iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XI **Month of publication:** November 2023

DOI: https://doi.org/10.22214/ijraset.2023.56668

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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 XI Nov 2023- Available at www.ijraset.com

Automated Pet Feeder with RFID Technology using Design Thinking Approach

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Abstract: ***With the increasing demand for technological solutions in the pet care industry, this paper presents the development of an automated pet feeder that integrates RFID technology and Arduino as the microcontroller. The proposed system aims to streamline and enhance the feeding process for domestic pets by enabling pulsed feeding schedules and portion control based on RFID-tagged collars. The system uses an RFID reader to identify individual pets, triggering a simple motor mechanism to deliver the designated portion of pet food. The Arduino microcontroller facilitates the coordination of RFID tag recognition and food delivery, providing a user-friendly and customizable interface for pet owners. The design and implementation considerations, including hardware integration, software development, and fuzzy control logic, were thoroughly discussed. Experimental results demonstrate the feasibility and efficacy of the proposed automated pet feeder in maintaining a consistent feeding schedule and portion management, ensuring the well-being and health of pets. The study not only contributes to the advancement of pet care technology but also highlights the potential for further enhancements and applications in the realm of smart pet management systems.***

I. INTRODUCTION

In recent years, the demand for automated solutions in the field of pet care has grown significantly, driven by the need for convenient and efficient pet management tools. Pet feeding, a fundamental aspect of pet care, often requires a structured and consistent approach to ensure the well-being and health of domestic animals. Automated pet feeders have emerged as a practical and innovative solution, offering pet owners the convenience of remotely managing feeding schedules and portion control, thereby addressing the challenges associated with busy lifestyles and erratic work hours.

A gravity feeder is one of the types of pet feeders, consisting of a container full of food that falls into a bowl as the bowl is emptied by the pet (Babu et al., 2019). This type of feeder enables the pet owner to ensure that their pet has access to food throughout the day or for a longer amount of time, and it does so without the need for human power, instead relying on gravity (Andi et al., 2016).

This innovative system places a strong emphasis on preparedness and rapid action. Parents are encouraged to maintain updated profiles for their children, including essential information such as photographs, age, and relevant details. These profiles serve as a critical foundationfor coordinated efforts in the unfortunate event of a child going missing or being abducted.

Leveraging advancements in technology, this study focuses on the development of an automated pet feeder integrating RFID (Radio-Frequency Identification) technology and the Arduino microcontroller platform. By combining RFID-based pet identification with a programmable feeding mechanism, the proposed system aims to provide a tailored and user-friendly solution for pet owners, enabling them to regulate feeding patterns and monitor dietary requirements for their pets.

This paper presents the design development, and implementation of the automated pet feeder, emphasizing the technological aspects and practical implications of the system in enhancing pet care management. The study contributes to the evolving landscape of smart pet care solutions and underscores the potential for further research and innovation in the domain of automated pet management systems. Auto feeders come in handy since pet care necessitates continuous commitments and time-consuming (Vania et al., 2016.The pet necessity, which needs to be fed regularly but does not lead to overeating and obesity, ashtray. All those concerns raised led to the development of a real-time pet auto feeder dispenser system benefiting not only the pet but also the owner.

II. LITERATURE REVIEW

1) A gravity feeder is a popular pet food that uses gravity to transfer food from container to bowl as the pet eats (Babu et al., 2019). These feeders allow pet owners to ensure that their pets are fed throughout the day or for long periods of time without relying solely on gravity and requiring manual intervention (Andi et al., 2016). Notably, it does not affect the amount of food the pet eats. In contrast, automatic feeders, also known as auto feeders, are available on the market to feed pets regularly when the owner is away (Seungcheon, 2016).

2) A recent study by Delgado et al. (2020) presented a prototype of a food automaton that integrates Raspberry Pi to feed pets at home. The study highlighted the versatility of the Raspberry Pi in terms of communication, facilitating interaction with drivers, sensors, and motor steppers to enable food delivery as the animal approaches. The program is expected to have a positive social impact, help family members and pets, and improve soft pet feeding.

3) Nur and Nadilah (2020) introduced an innovative standalone module, utilizing an Arduino UNO and a Node MCU ESP8266, for an automatic cat feeder and location tracker. This device incorporates various sensors, including an ultrasonic sensor, a servo motor, and a GPS module to track the cat's position. The system allows pet owners to feed their pets remotely via a mobile application by simply clicking a button to refill the bowl. Furthermore, it sends notifications to the owner when there is a critical level of food and water in the bowls. This dual functionality enables the pet owner to keep track of their pet's whereabouts while ensuring proper feeding even when they are not at home. The project resulted in a fully functional prototype that can be controlled remotely through a mobile application.

