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Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control

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Abstract: ***The smart two-wheeler stand automation system based on arduino with key-operated control is an innovative project designed to enhance safety, convenience, and automation in modern motorcycles. the system eliminates the need for manually handling the side stand by using a servo motor controlled through an arduino microcontroller. the stand automatically lifts or lowers based on user input via a key-operated switch, ensuring proper operation before the vehicle starts. this prevents common accidents caused by riders forgetting to retract the stand while riding. a 12v battery powers the system, providing reliable performance with minimal power consumption. this project demonstrates the integration of simple electronics and automation to improve vehicle safety and user comfort. the proposed system is cost-effective, user-friendly, and can be easily implemented in existing two-wheelers, making it a practical solution for everyday use.***

I. INTRODUCTION

In recent years, the demand for automation in vehicles has increased significantly due to the need for safety, comfort, and convenience. two-wheelers, being one of the most common modes of personal transportation, often face issues related to manual stand operation, which can lead to accidents or vehicle imbalance when the rider forgets to lower or raise the stand. to overcome these challenges, the smart two-wheeler stand automation system has been developed using arduino technology integrated with a key-operated control mechanism.

This system aims to automate the operation of a bike's stand by detecting the ignition key status and controlling the stand position accordingly. when the rider inserts or turns the key, the stand automatically folds up; similarly, when the ignition is turned off, the stand extends for parking stability. the system utilizes components such as an arduino uno microcontroller, servo motor, power supply, and sensors to perform precise and reliable stand movements.

By implementing this smart automation, the project enhances rider safety, prevents damage to the bike, and reduces human effort. moreover, the design is cost-effective, user-friendly, and can be easily installed on any two-wheeler without major modification. this innovative approach contributes to the modernization of conventional two-wheelers and promotes the concept of intelligent vehicle systems for safer transportation.

A. Background

In today's world, technology plays a major role in improving comfort, convenience, and safety in our daily lives. Two-wheeler vehicles are among the most common modes of transport, but their manual side stands often lead to accidents if the rider forgets to lift the stand before riding. Many accidents and damages occur due to this small but common human error. To overcome this problem, an automated system can be designed to control the movement of the stand using an Arduino microcontroller and a servo motor. This smart automation system not only ensures safety but also enhances the overall riding experience by introducing modern technology into everyday vehicles.

B. Problem Statement

Most two-wheeler riders forget to lift the side stand after parking, which can cause serious accidents or damage to the vehicle. Existing systems require manual effort and provide no alert or automatic control for the stand. Therefore, there is a need for a smart and reliable automatic stand system that can be operated using a key-based control mechanism to ensure both safety and convenience for the rider.

Total number of Accidents and Fatalities during 2018 to 2022

C. Objective of the Project

The main objective of this project is to design and develop an arduino-based automatic stand control system for two-wheelers that operates through a key switch.

Specific objectives include:

1) To automate the lifting and lowering of the two-wheeler stand using a servo motor.
2) To integrate a key-operated control system for easy and secure operation.
3) To enhance rider safety by preventing accidents caused by unlifted stands.
4) To develop a cost-effective and user-friendly system suitable for general use in two-wheelers.

D. Scope of the Project

This project focuses on developing an automatic side stand system for two-wheelers using arduino technology. the system can be implemented in bikes and scooters of various models with minor modifications. it aims to increase safety, reduce manual effort, and introduce automation into conventional vehicle systems. in the future, this concept can be further expanded with additional safety features such as ignition interlocking, sensor-based detection, and mobile app integration for smart vehicle management.

II. LITERATURE OVERVIEW / EXISTING SYSTEM

In the existing system, most two-wheelers use a manual side or center stand that the rider must operate physically every time the vehicle is parked. This manual operation often leads to inconvenience, especially when the rider forgets to lift the stand before starting the vehicle. Such negligence can cause accidents, damage to vehicle parts, or fuel wastage due to imbalance during movement.

