iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IV **Month of publication:** April 2023

DOI: https://doi.org/10.22214/ijraset.2023.50748

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

Smart Library Management with Android Application

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Abstract: ***Smart Library Management using RFID technology and an Android application is a modern and efficient approach to managing library operations. The proposed system aims to provide a user-friendly interface that allows patrons to browse and search for books, as well as to borrow and return them. RFID technology allows for the automation of tasks such as borrowing and returning books, and monitoring book circulation. An Android application enhances user experience by providing real-time information on book availability, due dates, and reservations. It improves efficiency, reduces errors, and is cost-effective in the long-term. This system revolutionizes the library experience for both users and staff, making it a worthwhile investment for libraries looking to modernize their services.***
Keywords: Smart library, RFID technology, Android application.

I. INTRODUCTION

Libraries play an important role in modern society by providing access to a wide range of information and resources. With the advancement of technology, libraries can now use RFID (Radio Frequency Identification) technology and Android applications to enhance their services and improve the overall library management system. By using RFID tags, library staff can easily scan and track items without the need for manual check-ins and check-outs.

Additionally, an Android application can be used to provide a user-friendly interface for library users to search for and borrow items, as well as manage their accounts. This application can also be integrated with the RFID technology to provide real-time information on item availability, location, and status. By using RFID technology, it sends the book information to the android application. It allows us to maintain all information in a standard database.

In this context, smart library management using RFID technology and an Android application has the potential to revolutionize the way libraries operate, making them more efficient, user-friendly, and accessible to a wider range of users. This system can help reduce waiting times, minimize human error, and enhance the overall library experience for both staff and patrons.

II. METHODOLOGY

A. Registration Unit

B. Door Unit

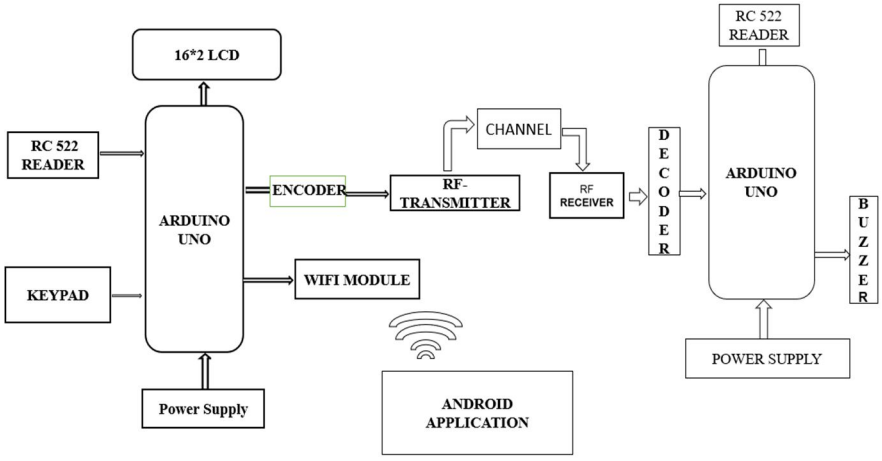

Fig1: Block Diagram of Registration Unit and Door Unit

We divide our project into 3 modules:

1) *Book Registration Module:* The availability and location of the books are always displayed on the LCD in this module. By looking through the LCD, students can quickly locate their required books. By clicking the borrow or return book button on the keypad, they can choose to either keep or return the book. The student has to enter their USN or serial number after clicking the switch. He must scan the book in order for it to be registered to his account and for the app database to receive the same information. He has to press the return book switch and type the USN or serial number in order to return the book. He needs to scan the book in order to return and update the app database to receive the same information. Whenever registration is completed, RF transmitter will send information to door Unit.
2) *Door Unit:* We have an RF receiver in the door unit, which will receive information about book registration from the registration unit. The system will set off an alarm if a book is attempted to be stolen without registration. We connect the RFID to the door unit to scan the book.
3) *Android App Interface:* We are developing an Android application for librarians and students as well. The books accessible in the library can be updated through the librarian module. Books can be added or removed by the librarian from the application. Students can create an account in the student's module by using their USN. Once a student has enrolled, he can use the app to check the library's book availability. Students can view information about penalties and book return deadlines. They can check rack for the respective book. Pre-booking of the desired book can be made available.

