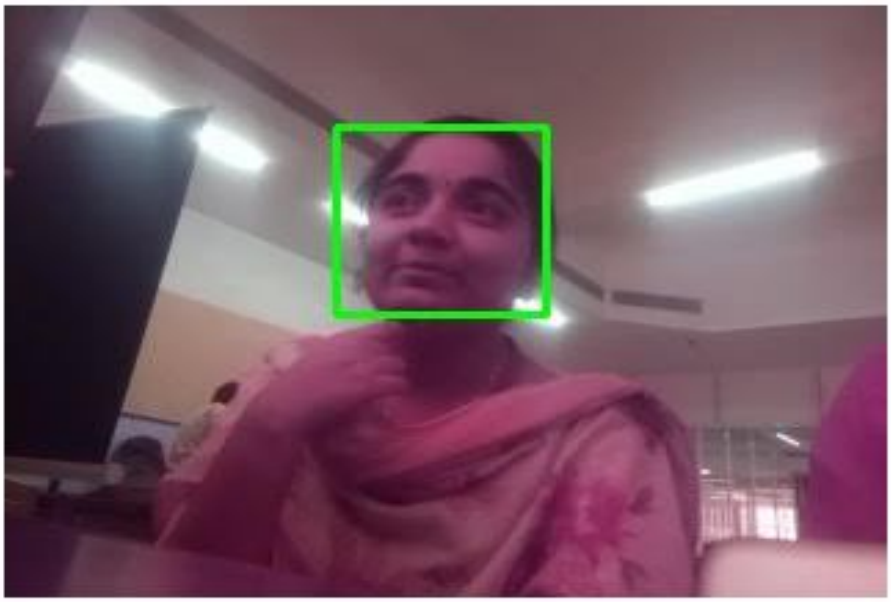

Fig. 6 Email received by the owner

The below image Fig.7 indicates that the door is unlocked and LED glows.

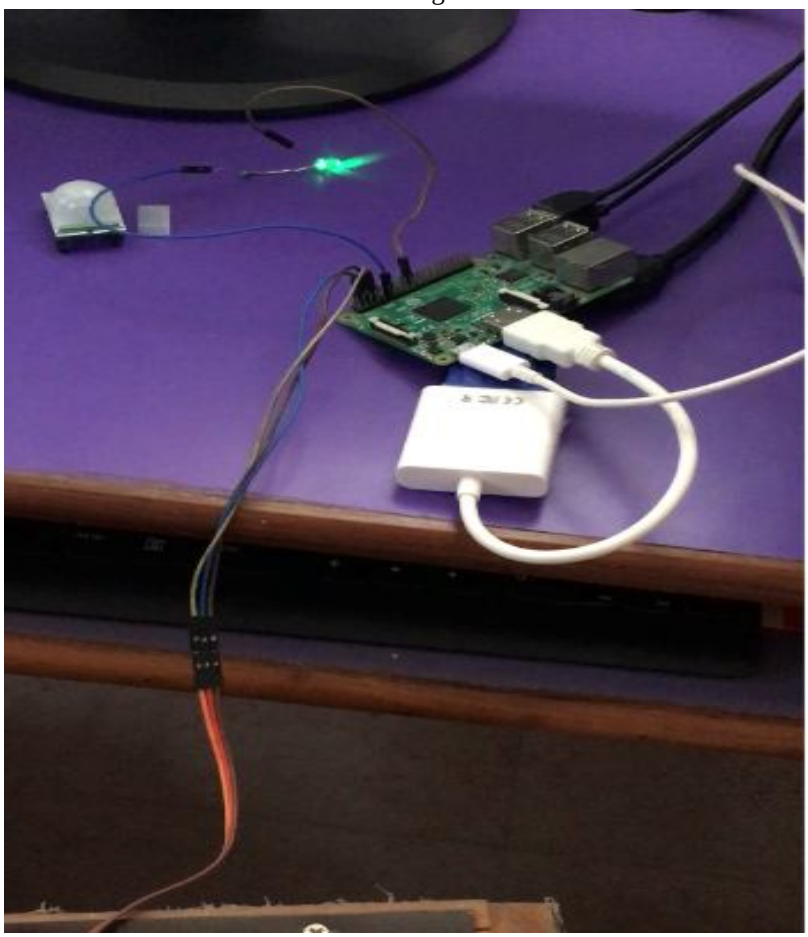

Fig. 7 Door Unlocked

The below image Fig. 8 indicates that the door has been locked and LED doesn't glow.