4) Gelila et al. (2014) proposed a system of a programmable pet feeder utilizing a microcontroller. The project aimed to develop a programmable pet feeder based on the rotational speed of a DC motor, providing the pet owner with the ability to dispense food. The system utilizes a stepper motor for speed control and a DC motor for food dispensing. Pet owners can set a time schedule for each feeding segment according to their specific requirements and objectives.

5) In another work, Babu et al. (2019) developed a mobile device using Arduino Mega. These feeders can provide the right amount of food at a given time based on the specific needs of the animal. This system allows owners to monitor feeding through a dedicated mobile app. Data is transferred via Ethernet to the PCB, which subsequently activates the feed gates. Not only does this technological advancement make it easier to feed pets to their owners, it also ensures that pets are getting the right amount of food at the right time, which can help offset their debt.

6) A gravity feeder is a popular pet food that uses gravity to transfer food from container to bowl as the pet eats (Babu et al., 2019). These feeders allow pet owners to ensure that their pets are fed throughout the day or for long periods of time without relying solely on gravity and requiring manual intervention (Andi et al., 2016).

7) Steve Whelan, founder of Encaya Corporation, developed a model known as Wireless Whiskers that can determine that if a pet reaches its available allowance, the AutoDietTM SMART feeder doors will immediately shut. Similarly, if a locked-out pet tries to feed, the feeder will shut them out. In a multi-pet household, you can set up different AutoDietTM SMART feeders for different animals depending on their food type.

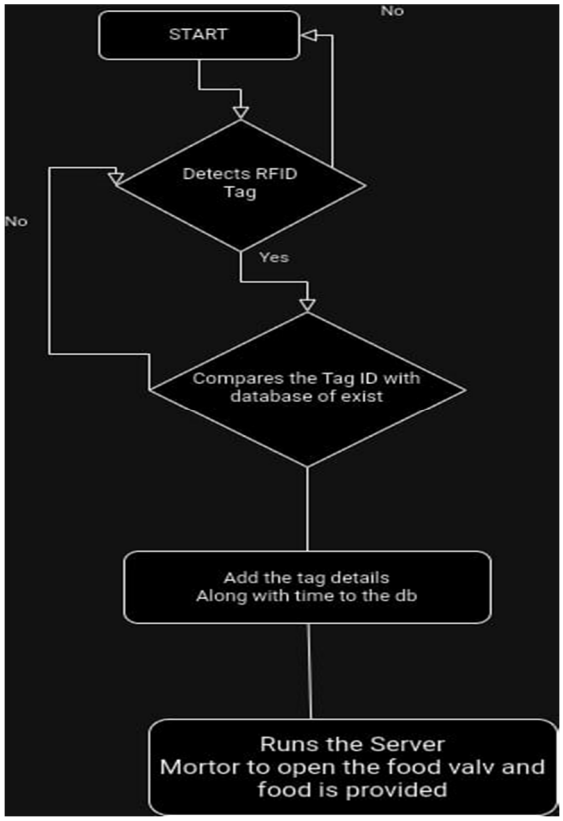
III. METHODOLOGY

This project possessed two inputs which is RFID tags and real time clock (RTC), a microcontroller using Arduino Uno and a servo motor as output. Similar to radar and sonar, RFID transmitter are used to analyse targets by evaluating reflected signals from the RFID tags which is connected in the collar of the pet. The distance of an object can be known by measuring the duration between transmitting a signal and getting an echo. In this project RTC is utilized to keeps track of the current time notifying Arduino on the feeding time. RTCs is chosen because it features a backup power source, which allows to keep track of time even if the primary power source fails or is unavailable. The alternate source of power for RTC is using a lithium battery.