Some vehicles use mechanical sensors or switches to indicate whether the stand is engaged, but these systems are limited to providing only a warning indication rather than automatic control. Moreover, they require additional wiring and are not fully automated.

In recent years, a few research works have introduced Arduino-based automation systems for vehicle safety and smart operation. However, most of these designs lack security features and do not provide key-operated control, which ensures that only the authorized user can activate or deactivate the system.

Therefore, the existing system still depends on manual effort and limited safety mechanisms, creating a need for a fully automated, reliable, and user-friendly solution that enhances both safety and convenience in daily two-wheeler usage.

A. Manual Side Stand Mechanism

The manual side stand is a simple mechanical device used to support a two-wheeler when it is parked. It is usually located on the left side of the vehicle and operated by the rider's foot. The stand is connected to the bike's chassis through a spring-loaded pivot mechanism. When the rider pushes the stand down with their foot, it swings outward and touches the ground, allowing the bike to rest at an inclined angle. The spring mechanism helps the stand return to its original position when it is pushed upward. This ensures that the stand stays securely folded while the bike is in motion. However, in manual systems, the rider must remember to lift the side stand before riding; failure to do so can lead to accidents or instability during movement. Although the manual side stand is simple, reliable, and low-cost, it lacks automation and safety features. To overcome these limitations, modern designs such as the Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control aim to replace the traditional manual mechanism with an automatic, sensor-based system that enhances rider safety and convenience.

III. PROPOSED SYSTEM

The proposed system is a Smart Two-Wheeler Stand Automation System that operates using an Arduino microcontroller and a key-operated control mechanism. The system is designed to automatically deploy or retract the two-wheeler stand based on the user's input through the key switch. This automation eliminates the need for manual operation of the stand, improving convenience and safety for the rider.

When the key switch is turned on, the Arduino receives the signal and activates a servo motor, which moves the stand to the desired position—either up for parking or down for riding. The system ensures that the two-wheeler remains stable while parked and prevents accidental retraction during use.

Overall, this system provides a reliable, efficient, and user-friendly solution for two-wheeler parking and enhances the safety of riders by automating a task that is typically manual.

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A. Overview of the Proposed Design

The proposed system is designed to automate the operation of a two-wheeler stand using Arduino and a key-operated control mechanism. The main objective is to provide a convenient, safe, and reliable method to deploy and retract the stand without manual effort. The system uses an Arduino microcontroller as the central control unit, which receives input signals from a key-operated switch to control a servo motor. The servo motor is responsible for lifting and lowering the stand automatically.

When the key is turned to the "ON" position, the Arduino activates the servo motor, which raises the two-wheeler stand to a secure parking position. Conversely, when the key is turned to the "OFF" position, the servo motor retracts the stand, allowing the vehicle to move freely. This automated mechanism reduces the risk of improper stand handling, ensures safety, and improves user convenience. The system is powered by a 12V battery, making it suitable for use with standard two-wheelers.

Overall, this design integrates simple hardware components with intelligent control logic to create an efficient, user-friendly, and practical solution for modern two-wheeler parking automation.

B. Advantages of the Proposed System

The proposed Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control offers several significant advantages over conventional bike stands:

1) Enhanced Safety: The key-operated control ensures that the bike stand can only be deployed or retracted by the authorized user, reducing the risk of theft or accidental misuse.
2) User Convenience: The automated operation eliminates the need for manual effort in lifting or lowering the stand, making it easier for riders of all ages to park their vehicles comfortably.
3) Time-Saving: The quick and efficient deployment of the stand reduces the time required for parking, especially in busy areas.
4) Durability and Reliability: The use of an Arduino-based control system ensures consistent performance, reducing mechanical wear and tear compared to manual stands.
5) Compact and Space-Efficient Design: The system is designed to occupy minimal space, allowing smooth parking even in tight areas.
6) Energy Efficiency: The system consumes very low electrical power while operating, making it cost-effective and environmentally friendly.
7) Integration Capability: The Arduino-based design allows future upgrades, such as adding sensors for obstacle detection or integration with smartphone applications.