III. TECHNICAL REQUIRMENTS

A. *Arduino Mega*

The Arduino is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

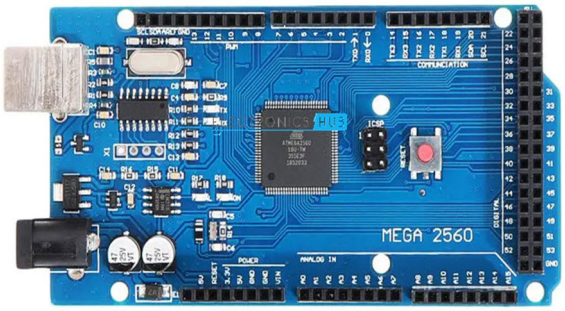

Fig 2 : Arduino Mega

B. *LCD 16*

LCD 16x2 refers to a type of liquid crystal display (LCD) module that has 16 characters per line and 2 lines. The 16x2 LCD module is widely used in various electronic devices, such as digital clocks, calculators, and programmable controllers. The LCD module typically has a backlight to improve visibility in low light conditions. It also has a controller chip that handles the display of characters on the screen. To use an LCD 16x2 module, the host device sends commands and data to the controller chip to display characters on the screen.

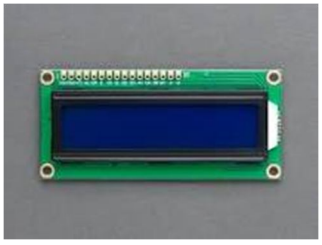

Fig 3: LCD Display

C. RFID Reader

Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory goods. A RFID reader is a radio frequency device that emits a signal through an antenna. This signal is received by RFID tags that respond to interrogation by the reader. Responses are read by the reader, and through a variety of protocols the reader can communicate with all the RFID tags in its field. The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data. The transponder is in the RFID tag itself. Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

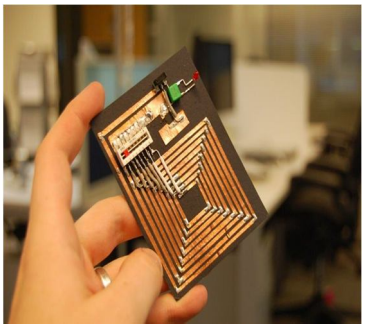

Fig 4: RFID Reader

D. RF Transmitter and Receiver

The RF transmitter receives serial data and transmits it wirelessly through its RF antenna. The transmission occurs at the rate of 1 Kbps – 10 Kbps. RF receiver receives the transmitted data and it is operating at the same frequency as that of the transmitter. A transmitter wirelessly sends a data signal stream. A receiver receives the data and streams it to your TV. Point-to-point microwave antennas transmit and receive microwave signals across relatively short distances (from a few tenths of a mile to 30 miles or more). RF interference can occur in your WLAN when 802.11 devices are trying to send packets and another device is sending a packet at the same time. These interfering signals then disrupt your Wi-Fi service, leading to problems that the end-user experiences, decreasing performance and satisfaction with the network.

Fig 5: RF Transmitter and Receiver

E. Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power.

All power supplies have a *power input* connection, which receives energy in the form of electric current from a source, and one or more *power output* or rail connections that deliver current to the load. The source power may come from the electric power grid,

such as an electrical outlet, energy storage devices such as batteries or fuel cells, generators or alternators, solar power converters, or another power supply. The input and output are usually hardwired circuit connections, though some power supplies employ wireless energy transfer to power their loads without wired connections.

Fig 6: Power Supply

F. Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke. The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage. This buzzer uses a DC power supply that ranges from 4V – 9V.

