iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VIII **Month of publication:** August 2017

DOI: http://doi.org/10.22214/ijraset.2017.8070

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

Smart Door Locking System using Wireless Communication Technology

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Abstract: Today's word widely deploying innovative technologies for different applications like smart cars, home automation, building surveillance, forest fire monitoring, health monitoring, etc. Such innovations are caused due to different technologies as embedded, wireless, mixed signal, etc. Considering such innovations, it is proposed to design smart and highly secure lock/unlock system based on wireless communication technology. To achieve the desired goal of system designing, the system is connected about smart microcontroller PIC 16F877A and ZigBee. For human commands, Human Interface Remote Terminal Unit (HIRTU) is designed, which transmit the lock unlock key wirelessly. On other hand, Sensor Actuator Remote Terminal Unit (SARTU) is designed to sense the burglar and alarms. In addition, after receiving the secret key from HIRTU, SARTU produces commands to lock or unlock the door.

Keywords: Human Interface, Sensor, Actuator, Remote Terminal Unit, WSN, IoT, PIC 16F877A, etc.

I. INTRODUCTION

Nowadays, smartness of homes through automation system is widely used. The 21st century will become more and more self-controlled and automated due to innovative technologies such as embedded, wireless and Internet of Thing (IoT). A home automation system consists of controlling various electric appliances such as television, bulbs, fans, washing machine etc. Many existing, home automation systems are based on wired communication. But, wired system is complex, costly and to overcome such problems wireless system is adopted by many users [1]. The wireless network is widely used for home automation, industrial, agricultural, medical sectors [2] etc. On literature survey it is found that home automation is widely developed by many researchers but the home security is rarely reported. On survey, it is found that home automation realizes monitoring of temperature, humidity, Motion detection, Fire and smoke detection, Light level, Fan on/off and on/off other different appliance. However, home security is

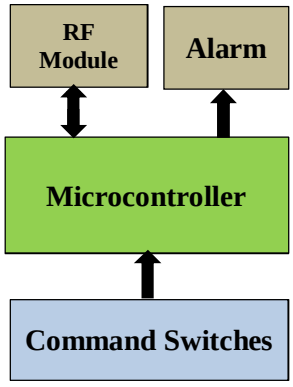

Figure 1(a): Human Interface RTU

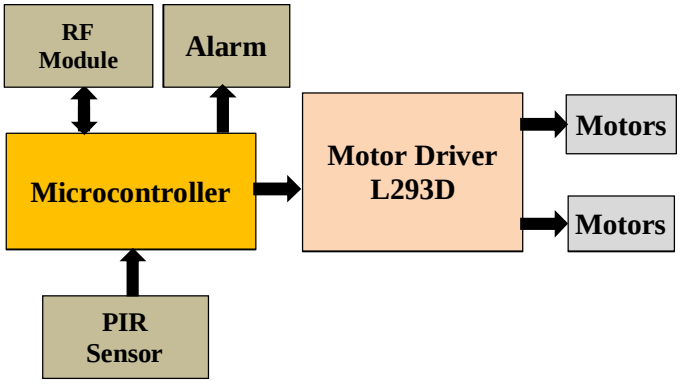

Figure 1(b): Sensor Actuator RTU

one of the major aspect, considering such facts it is proposed to design and implement smart locks for windows and door using IoT [3]. The Internet of Thing is internet of objects with capabilities of sensing actuating and designs. Sometimes such equipment's are integrated with Human Machine Interface (HMI) protocol, to interact human interface with the system. For present system the Remote Terminal Units (RTU) are designed for security purpose and installed at door and windows. The designing of the system is discussed through following points.

II. DESIGNING OF HARDWARE OF THE SYSTEM

The designing of IoT realizes the embedded system, which is combination of hardware as well as software. For designing of IoT both Hardware and software are co-designed. The figure 1(a) shows the Human Interface Remote Terminal Unit (RTU) and figure

1(b) shows Sensor Actuator RTU. The Human Interface Remote Terminal Unit (HIRTU) helps to send control signal to ON/OFF as well as Lock/Unlock door. The HIRTU consist of RF module, Microcontroller, switches, alarm and rechargeable battery as power supply unit. On other hand Sensor Actuator RTU receives the control signal from HIRTU and performs dedicated action according to the command received. The circuit diagram is designed as figure 2. As shown in figure 2 (a), the circuit schematic for Human Interface RTU and in figure 2 (b), the circuit schematic for Sensor and Actuator RTU is designed and simulated on proteus for testing of same. After that, the according to the circuit schematic, both units are designed for practical implementation of the system. The details of designing of hardware part are discussed through following points.

