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Arduino Based Smart and Remote Voting System with Smart Card Implementation and Dual Biometric Authentication

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Abstract: ***Democracy is a synonym for progress of the nation. Improving voting numbers will boost in overall development of the country. To achieve this task, we propose an IoT based remote electronic voting system, provided with dual biometric authentication, composed of fingerprint verification and face recognition. Instead of paper based identification card, we intent to implement an RFID based smartcard with details of the voter stored in the card, including biometric data saved alongside information like name, age, locality, constituency and even aadhar identification number. This model uses face recognition using Haar cascade and LBPH algorithms, set up using OpenCV libraries. The EVM system captures the face data of the voter, verifies by comparing it with existing face datasets, and upon validation will be allowed to cast their vote.***
Keywords: Embedded system, RFID, Fingerprint verification, Face recognition, Haar cascade, LBPH, Training and testing

I. INTRODUCTION

The progress of a democratic nation like India depends on its citizens for overall development and progress. It becomes the responsibility of citizens to take active part in elections. Similarly, it is the responsibility of the electoral commission of India to make sure that voting becomes a simple and easy process for citizens. One such aspect that has to be considered is reducing the time of travel. This can be done by implementing a remote voting system wherein a voter is allowed to cast his vote from any polling booth, in any part of the state. This will enable reduction in travel time and enable more people to vote. The next aspect in voting is smart and efficient identification of the voter.

We propose and smart RFID based identification card, which can be used not only for voting purposes, but also other high security firms and government establishments. All that is needed would be a RF receiver module to scan the card. This smart card will also have the capability to store details of the individual along with face and finger data. This will be an enhanced and smarter version of existing Aadhar card.

Upon successful and simple way of user identification, we now have dual biometric authentication, namely fingerprint verification and face recognition. We also have added features like alcohol detection and automated door opening and closing of the polling booth. Our model also prevents double voting and fake voters, added with the capability of generating results as soon as voting are complete.

II. LITERATURE SURVEY

The current system in use today, has a number of flaws which ultimately, our proposed system would aim to correct. The system is insecure and prone to election malpractice, due to the fact that any person can cast a vote without proper authentication is a major concern. The administration of the voting system as a whole is highly inefficient, slow and time consuming, and is highly prone to human error. Keerthi et al [1] presents a e-voting website as an interface between offline and online voting. It provides migrated people an opportunity to vote for their constituency. Ashok Kumar et al [2] surveys several voting systems, devices, issues and compares existing voting system and a biometric EVM. Rikwith et al [3] propose an enhanced model with biometric authentication added to the EVM. Additionally, Anik et al [4] have designed a solar powered EVM. This is a renewable energy based system that can prove to be efficient as well as energy saving. Djanali et al [5] propose a secure and encrypted web application as a means of Electronic-Voting. Although E-voting can become a 100% effective solution for remote voting, it cannot be implemented right away in a country like India. It is because of the pandemic that students got access to smartphones. Until then, majority of families did not have access to smartphones, or had only one smartphone per family. So, we propose a remote voting system, where a voter can visit any nearest polling booth and cast their vote to their constituency. Our model also has a smart RFID based identification card, along with dual biometric authentication.

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III. IMPLEMENTATION DETAILS

This project is done with the use of Arduino uno Atmega 328P controller, and RS232 as interface to the computer for programming. Embedded C in Arduino IDE software is used for programming the microcontroller. The other hardware components including EM18 module, alcohol sensor, LCD and so on will be discussed in the following sections. Fig 1 shows the prototype for our proposed system.