Fig 7: Buzzer

G. Wi-Fi Module

Wi-Fi modules (wireless fidelity) also known as WLAN modules (wireless local area network) are electronic components used in many products to achieve a wireless connection to the internet. Wi-Fi modules are used to provide internet connection to robotic and electronic projects. Wi-Fi modules allow developing IoT (Internet of Things) projects. By using Wi-Fi modules, you can send data over the internet to your robot or make it send data over the internet. The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network.

Fig 8: Wi-Fi Module

H. Arduino Sketch

A sketch is the name that Arduino uses for a program. It's the unit of code that is uploaded to and run on an Arduino board. The Arduino language is a subset of C/C++, where you can also use assembly for ultra-low-level code. When saying “programming on Arduino”, in fact you don't program the Arduino board itself, but the microcontroller inside the board. For example, the Arduino Uno has a AtMega328p microcontroller. The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV.

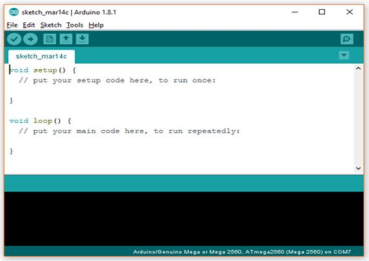

Fig 9: Arduino Sketch

I. Arduino Studio

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.[9] It is available for download

on Windows, macOS and Linux based operating systems.[10] It is a replacement for the Eclipse Android Development Tools (E-ADT) as the primary IDE for native Android application development. Android Studio supports all the same programming languages of IntelliJ e.g., Java, C++, and more with extensions, such as go and Android Studio 3.0 or later supports Kotlin and "all Java 7 language features and a subset of Java 8 language features that vary by platform version."[22] External projects backport some Java 9 features. While IntelliJ states that Android Studio supports all released Java versions, and Java 12, it's not clear to what level Android Studio supports Java versions up to Java 12. At least some new language features up to Java 12 are usable in Android. Android Studio provides a unified environment where you can build apps for Android phones, tablets, Android Wear, Android TV, and Android Auto. Structured code modules allow you to divide your project into units of functionality that you can independently build, test, and debug.

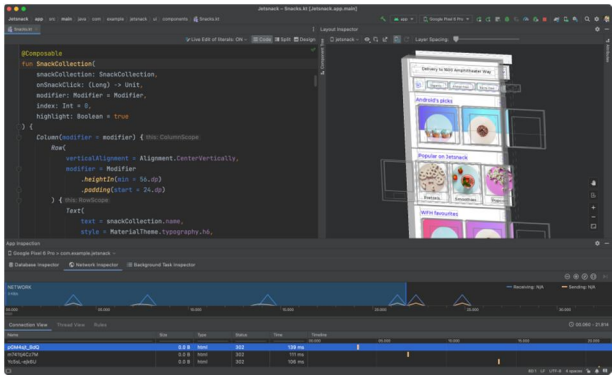

Fig 10: Arduino Studio

IV. IMPLEMENTATION & RESULT

In our project the hardware implementation is divided into 2 major sections namely, Registration unit and Door unit.

A. Registration Unit

The registration unit is installed at the front desk of the library. Here, the student ID is scanned to retrieve the student's information like his/her USN, along with a prompt requesting if he would like to borrow or return any book. It is also checked to see if the book is registered before borrowing it.

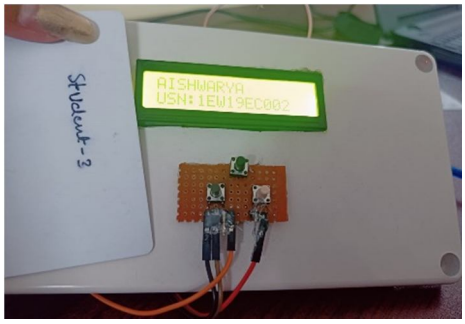

Fig 11: student's name and USN is displayed

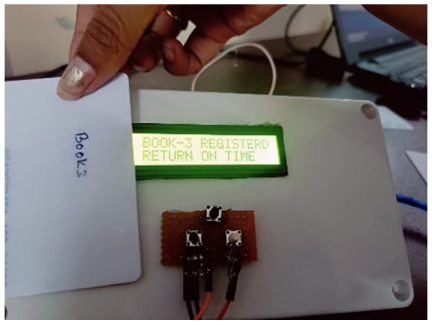

Fig 12: desired book is registered

Fig 13: displays that the registered book has been returned

B. Door Unit

Door unit plays a important role in book authentication that is registering the prescribed book for the respective student and it also works like an antitheft detector for the library system by informing the librarian and setting off an alarm if an unregistered book is passes through the door unit.