A. Human Interface Remote Terminal Units

The Human Interface Remote Terminal Unit (RTU) allows user to interact with RTU. The HIRTU is wired about PIC microcontroller. The user provides control signal (Lock/ Unlock) by using control switches. After receiving the input signal, the same data is processed and after that data is securely transmitted towards SARTU for dedicated application. Moreover, the Network Identifier (ID) is used as key for smartness of the desired device.

1) *Command Switches:* The simple switches are connected as shown in figure 2(a). The two switches are connected for lock and unlock of door respectively. When respective switches are pressed, the active low pulse is generated and applied to the port pin of the microcontroller PIC 16F877A. The microcontroller processes the received signal and generates respective command. The microcontroller is discussed through next sub point.
2) *Microcontroller:* The microcontroller is the brain of the remote terminal unit, which process input signal according to the user software. After comparing different controllers, PIC 16F877A [4] is selected. The PIC microcontroller operates on low power typically 2.0 to 5.5V. Also support different power saving modes like, idle, sleep, etc. The PIC16F877A have advanced on chip peripherals as analog to digital convertor with 10 bit resolution, Universal Synchronous Asynchronous Receiver Transmitter (USART) [4]etc. As compared to other controllers PIC [4] have large on-chip memory and easily in-circuit serial programming via two pins with single power supply. The controller has 25mA sink and source current to each port pins, able to drive external peripherals without any pull-up.

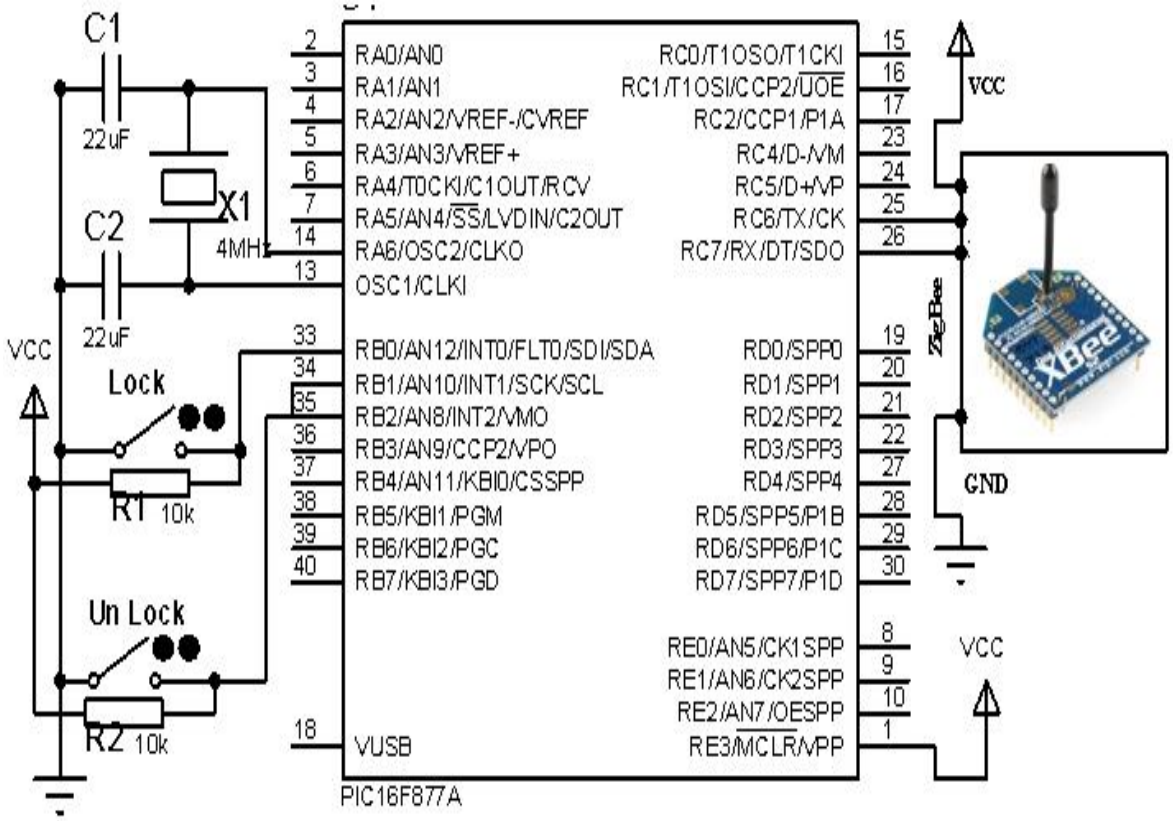

Figure 2 (a): Circuit Schematic of Human Interface Remote Terminal Unit (RTU)