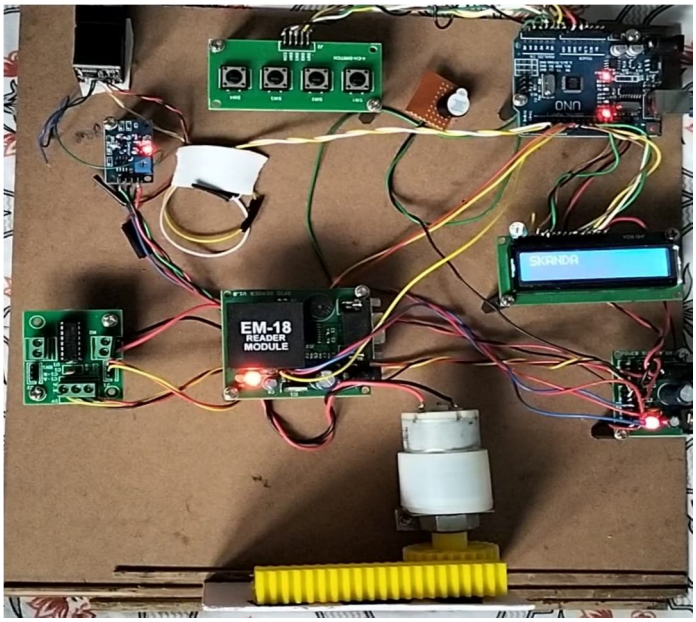


Fig. 1 Complete Hardware model

IV. BLOCK DIAGRAM

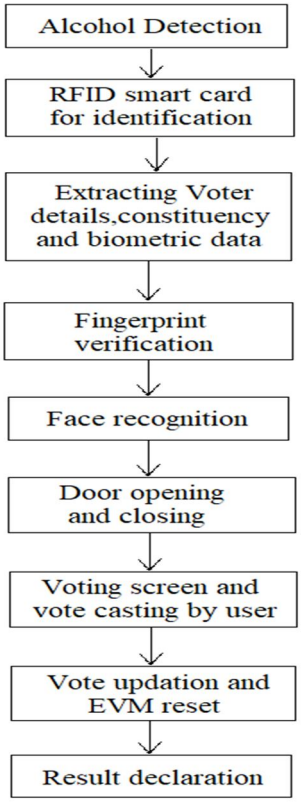


Fig. 2 Block Diagram for proposed model

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V. CIRCUIT DIAGRAM

Fig 3 shows the circuit diagram, depicting the different models or subsections as mentioned in the methodology. It also shows the hardware components used for each particular operation. Here is a look at the subsections and it's particular components.

1) Alcohol detection- MQ6 sensor
2) Door opening and closing- DC Motor and H bridge
3) Camera module- Web camera
4) Fingerprint sensor- AS606 sensor
5) Casting vote- EVM (For prototype, Laptop is used)
6) LCD- 16x2 display

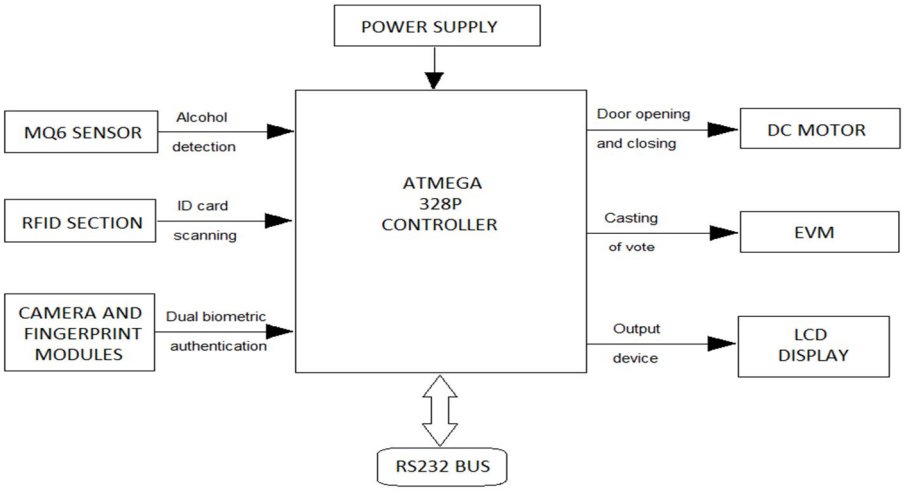


Fig. 3 Circuit diagram

VI. METHODS

A. Alcohol Detection

The aim of using an alcohol sensor is to prevent drunken people from voting. This can be achieved by using Alcohol gas detection sensors such as MQ3, MQ2 or MQ6. Here MQ6 sensor is used, as it can also detect LPG gas as well as smoke.