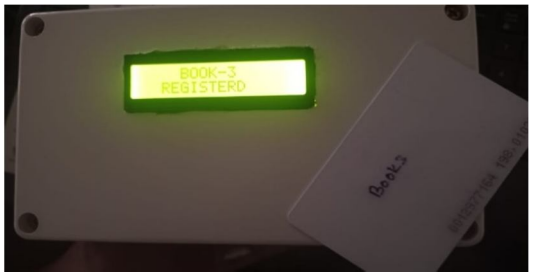

Fig 13: Displays the registered book

Fig 14: displays an unregistered book registered

Now that the hardware implementation and operation are complete, let's see the admin and student displays on the Android application.

C. Android Application

An android application is developed where the admin has access to the database which allows him to update the new books that has been arrived and delete the books that are unavailable. He can also keep a track of the number of books borrowed by a student and calculate the due.

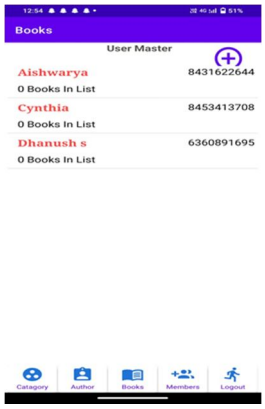

Fig 15: Admin can keep tabs on no of books borrowed

In addition, the students can make use of the app to check the availability of any book and the time at which the book was borrowed and returned. Alongside, the student also gets a notification about the due balance.

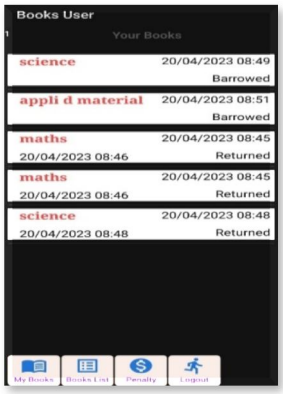

Fig 16: displays date and time when book was Borrowed and returned

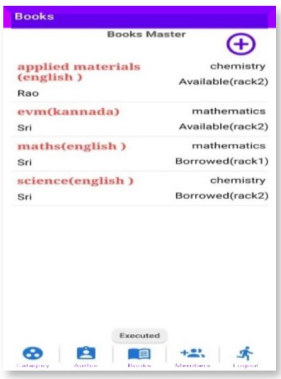

Fig 17: availability of the book

V. RESULT

The proposed library automation mobile application is developed. Depending on the requirements of each university, features can be added or modified. This application avoids the manual work and the problems concerned with it. It is an easy way to obtain the information regarding the various books that are present in the library of a college.

Fig 17: Smart Library Management System Using RFID Technology and Android Application

VI. CONCLUSION

Finally, we have proposed and implemented a system that can significantly improve the efficiency and accuracy of the library system. With RFID tags attached to books, the library staffs can easily track their location, monitor their circulation, and automate the borrowing and returning process. The android application can provide user with real time information on book availability, due dates and reservations, enhancing their experiences. Overall, the use of RFID technology and an Android application can streamline library operations, reduce manual labor, and improve service quality, making it a worthwhile investment for any library looking to modernize its service.

VII. FUTURE SCOPE

With proper knowledge one can develop a system by implementing RFID technology and Android application that is integrated along with other emerging technologies, such as artificial intelligence and machine learning, to improve the efficiency of library operations. For example, AI algorithms can analyse borrowing patterns and recommend personalized books etc. It can also be used to offer additional services such as, remote book reservations, online payment and virtual book clubs. We can also collaborate with libraries to create a network of interconnected system that share resources, reducing costs and increasing accessibility for users.