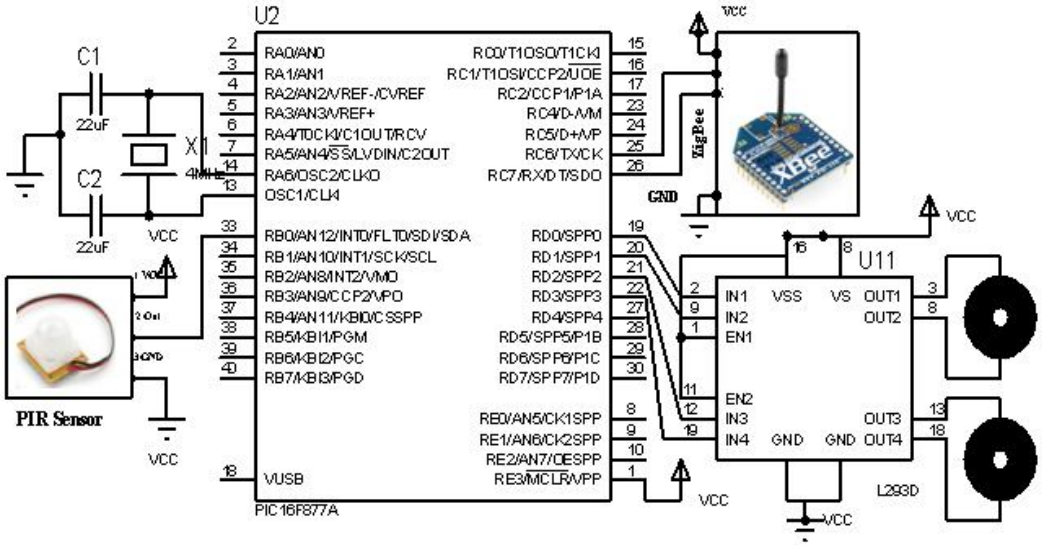

Figure 2 (b): Circuit Schematic of Human Interface Remote Terminal Unit (RTU)

The microcontroller is wired as shown in figure 2 (a). The output of microcontroller is connected to the RF module for transmission of the control signal securely towards Sensor Actuator RTU. The programming of the controller is discussed in software part.

3) *RF module:* The major aim of the present work is to design Wireless communication technology based smart door lock system. To achieve the desired goal, the RF module is necessary. The ZigBee is the wireless communication technology [5], the Digi built on the 802.15.4 standard. The zigbee device is shown in figure 3. The beauty of the 802.15.4 wireless standard is it offers self-healing mesh networks, small size, secure network, etc. These are valuable characteristics for building a wireless control network for dedicated application. It consumes very low power due to sleep mode and operates on low power supply typically 2.8V to 3.3V, chargeable batteries. Moreover, the ZigBee supports personal area network with unique PAN ID. Salient features of ZigBee modules are:

1)Power Output: 1 mW (+0 dBm)
2)Indoor/Urban Range: Up to 100 ft (30 m)
3)Outdoor/RF Line-of-Sight Range: Up to 300 ft (90 m)
4)RF Data Rate: 250 Kbps
5)Operating Frequency: 2.4 GHz
6)Operates on DC +3.3 volt

The ZigBee is reprogramming device. To program the ZigBee for dedicated application X-CTU IDE is used. Using X-CTU ZigBee is programmed for personal Network [6].

Figure 3: The ZigBee module

B. Sensor Actuator Remote Terminal Unit

According to the circuit schematic as shown in figure 2(b) the SARTU is designed about PIC 16F877A microcontroller. In addition to that, PIR sensor, RF module, Alarm unit and L293D are connected as peripherals. The SARTU couples the electromagnetic waves through antenna of ZigBee and after decoding the same, if key matches, the data is processed by using PIC 16F877A. The PIC generates control signals for Locking/ Unlocking and connected to the motor driver circuitry. Moreover, PIR sensor collects

information about intruder and proves signal to microcontroller for generation of control signal for alarm indication and safety requirements.