B. Smart RFID card Implementation

Here, passive RFID cards are used for scanning as an alternate for existing Aadhar card. With this smart card implementation, it not only acts as a voter identification card, but also be used as an attendance card for schools or colleges, or as a means of identification in high-security firms and government offices. It can be useful in all kinds of day to day applications.

EM18 module is a Radio Frequency Identification Reader, that can scan and recognize frequencies of upto 125KHz. After reading the passive RFID tag, it transmits the unique 12 digit ID for that particular card, to the Arduino serially, using UART communication.

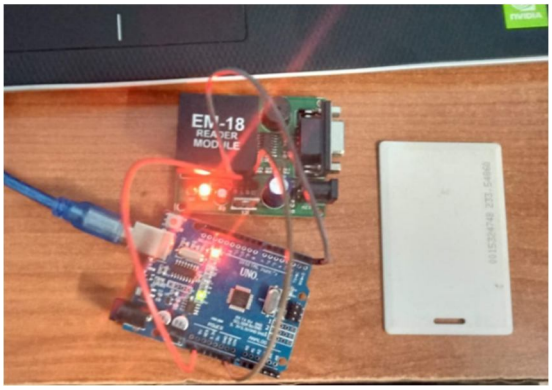


Fig. 4 RFID EM18 reader module with RFID Passive Tag

C. Eligibility of voter

The eligibility of voter includes conditions like, carrying valid Smart Identification card (Unique RFID for each person), satisfying minimum age criteria of 18, and should not have already cast the vote. The legitimacy of RFID card is verified in the fingerprint matching step.

D. Extracting Details

Details of voter including name, pin code to determine constituency of the voter and biometric data, including both fingerprints and face data is extracted. Furthermore, for real-time usage of proposed voting system, data can be extracted from existing Aadhar database by linking smart card with unique individual Aadhar number. For testing our prototype, we used details of 5 users, by capturing face and finger data in real-time.

E. Dual Biometric Authentication for user Verification

1) *Fingerprint Matching:* Here, AS606 fingerprint sensor is used. It is an optical fingerprint sensor, that captures image of finger ridges, and matches it with stored data to verify every individual.

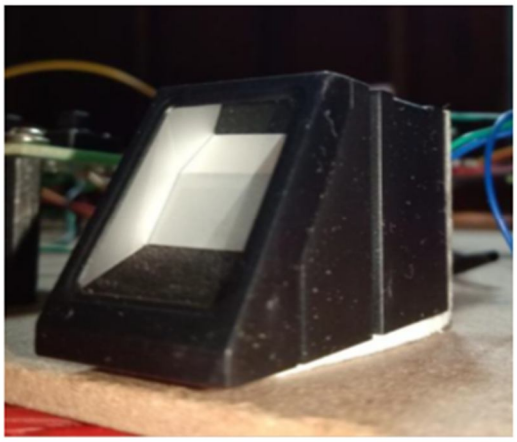


Fig. 5 AS606 module

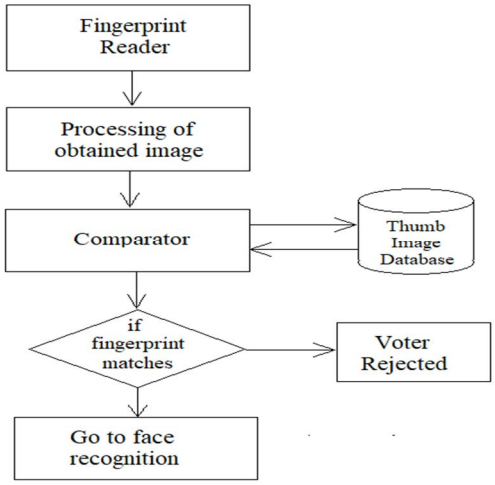


Fig. 6 Block diagram for fingerprint verification

2) *User Authentication using Face Recognition:* An algorithm that takes image data or video as an input, and automatically identifies a person from that data is called a face recognition algorithm. In our paper, Haar cascade and LBPH is used for face detection and recognition respectively. The steps include dataset creation, Haar cascade as a classifier for face detection, bounding box (or object localization), face recognition using Local binary pattern histograms, and finally training and testing of the algorithm.