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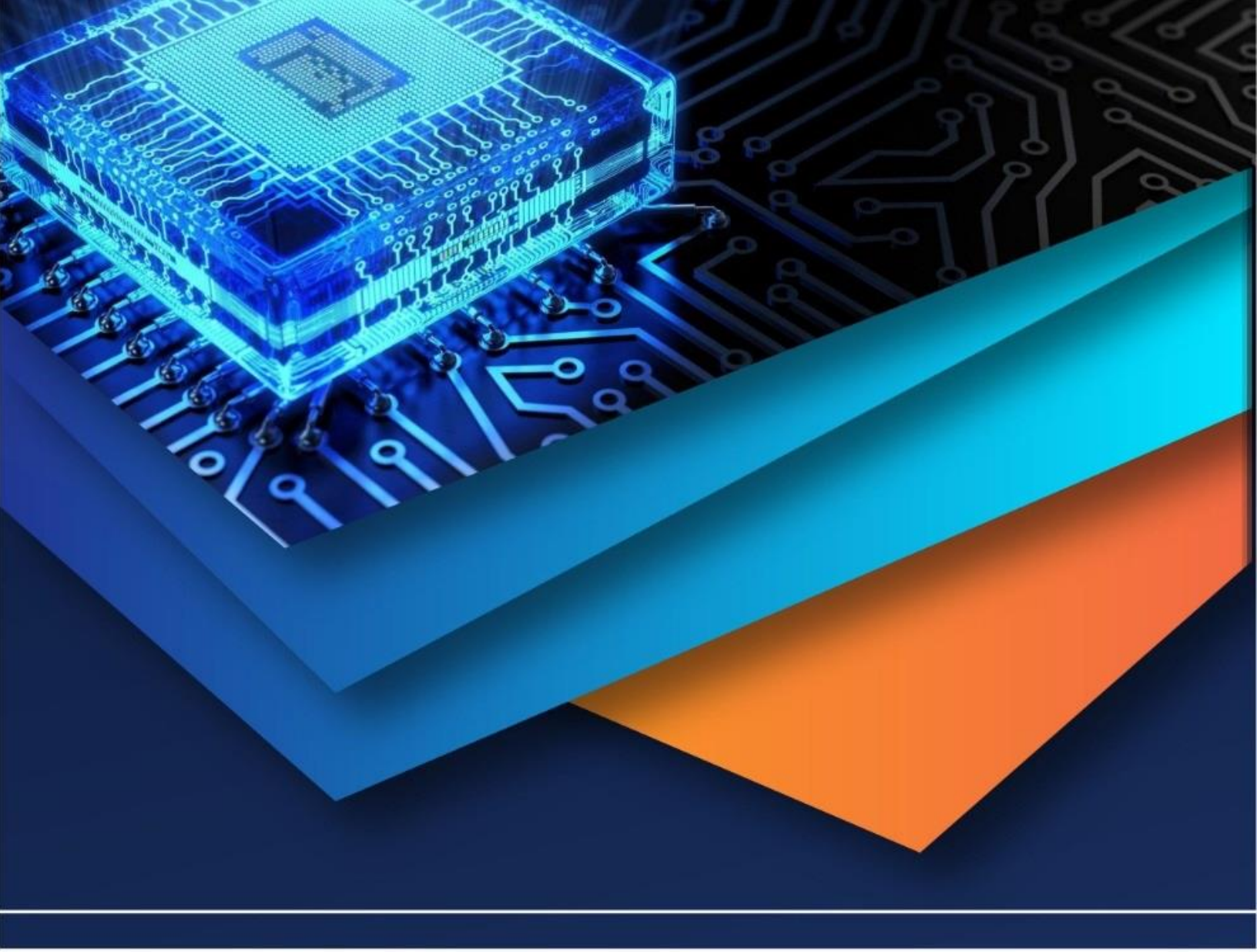

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