The microcontroller which is Arduino Uno is an open-source microcontroller board used in this developed system. Arduino board is known equipped with sets of digital and analog input or output pins interface. Finally, the servomotor acts as an output, allowing the food grain to flow from the container into the bowl. It is a rotary or linear actuator that can control angular or linear position, velocity, and acceleration precisely. The server motor will open for a specified time which is encoded in the Aurdino code.Once the time limit reaches, the servo motor will slide back to initial position stopping the food flows. Figure 1 shows the block diagram of the project

Fig.1 Block Diagram for automatic pet feeder

In the proposed system, a fixed time is scheduled for feeding time, when the scheduled feeding time is reached, an audible beep indicates that the dog will approach if it will approach a trap fed and the system is designed to recognize an RFID tag associated with a specific dog. Once the RFID is detected, the servo motor is momentarily activated, allowing food to flow into the pet's bowl. Importantly, the servo motor works uniquely for each dog, responding only to the specific RFID number associated with that particular pet. This absolutely ensures that the pet receives the prescribed diet. The combination of scheduled feeding times, audio signals, RFID detection and individual servo motor feedback helps achieve a customized and efficient pet feeding system.



In conclusion, the process of developing an automated pet feeding system using RFID technology shows a comprehensive and user-centred approach. Combining RFID tags for accurate pet identification with a real-time clock (RTC) for programmed feeding provides a strong foundation for automated pet care. Servo motor control ensures precise feeding and control, promotes portion control, and improves overall pet health.

S. NO.	TITLE	AUTHORNAME	TOOLS / TECHNOLOGIES USED	ADVANTAGE	DISADVANTAGE
1.	Arduino Mega based PET Feeding Automation	B. Ravi Babu , P. Pavan Kumar , Dr. P. G. Kuppusam.	Arduino IDE Software Arduino Board (Node MCU)	-Timely and Controlled Feeding -Customizable Feeding Schedule -Internet Connectivity	Power Dependency Complexity for Some Users
2.	Pet food dispenser design using Raspberry Pi	Delgado Villanueva, Alexi, and Hilary Nicole Vargas Alcantara.	Ultrasonic Sensor Technology Real-Time Clock (RTC) Technology Arduino Uno Microcontroller Technology	Backup Power for Timekeeping	Potential for Mechanical Failure Sensitivity of Ultrasonic Sensor Cost

				Flexible Feeding Times	
3.	Automatic Cat Feeder And Location Tracker	Nur Izzatul Nadia Binti M Razif, Nadilah Binti Mohd Ralim	Ultrasonic Sensor Technology Arduino Uno Microcontroller Technology Servo Motor Technology Blynk Application for Mobile Interface Node MCU ESP8266 for Wi-Fi Connectivity	Real-Time Cat Tracking with GPS Collar	Dependency on Power and Connectivity Complex Circuit Construction Regular Maintenance Requirements Limited Food Release Options with Servo Motor
4.	Programmable Pet Feeder	Gelila Berhan, T., Ahemed, W. T., & Birhan, T. Z.	Stepper Motor IR Sensor GSM Module	Convenience Scheduled Feeding	Dependency on Power
5.	Seungcheon Kim.	Smart Pet Care System Using Internet of Things.	GPS, GSM, ARM7 Microcontroller	Remote Monitoring: Automated Feeding: Wireless Control: IoT Technology:	Initial Cost: Limited Device Availability: Dependency on Connectivity:

IV. 5 STAGES OF DESIGN THINKING

A. Stage - 1 : Empathize

In the empathy phase of automating pet feeding devices using RFID technology, we immerse ourselves in the world of pet owners in order to gain deeper insight into their experiences and challenges. We try to understand the daily struggles and aspirations of pet owners who sympathise, expressing possible pain points such as stress associated with managing multiple pets or concerns about how accurate a feeding schedule is.

In this stage, we aim to capture the subtleties of pet behaviours, considering factors such as food preferences, food restrictions, individual eating patterns, etc. The openness of emotional connections between pets and owners' private needs and desires is explored, paving the way for a more holistic approach to the later concept of design. Also, Persona (Fig 3), Empathy map (Fig 4) and Journey map (Fig 5) was designed for the empathize stage.

B. Stage - 2 : Define

From the Empathize stage, the problem statement can be defined. Problem Statement: "The most prevalent problem that pet owners are facing is feeding. Certain pet owners have a very hectic daily routine at work, so the pet is left alone for a day or days while the owner attends to other activities, training, or business concerns. As a result, the automatic cat feeder was created to help the pet to always be fed without the owner's presence. "

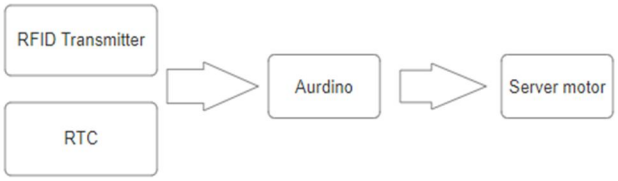
C. Stage – 3 : Ideate

In the ideation phase of developing automated pet feeder using RFID technology, the focus is on developing different solutions to solve the identified challenges. We participate in brainstorming sessions with stakeholders, encouraging open and innovative thinking. Ideas flow freely as our team explores potential improvements in RFID technology, feeding techniques, and deployment methods.This stage embraces the "any idea is too little or too ambitious" mentality, creating a collaborative environment where unconventional solutions are encouraged. Ideas such as integrating additional sensors for real-time health monitoring or adding gaming features to engage pets while they eat can be considered. The ideation phase is important to explore more possibilities and pave the way for the preparation of unique, effective, user-centred solutions in the next phase of the design process.