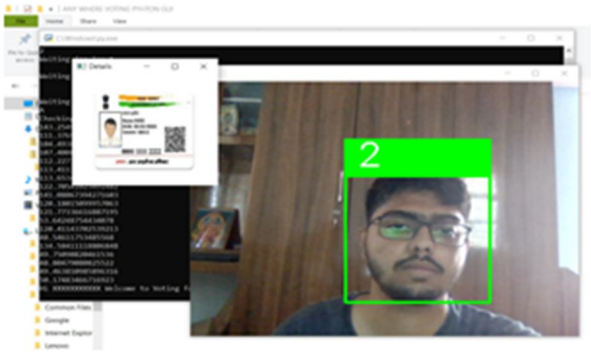


Fig. 7 Face recognition during real-time voting

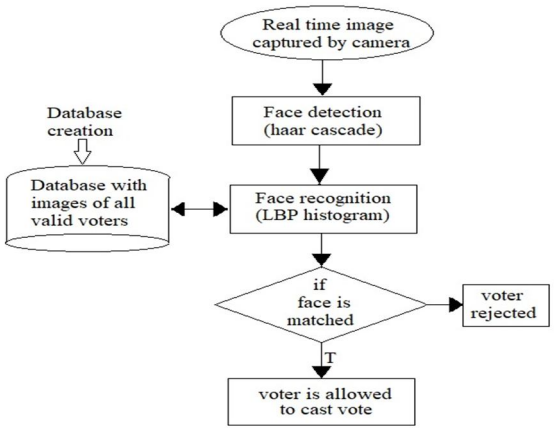


Fig. 8 Flowchart for proposed face recognition model

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F. Door Opening and Closing

We are using a DC motor for the opening and closing of the door in the project. In addition to the motor we use H bridge and (L298 module driver module) as motor alone cannot be directly interfaced.

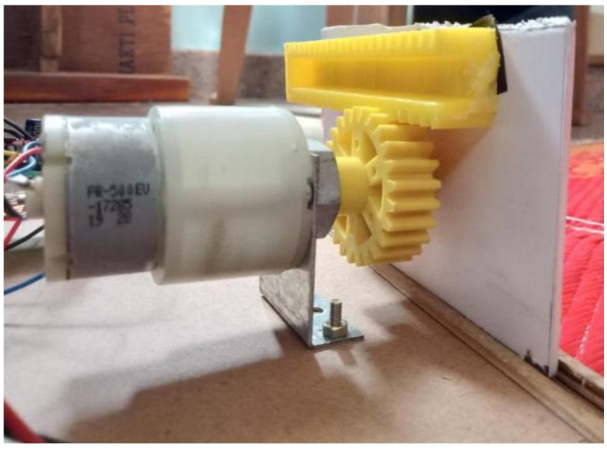


Fig. 9 Door attached to DC Motor

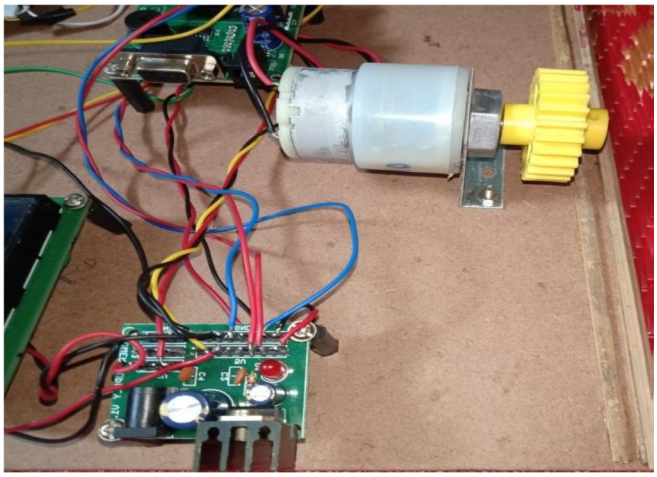


Fig.10 Interfacing DC Motor and H-bridge to Arduino

G. Voting Screen

Display constituency details and list of appearing candidates in the election, on the electronic voting machine. Under all satisfied conditions, the person is allowed to cast his vote. This is the online voting system, which is designed using python. In the initial screen, the constituency of voter is displayed. Further, the candidates or parties contesting in the election are displayed, and the user can cast his vote.