IV. BLOCK DIAGRAM

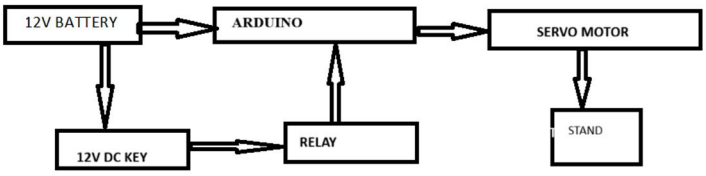

Fig.4.1.1 Block Diagram of Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control

A. Description of the Block Diagram

1) Key Switch: The key switch acts as the primary control for the system. When the key is turned ON, it sends a signal to the Arduino, initiating the automatic operation of the two-wheeler stand. This provides secure activation, ensuring the system operates only when authorized.
2) Arduino Uno: The Arduino Uno is the central controller of the system. It receives input signals from the key switch and sensors, processes them, and sends appropriate control signals to the servo motor. It ensures smooth and accurate operation of the stand.
3) ServoMotorMG995: The servo motor is responsible for the mechanical movement of the two-wheeler stand. Upon receiving a signal from the Arduino, it rotates to deploy or retract the stand automatically. The MG995 is used for its high torque and precise control, suitable for supporting a two-wheeler.

4) Limit Switch/Sensors: Limit switches or sensors are used to detect the position of the stand. They provide feedback to the Arduino, indicating whether the stand 5is fully deployed or retracted. This prevents over-rotation and protects both the motor and the stand from damage.

5) 12VBattery:The battery serves as the main power source for the Arduino and the servo motor. A regulated supply ensures stable operation of the electronics, while sufficient voltage is provided to drive the servo motor effectively.

V. CIRCUIT DIAGRAM AND WORKING

A. *Circuit Diagram*

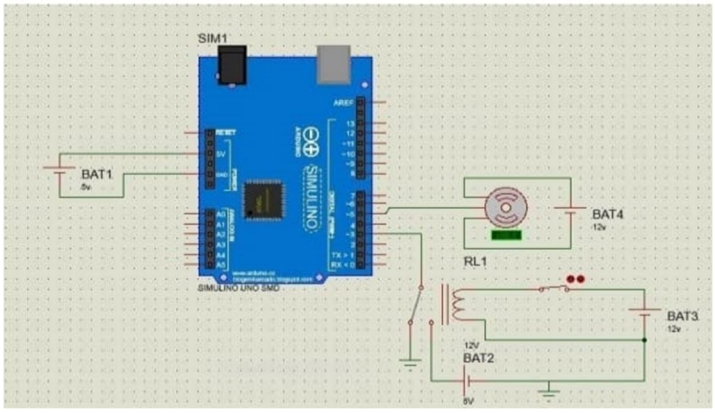

Fig.5.1.1. Schematic Diagram of Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control

Initially motor stand at 0degree position (down side verticle)
When we slightly rotor the key to the right side, relay coil get excited and common pin 5V connect to the normally open pin through that 5V given to input Pin of the controller.
This 5v input signal given to output pin of the controller to generate servo pulse and motor will go to exactly 90degree position.
When key rotate to the original position the motor or stand come back to 0 degree and relay common point connect back to normally close pin.

VI. WORKING PRINCIPLE

The Smart Two-Wheeler Stand Automation System operates on a simple yet efficient principle using Arduino and a key-operated mechanism. In this system, the two-wheeler stand is controlled electronically rather than manually. When the key switch is turned on, the Arduino receives the signal and activates a servo motor or actuator connected to the stand. This mechanism automatically raises or lowers the stand based on the user's input.

