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Remote Accessing of Door System using GSM

Venkat Sai Krishna T[1], Vishruth Y S[2], Sujay Biradar[3], Tanmay Kodia[4], Mrs. Flory Francis[5]
[1, 2, 3, 4, 5]*Department of Electronics and Communication, Ramaiah Institute of Technology, Bengaluru, Karnataka, India*

Abstract: ***In this paper, a novel design and implementation of a secure smart door lock is discussed. The prototype built comprises of an electronic unit fixed behind a door to control the lock. This electronic unit consists of an Arduino Uno Microcontroller, a motor driver and a geared motor. When an authorised user sends an OTP (One Time Password) through SMS (Short Message Service), its authenticity is checked and the motor is rotated for a small time period to unlock the lock so that the door can be opened. The main intention of developing a microcontroller based remote locking system is to provide modern security enhancements and to replace the use of physical keys with GSM phones. Hence remote and shared access without compromising on security is provided in a cost-effective way.***

Keywords: GSM, Security, Arduino, Lever Lock, Remote Access, Shared Access, Intruder alert, Smart home, OTP

I. INTRODUCTION

The security division is observing advancements in door lock technologies and there is growth in new categories like never in the past. This has sparked a need to review the quality of the existing framework and research the likelihood of making better frameworks, which are more intelligent and progressively secure. Currently, in home security, there are very fewer implementations of technology in doorknobs due to lack of technological advancements or due to exorbitant rates. Hence it becomes a luxury to implement them in households.N Adnan Ibrahim et al [1] discusses implementing a door lock security system which is developed on PIC platform and uses GSM technology. A predetermined invariable password is made use of to authenticate the user and then actuate the geared motor, thereby controlling the state of the door to enhance security, a cautionary message would be sent to a pre-set mobile number on encountering three consecutive unsuccessful attempts. Pradip Tilala et al [2] proposed a system that monitors and operates on the door lock using an application developed on the Android platform and also using Wireless Fidelity service provided by WeMos Dl hardware, that is attached to the door. Ushie James Ogri et al [3] developed a blueprint of a security door which could be controlled by a GSM phone present at a remote location far away from the door, working as the transmitter and another mobile present at the door with dual tone multi-frequency (DTMF) interfaced to a motor. Through a DTMF decoder connected to the microcontroller unit, the stepper motor can be controlled. Pratiksha Misal et al [4] designed a Door lock security system combining SMS Technology with cellular communication services such as GPRS. The system was designed to automate the locking mechanism of the door on receiving a pre-set command, which would be sent as an SMS by the authenticated user. On reception of the SMS from the authenticated number, the microcontroller will consequently actuate the DC motor. The motor operates on the door to perform either the locking mechanism or the contrary unlocking mechanism. On encountering an intrusion by an unauthorized entity, the Infrared sensor detects the motion and alerts by sending an SMS to the appropriate predefined user. Yanbo Zhao and Zhuhai Ye [5] developed a cost-effective and power-efficient system to provide home security. The proposed system comprises of GSM/GPRS gateway, various kinds of sensor nodes designed to provide wireless security, IR security. The system is designed to respond immediately to a raised alarm event and has an easy to use interface presented using an LCD and a capacitive sensor keyboard. Yusekkaya et al [6] designed and implemented a home automation system integrating the GSM technology with internet accessibility. Complete features of the system are accessible through an interactive user interface. Piyare et al [7] designed an economical, adaptable and reliable mobile based home automation system. It uses an AVR microcontroller-based Arduino board and its interaction with the mobile which occurs wirelessly is used to control the home appliances through an interface. Huiping Huang et al [8] used a power efficient alarm system to provide home security, developed by applying WSN technology to detect an intrusion, gas leakage or presence of fire. The system also sends remote alerts using GSM technology. The system proposed by Ahmad et al [9] consists of a controller interfaced with various sensors and AT modem commands were used to perform serial transfer of data. The hardware consisted of microcontroller unit Atmega128 and a mobile phone set. ZigBee Technology was implemented by interfacing the microcontroller unit (MCU) with a ZigBee module. In the work on Digital Door Lock system, Mohammad Amanullah et al [10] designed a security system that can be operated by using a cellular network combined along with a DTMF keypad. A Dual Tone Multi-Frequency circuit and PIC microcontroller were adopted in this design. A mobile or telephone was used to control the operation of the system. In this work, a cost—effective way to implement home security system using a GSM module interfaced with a microcontroller (Arduino) has been proposed.