D. Stage – 4 : Prototype

In the prototype phase of developing an automated pet feeder with RFID technology, the focus shifts from ideation to creating tangible representations of the proposed solutions. Designers transform selected ideas into physical or digital prototypes, allowing for practical testing and iteration. The prototype encompasses key elements such as RFID integration, servo motor control, and the overall physical structure of the feeder. The integration of the Real-Time Clock (RTC) system and servo motor control mechanisms is simulated to ensure precise and timely feeding responses according to the programmed schedule. Physical prototypes may include the actual feeder structure, taking into account factors such as material durability, ease of cleaning, and pet safety.

The block diagram for our project is given below,



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E. Stage – 5 : Test

Testing during the prototype phase is crucial for validating the feasibility and functionality of the proposed design.

This iterative process helps us to to identify potential challenges and areas for improvement. Feedback from initial testing guides adjustments to enhance the overall performance, accuracy, and user experience of the automated pet feeder.

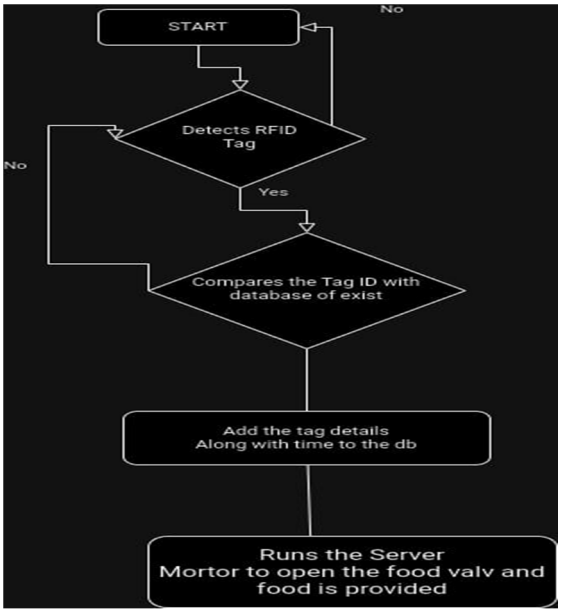

Fig.2,Hardware-flow

Fig 3. Persona

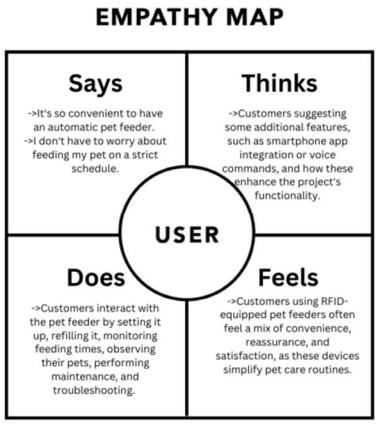

Fig 4.Empathy map

Fig 5. Journey Map

V. CONCLUSION

In summation, the process of developing an automated pet feeder that relies on RFID technology has gone through a thorough design considering approach, dealing with the multifaceted challenges correlated with exact and tailored pet feeding. Starting with the empathy stage, we acquired precious knowledge into the regular habits and specifications of pet proprietors, comprehending the close bond between pets and their partners. Through this methodology, the automated pet feeder emerges as a sophisticated solution, balancing convenience for pet owners with the health and happiness of their beloved pets

VI. FUTURE SCOPE

The future scope of the automated pet feeder utilising RFID technology is set for significant expansion and improvement. As technology advances, the incorporation of intelligent connectivity is a natural progression, allowing pet owners to remotely track and manage the feeding process through mobile applications or voice-activated assistants. By employing machine learning algorithms, there is an opportunity to analyse the eating patterns, preferences, and health information of pets, offering personalised insights and recommendations. Expanding the capabilities of the system to accommodate households with multiple pets requires the advancement of RFID algorithms for accurate identification and customised feeding.