1) *PIR Sensor:* The PIR is integrated sensor widely used for security and protection applications [7]. The PIR sensor KC7786 is employed, which is based on the Passive Infra Red (PIR) technology. The sensor has three pins, input supply, output signal and ground. Sensor operates on typically +5 volt. Sensor consists on chip in built regulator with an amplifier. Due to such silent features PIR sensor KC7786 is adopted. This sensor detects human body movement within the range of several meters, and provides logical high output pulse. Moreover, a lens is required for detecting any motion more than a few feet away. Hence, a Fresnel lens [8] zone is adopted in front of the PIR detector. Sensor produces low output at normal conditions. The sensor output signal is provided to the input channel of microcontroller for further processing, as shown in figure 2(b).
2) *RF Module:* The ZigBee is selected for present work and connected as shown in figure 2(b). The RF module, ZigBee helps to receive data after secure key matched and then signal is given to the controller for further action [5, 9].
3) *Microcontroller:* As discussed earlier, PIC 16F877A is selected for present work. The sensor actuator circuit is wired about PIC 16F877A as shown in figure 2(b), which has salient features as well as promising on-chip peripherals [6]. The controller receives signal from ZigBee, process the same and generates control signal fo
4) *L293D.* The programming of the PIC for sensor actuator Remote Terminal Unit is discussed in software part.*L293D:* The L293D devices are quadruple high- current half-H drivers [10]. The L293D is bidirectional drive currents of up to 600 mA at voltages from 4.5 V to 36 V. L293D is capable to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive supply applications. Hence, L293D is wired as shown in figure 2(b) to drive the DC motor. The output control signal of microcontroller is coupled to L293D and output of L293D is connected to DC motor to convey the control action for Lock/Unlock door.
5) *Motors:* DC motor of 6V is used to lock/unlock. When the control signal is received, then motor rotates for 30s clockwise for locking the door on other hand for unlocking, DC motor rotates for 30s anticlockwise. Using two motors the locking system makes more secure.
6) *Alarm:* The speaker which operates at 5V is deployed. After receiving the command signal, the alarm starts indication of bugler [7].

III. SOFTWARE

The hardware part is successfully designed for present system and as discussed earlier the software is essential to synchronize the peripherals and to configure on chip resources of microcontroller. The software is developed for both Human Interface RTU and Sensor Actuator RTU. The software is developed in Microc C pro for PIC IDE and after compiling the source file, hex file is created. The hex file is flashed in program memory of respective PIC microcontrollers of RTUs [4]. The algorithms for both are as fallows.

A. *Algorithm of Software of Human Interface RTU*

a) Initialization of Global variable and declaration of user defined functions.
b) Configuration of ports as I/O.
c) Sensing the Commands from command switch and process the data.
d) Configure USART for interfacing of RF module.
e) Same signal is transmitted towards the SARTU through RF module.

B. *Algorithm of Software of Sensor Actuator RTU*

a) Initialization of Global variable and declaration of user defined functions.
b) Configuration of ports as I/O.
c) Configure USART for interfacing of RF module.
d) Receive signal from RF module.
e) According to control signal, the command signal is generated for Lock/Unlock the door securely.
f) Acquire signal from the PIR sensor and alarm if any burglar occurred.

IV. RESULT AND DISCUSSION

The wireless communication technology based smart lock/unlock system for home door is designed about PIC 16F877A microcontroller and ZigBee module. The two units are developed as Human Interface RTU (HIRTU) and Sensor Actuator RTU

(SARTU). The HIRTU is portable device and may be carrying by user anywhere, which is a secret key for door. On other hand, SARTU is fixed unit fixed at the door from inner side as shown in figure 4(b). At the time of leaving the house, user close the door and sends the lock signal from HIRTU. After receiving the same signal, SARTU process the data and produces control signal for motors to lock the door.

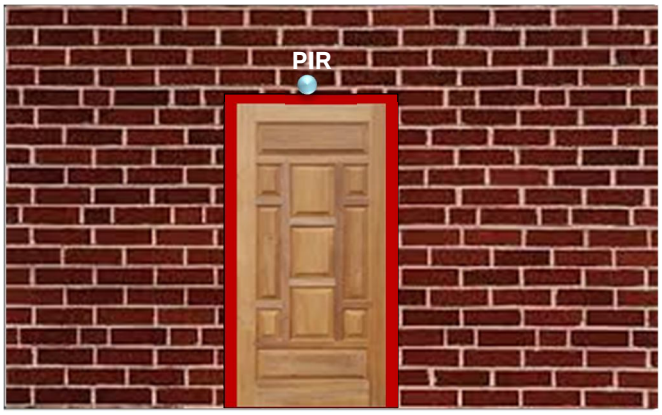

Figure 4(a): Outer side of door

If user is out of station and any burglar try to crack the door then PIR sensor sense the motion for particular time period and starts alarming. When user activates the HIRTU and sends command signal for open the door, then the SARTU sense the signal, decode it, if address is match then the motors quickly rotates for unlock the door. The developed system is successfully implemented for practical purpose and it works satisfactorily.