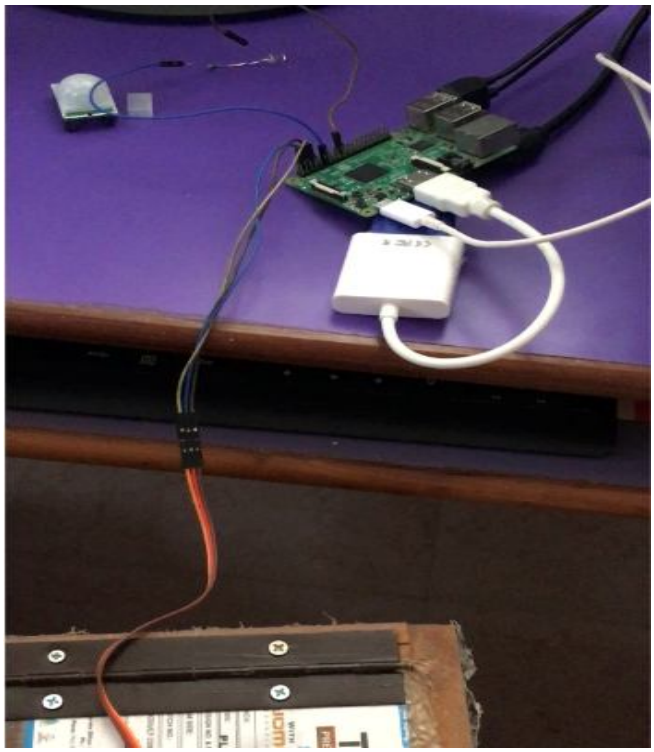

Fig. 8 Door locked

VI. CONCLUSION

Technology has been advancing at a rapid pace in the current world. If we can make use of technology to a maximum extent, it will make our job easier. With the proposed Smart Door system, we can monitor our houses from anywhere without relying on neighbours. Also we can take necessary defense action at the earliest in case of a suspicion. Thus, this system surely brings down the percentage of crimes in the society.

VII. ACKNOWLEDGMENT

It gives us immense pleasure to present our research paper titled "IOT based Smart Door System". We are extremely thankful to all those people who guided us in every means possible without which this would have been absolutely impossible today.

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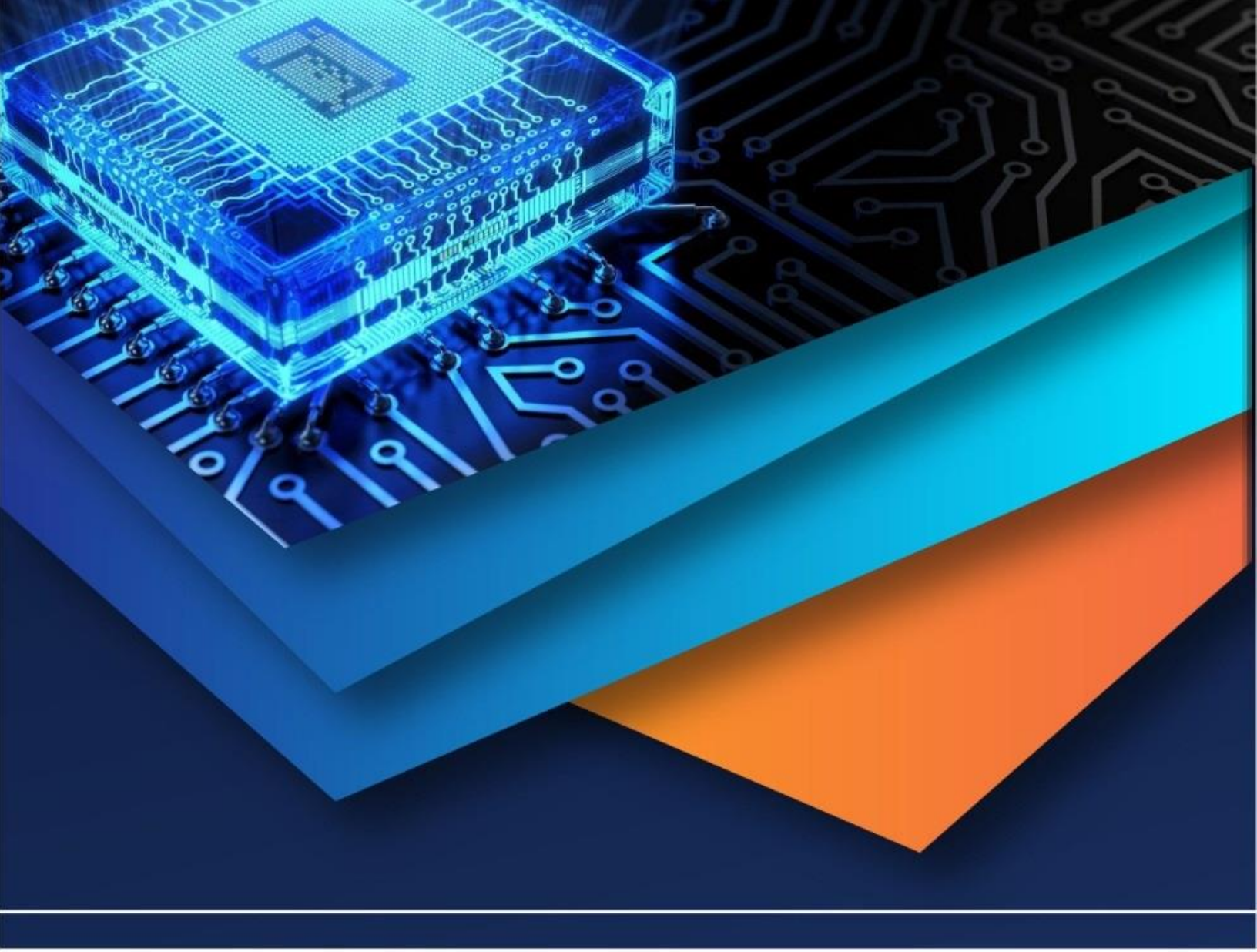

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