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II. METHODOLOGY

As shown in Figure 1, the system describes a secure door lock system which is both convenient and easy to use. In this system, a high torque DC motor along with gears is used to unlock the door. It is controlled by a GSM module to actuate the locking and unlocking mechanism of the door. It can be remotely accessed by its owner or an authorized guest. Use of an OTP instead of a fixed password enhances the security provided by the system. Sharing of OTP's for granting one-time access to guests can be established by the registered user. The system and mechanism designed to operate the lock is such that it can be used on all types of existing physical locks in various households. Figure 2 shows the flow diagram of the proposed system.

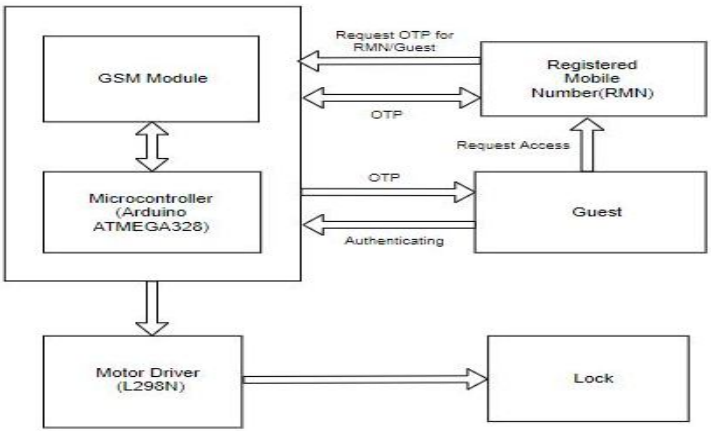

Fig. 1 Architecture of proposed system

OTP Generation: A random 6-digit number which serves as One Time Password (OTP) enhances the security of the system. Arduino's inbuilt random() function generates pseudo-random numbers between the range specified as parameters to the random() function. These pseudo-random numbers generated are not desirable as OTP, since they follow a sequence every time the Arduino module is reset and therefore make the system vulnerable. The sequence of numbers generated by the random() function is altered by initializing it with randomseed() inbuilt function which takes an integer as input called as "seed" value. A different list of the sequence of pseudo-random numbers is generated every time the module is reset, which is again undesirable. The analogRead() function reads a value from an unused analog pin and since the pin is floating, an indeterminable noise value returned serves as input to randomseed() and thereby producing a stochastic sequence. This concept has been utilized in a recursive function to generate a 6-digit OTP.