Additionally, environmental sensors could be integrated to monitor factors such as temperature and humidity, guaranteeing optimal conditions for storing pet food. Collaborations with veterinarians could result in the creation of a feeder that dispenses tailored diets based on the individual health requirements of each pet. Moreover, the integration of voice recognition technology and wearable devices could contribute to a more interactive and enjoyable feeding experience. Automatic food replenishment services and improved security features would add to the overall convenience and well-being of both pets and their owners. This forward-thinking approach positions the automated pet feeder as a sophisticated and comprehensive solution in the ever-evolving world of intelligent pet care.

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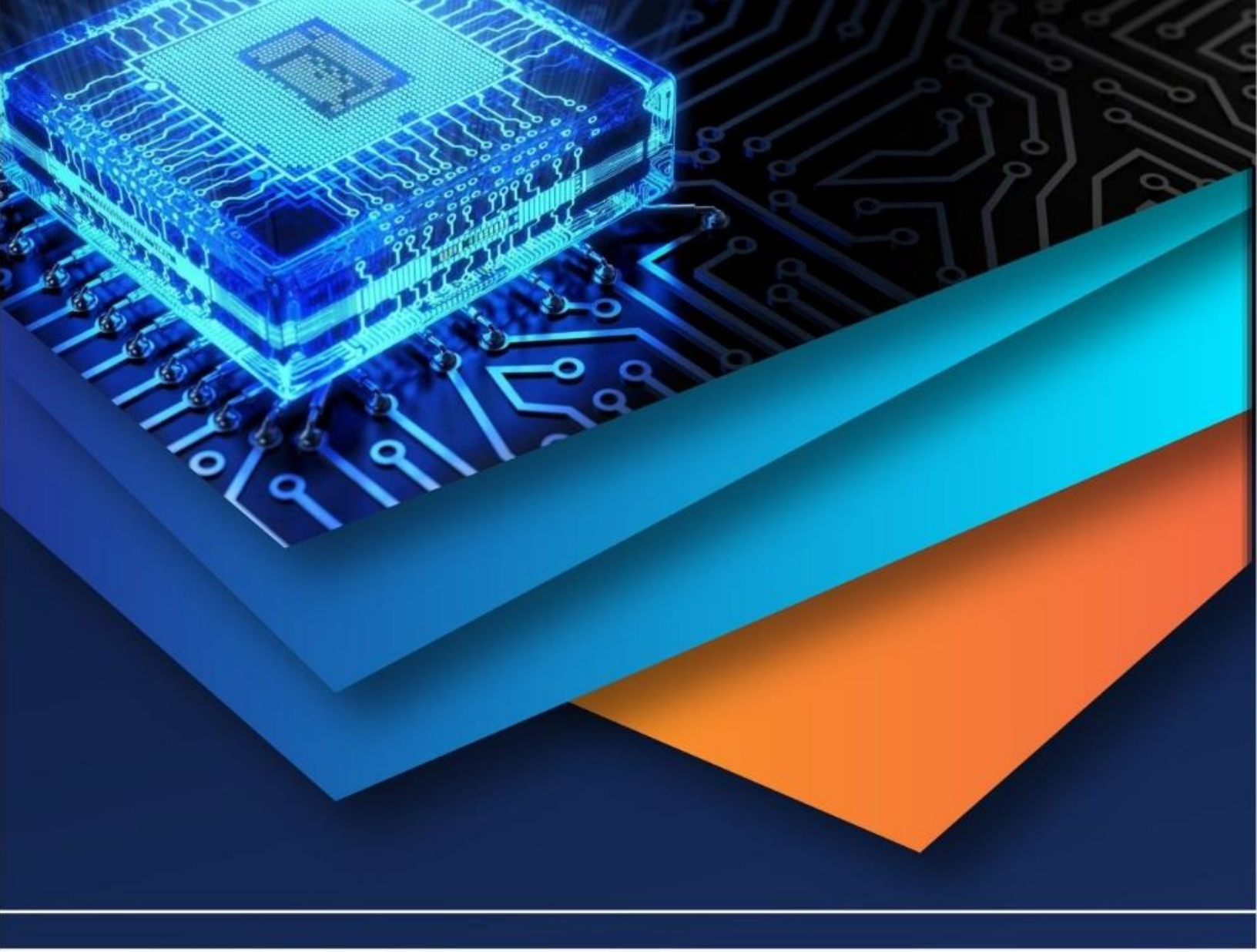

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