V. CONCLUSION

The major aim of designing the home safety is achieved by embedded and wireless communication technologies. For this advanced microcontroller PIC 16F877A is deployed. Moreover, for wireless communication, ZigBee is used as discussed earlier. The developed Human Interface Remote Terminal Unit (HIRTU) and Sensor Actuator Remote Terminal Unit (SARTU) are implemented successfully for practically authentication purpose. On investigation of the results, it is found that the developed home security system works successfully and lock/Unlock the doors with secret key which is assigned by user.

We planned to integrate developed system with GSM for extension of the range of the device in feature. Moreover, number of parameters for home safety will be monitor as gas leaks, visual camera, etc.

Figure 4(b): Inner Side of Door Locked.

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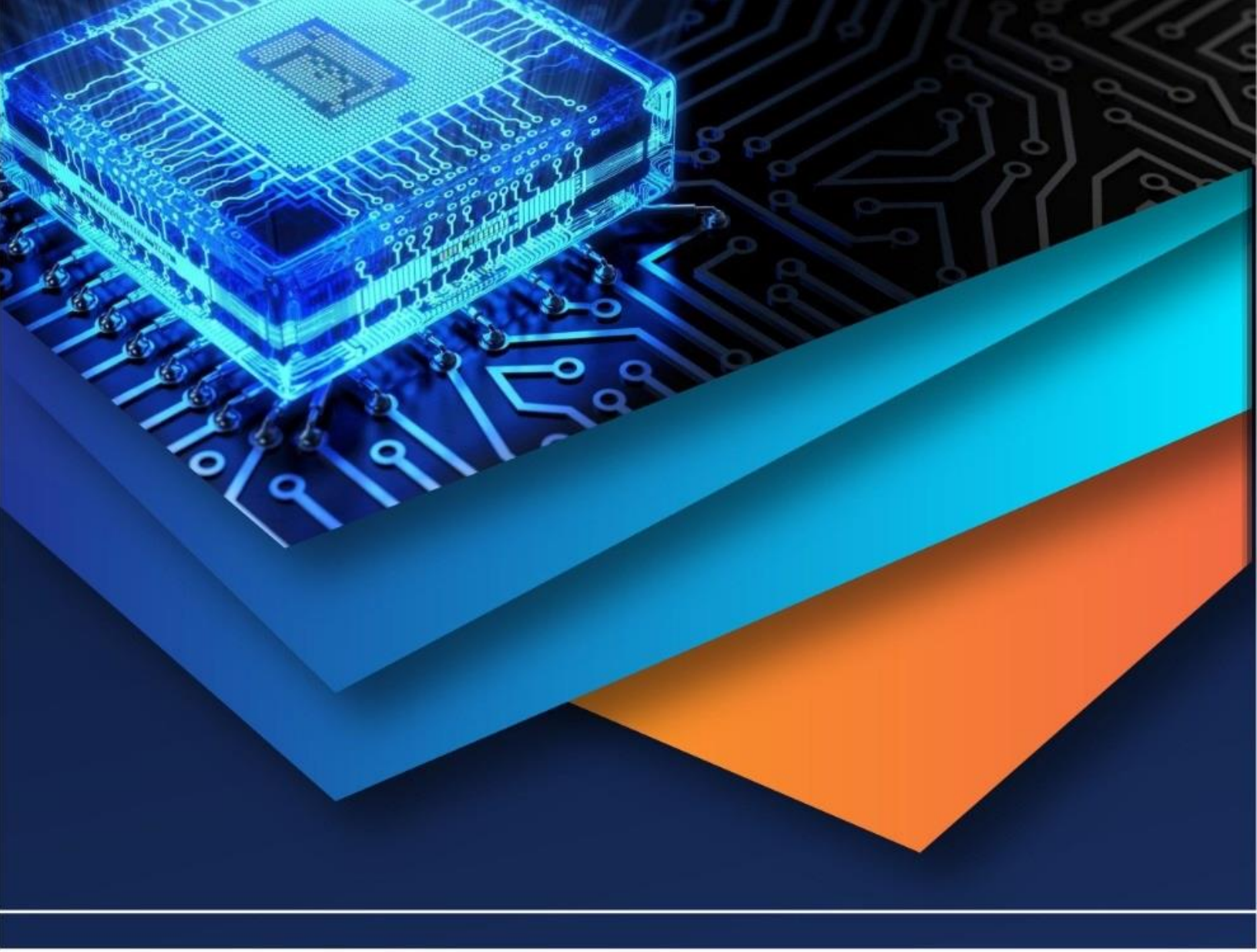

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