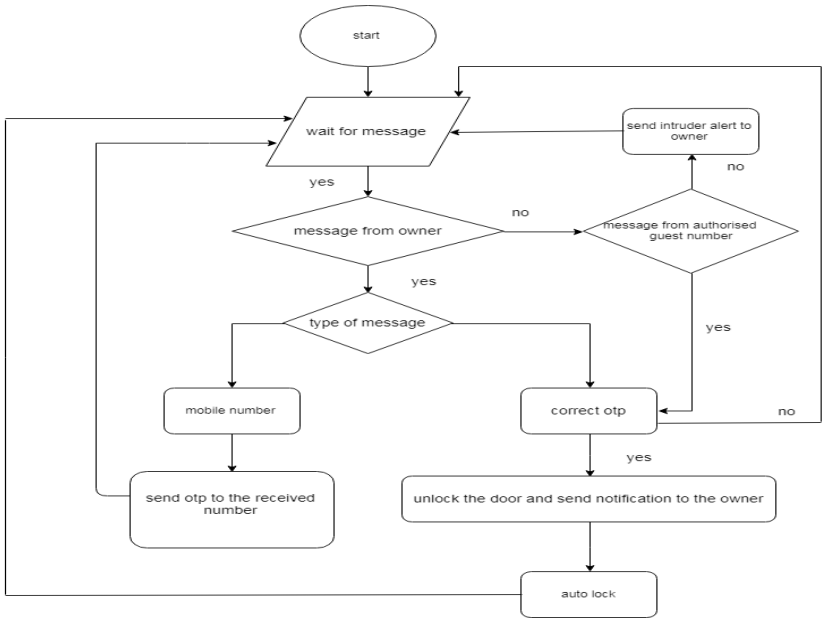

Fig. 2 Flow diagram of proposed system

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III.COMPONENTS

A. SIM800 GSM Shield

Figure 3 shows a SIM800 GSM/GPRS module which supports quad-band frequencies of 850/900/1800/1900MHz. It can be used to send and receive messages, voice and data. It supports a TTL level of 3.3 volts /5 volts and also features Bluetooth and embedded AT command capability. LED indicators present on the GSM shield convey information regarding the state of connectivity and power to the user. The Network LED indicates the status of availability of the network to the module. The use of SIM800 module is favoured because of its convenience of operation and compatibility with commonly used microcontrollers.

Fig. 3 SIM800 GSM Shield

B. Arduino Uno

The Arduino Uno R3 development board used as shown in Figure 4 is based on single chip microcontroller ATmega328p. 16 MHz of clock speed is achieved by the quartz crystal used in the board. The digital and analog input and output pins provide the interfacing capability of Arduino with its compatible modules. It operates at 5V providing 20 mA DC current per input/output pin and 50 mA DC current per 3.3V operated pin. A pulse width modulated (PWM) output is available on 6 pins out of the 14 digital pins of the microcontroller board. 6 analog inputs that can be taken from the board also serve as input to 10-bit Analog-to-Digital (ADC) thereby providing a digital value in the range of 0 to 1023.

Fig. 4 Arduino uno

C. L298N Motor Driver

The L298 shown in Figure 5 is a dual H-bridge motor driver. The H-bridge comprises of 4 switching elements, metal oxide semiconductor field effect transistors (MOSFET) and the motor. It is designed to accept standard TTL levels of 3.3V/5V as input to drive loads such as motors and relays. The enable (EN) inputs operate the motor driver independent of the input signals and decide whether to enable or disable the driver based on EN input. A supplementary input supply applied lets the driver be operated at smaller voltages. The motor driver can drive DC or stepper motors that have voltages between 5 volts and 35 volts with 2A peak current. The motor driver module has an onboard voltage regulator which can be controlled to enable the motor driver to provide 5 volts as output when the input is greater than 12 volts.

Fig. 5 L298N Motor driver

D. Johnson Motor

Johnson Gear motor shown in Figure 6 is a simplistically designed gear motor coupled with a gearbox. A DC gear motor designed to produce high torque so as to rotate the lock with a calculated force is required for this application. The motor is attached with a gear head which surrounds the shaft connected to the geared motor powered from direct current (DC). Higher the input voltage, greater is the RPM (rotations per minute) of the motor but the achievable torque is less.10 RPM 12V DC geared motors is best suitable for robotics applications where more torque is desirable and ample RPM is attained. The 10 RPM geared motor provides a massive torque of 40Kgcm. It features a metal gearbox with 15 mm shaft length, 6mm shaft diameter, 28.5 mm motor diameter and a gearbox diameter of 37 mm.