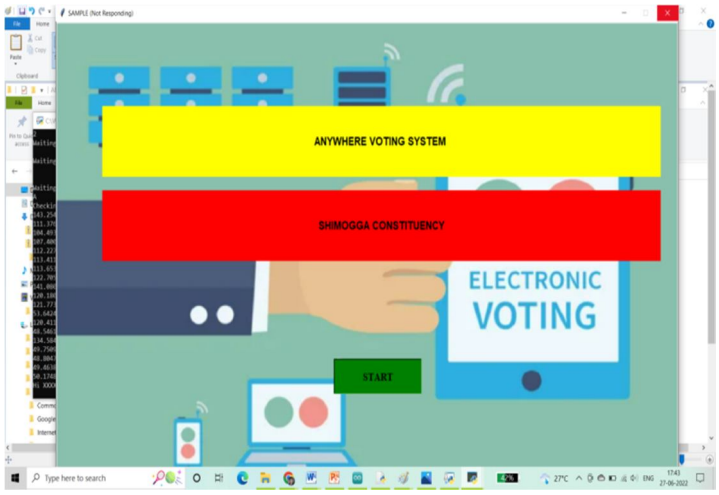


Fig. 11 Voter screen

Voter has to follow three steps, namely, click on start, cast his vote to required party, and exit. This will confirm that the voter has cast his vote to the proper candidate.

H. Vote Updating and Results

The vote cast towards a particular candidate is updated in a secure Electoral commission server or cloud. The voter name is tabulated to ensure same person does not cast vote again.

The results of the election will be accessible only to designated admins, who have to swipe their RFID card, followed by Fingerprint matching. Upon successful authentication, he will be asked to enter password to access the results. Each constituency admin will be given a unique password, which upon validation results will be displayed.

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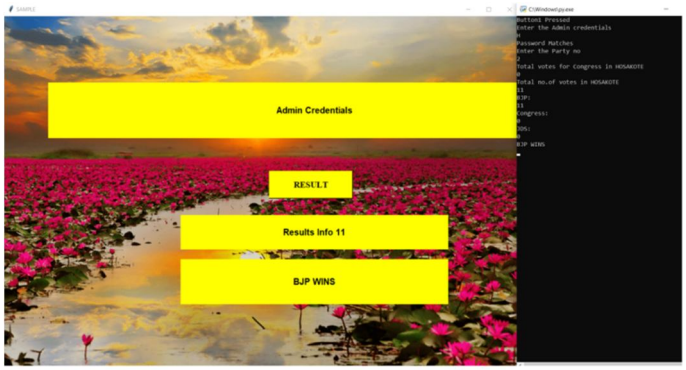


Fig. 12 Results screen accessed by admin

I. EVM Reset

After the vote is cast, the EVM is reset, and the next voter can begin the process of voting again.

Once the entire election is complete and results are obtained, the results can be erased, and be the entire system can be reset for the next elections.

VII. RESULTS AND DISCUSSIONS

The flaws in the existing voting system are reviewed and attempts were made in our prototype to overcome as many of them as possible. To provide better security and enable safe voting, we have dual biometric authentication, namely fingerprint authentication followed by face recognition. The optical AS606 fingerprint sensor, under ideal conditions works with a very high accuracy, whereas Haar cascade and LBPH tests showed accuracy of 90% with OV7670, but only 70% due to low camera resolution of laptop webcam used in the prototype. The final polling results will be accessible only by the Regional Admin specific to each constituency, who can check the results for designated constituency after RFID scanning, finger verification and password matching. Upon testing the prototype, the average time for the entire process of voting by the user was around 53.7seconds, implying that the procedure was simple and smooth.