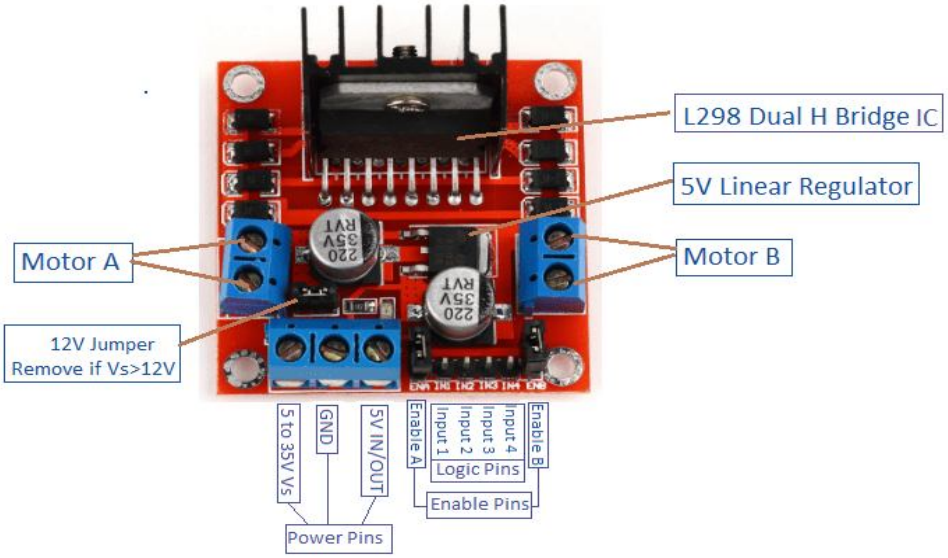

Fig. 6 Johnson motor

IV. EXPERIMENTAL SETUP

In the setup shown in Figure 7, Arduino Uno board is the controlling unit which takes required actions according to the SMS received (INPUT). The GSM shield is stacked on top of the Arduino board which provides the supply and GND to the module. Serial transfer of data between Arduino and GSM module is achieved by connecting the transmitter (TX) pin of Arduino to the receiver (RX) pin of GSM module and Vice versa.

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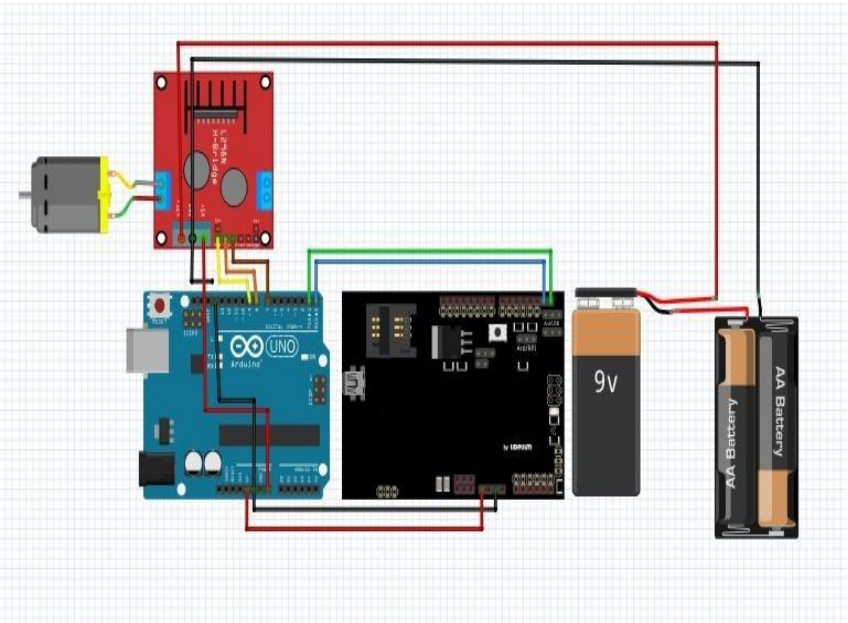

Fig.7 Experimental setup

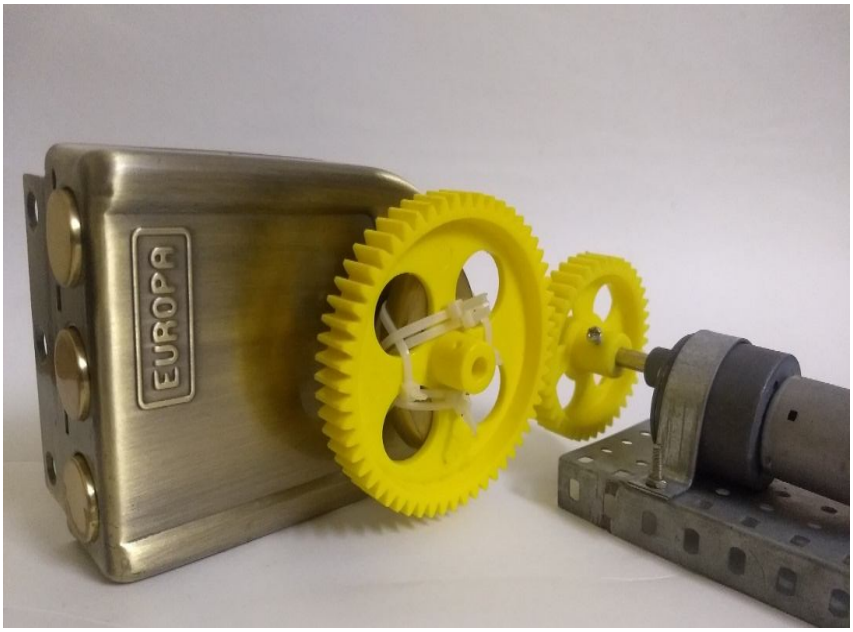

Fig.8 Locking and unlocking mechanism

On receiving an authorized SMS, the lock needs to be either unlocked if authenticated or OTP needs to generated and sent to the mobile number for later authorization. Unlocking mechanism is achieved with the help of L298N motor driver and a Johnson motor which is powered by a 12V lead acid battery. The knob of the lock is fixed firmly to a gear with the help of zip tags as shown in Figure 8 to hold the gear in place. This gear is then rotated by the gear connected to the motor. The direction and timing of the motor is controlled by the Arduino.

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V. RESULTS

A. Granting Access to Self

The Figure 9 shows the RMN (Registered Mobile Number)/owner requesting his/her access by specifying their mobile number between the special characters. After sending the correct OTP the OTP is authenticated, and the door is unlocked.

Fig.9 RMN controlling Lock

B. Granting Access to Guest

Figure 10 shows the RMN/owner sharing access to the guest by specifying his/her number between the special characters. The door is unlocked when the guest sends the correct OTP to the lock.