VIII. ACKNOWLEDGEMENTS

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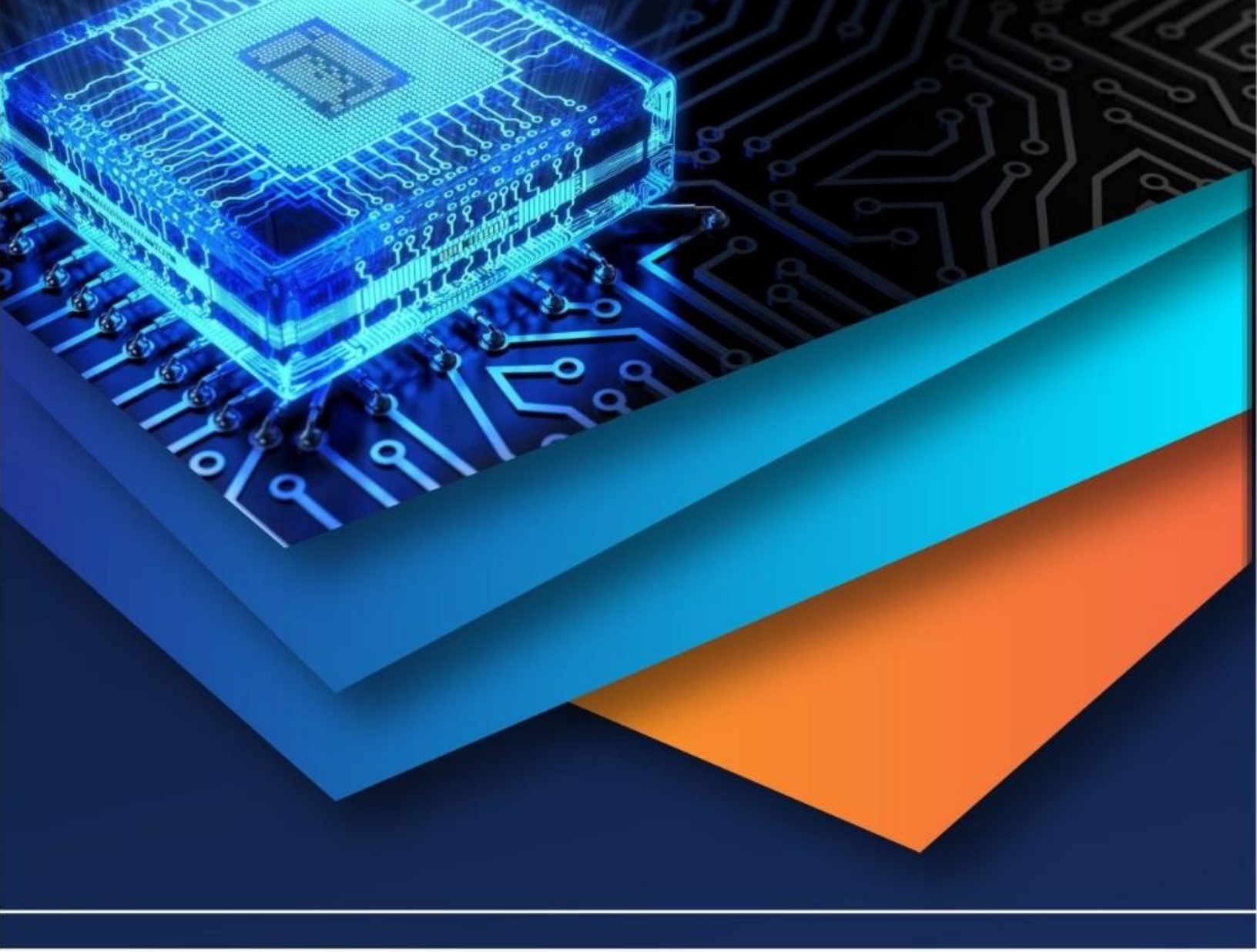
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