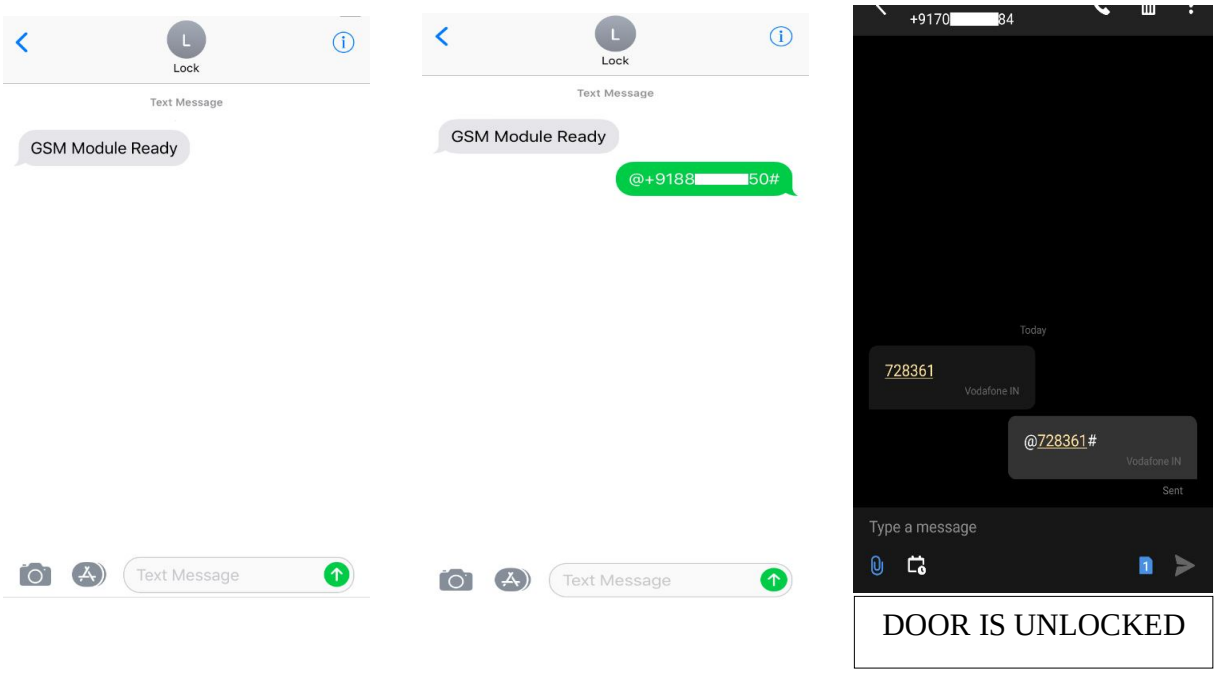

Fig.10 Granting access to guest

C. Intruder Alert

Figure 11 shows a warning message sent to the RMN along with intruder's details when an unauthorized person tries to gain access and unlock the door.

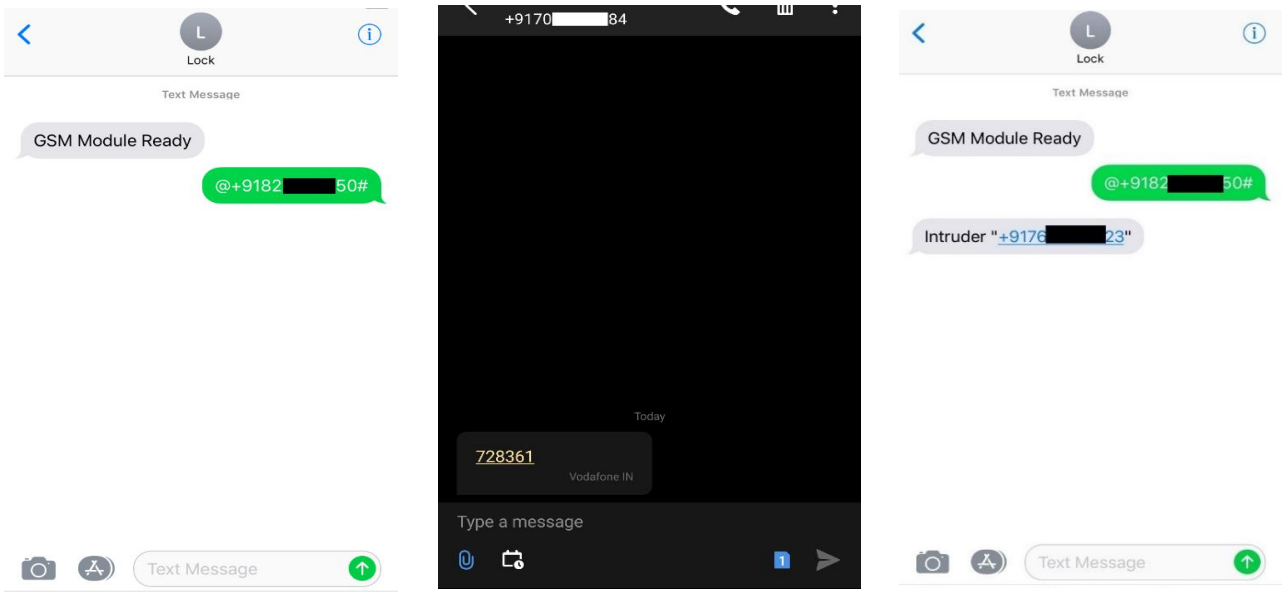

Fig.11 Intruder alert

VI. CONCLUSIONS AND FUTURE WORK

The system developed is cost effective. It has reliable network coverage because GSM is used instead of Wi-Fi whose coverage is restricted. Remote access from anywhere around the world is possible. Random 6-digit OTP is generated during each request. Access can be shared with trusted persons via OTP. Status alerts are sent to the registered mobile number each time the door is locked/unlocked. Intruder alert is sent to the RMN when an unauthorized person tries to unlock the door even with a correct OTP.

Following improvements are suggested for future development of this system,

1) An optional smart phone app can be developed to simplify the manual entering of commands by RMN to unlock the door.

2) For more enhancement in security, cameras for face authentication can be integrated with the current system.

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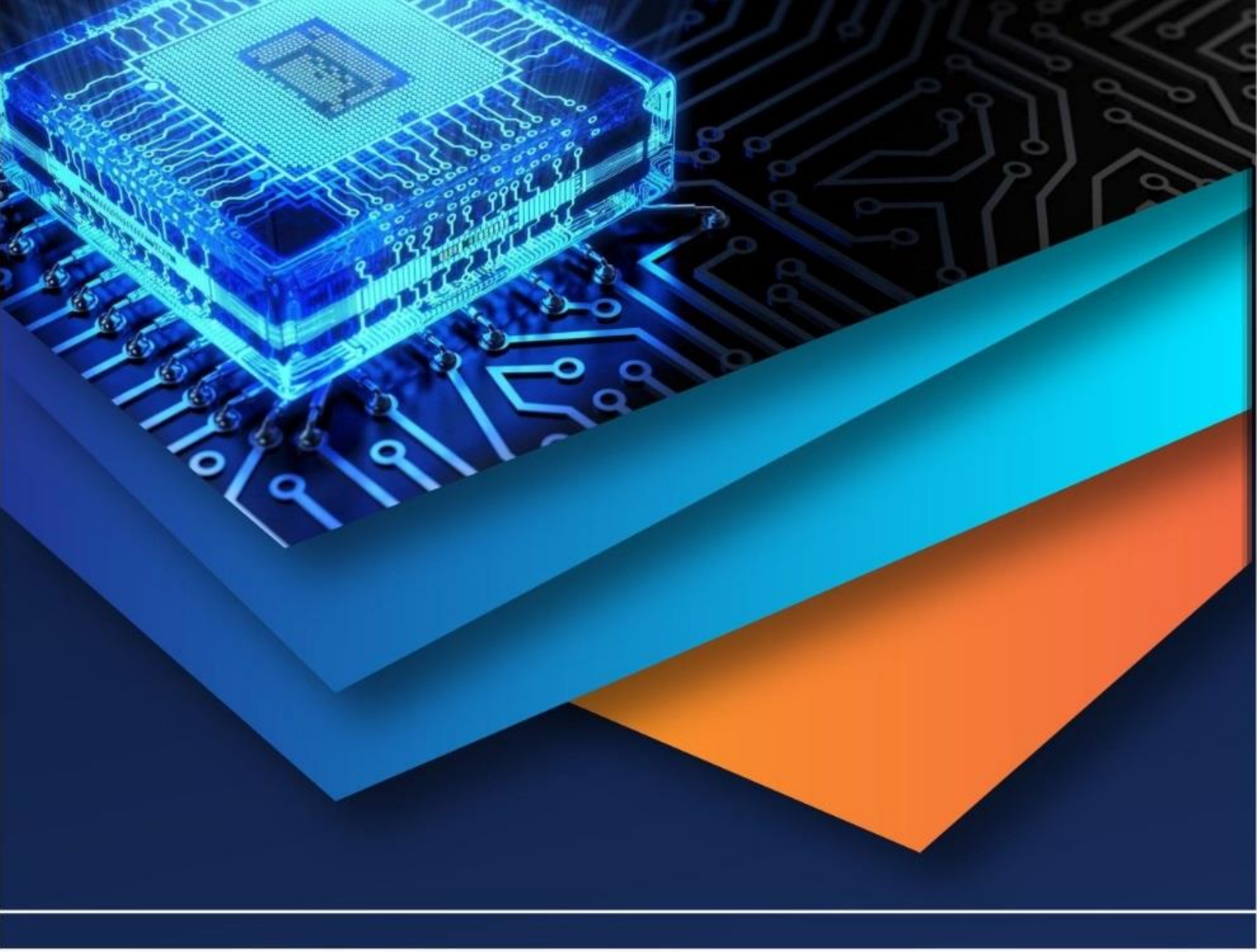

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