The key-operated control ensures that the stand operates only when authorized, providing safety and preventing accidental movement. Sensors can also be integrated to detect the position of the vehicle, ensuring the stand operates smoothly and prevents any imbalance. Overall, this system reduces physical effort, improves safety, and adds convenience for two-wheeler users.

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VII. HARDWARE COMPONENTS USED

A. *Arduino*

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/output pins (I/O), shields, and other circuits.

The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

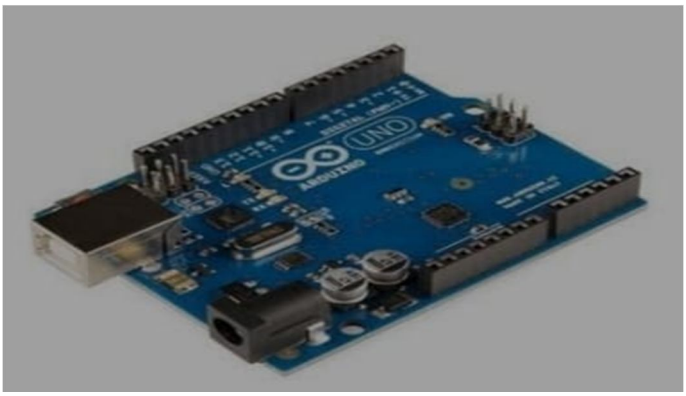

Fig7.1.1:- Arduino uno

ATmega328 Microcontroller- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.

Specification:-
ICSP pin - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.
Power LED Indicator- The ON status of LED shows the power is activated. When the power is OFF, the LED will not light up
Digital I/O pins- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.
TX and RX LED's- The successful flow of data is represented by the lighting of these
LED's. AREF- The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply. Reset button- It is used to add a Reset button to the connection
USB- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.
Crystal Oscillator- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.
Voltage Regulator- The voltage regulator converts the input voltage to
5VGND- Ground pins. The ground pin acts as a pin with zero voltage
Vin- It is the input voltage
Analog Pins- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

B. Servo Motor MG995

The unit comes complete with color coded 30cm wire leads with a 3 X 1 pin 0.1" Pitch type female header connector that matches most receivers, including Futaba, JR, GWS, Cirrus, Blue Bird, Blue Arrow, Corona, Berg, Spektrum and Hitec.
This high-speed servo actuator is not code dependant; You can use any servo code, hardware or library to control them. The MG995 Actuator includes arms and hardware to get started.Challenges and Future Enhancements

FIG NO 7.2.1:-Servo motor MG995

Specifications :-

•Weight: 55 g
•Dimension: 40.7 x 19.7 x 42.9 mm approx.
•Stall torque: 8.5 kg f ·cm (4.8 V), 10 kg f· cm (6 V)
•Operating speed: 0.2 s/60º (4.8 V), 0.16 s/60º (6 V)
•Operating voltage: 4.8 V to 7.2 V
•Dead band width: 5 µs
•Stable and shock proof double ball bearing design
•Temperature range: 0 ºC – 55 ºC31150-MP
•Rotation Angle: 120deg. (+- 60 from center)

C. 12V Battery

A 12-volt battery gets your engine going and helps keep it running. Its main role is to start the car. When you push the ignition button or turn the ignition key, the electricity stored in the battery zaps the starter motor into motion. This explains why you can't start a car with a weak or dead battery.

FIG NO7.3.1:- LI-ION Battery Set

When key rotate to the original position the motor or stand come back to 0 degree and relay common point connect back to normally close pin.

VIII. SOFTWARE REQUIREMENTS

The software requirements for this project include the necessary tools and programming environment used to develop, compile, and upload the control program to the Arduino microcontroller. The system is programmed to automate the movement of the stand based on key-operated input signals. The software ensures smooth operation, proper synchronization between components, and error-free control of the servo motor.

1) Arduino IDE (Integrated Development Environment): The Arduino IDE is used for writing, compiling, and uploading the source code to the Arduino Uno microcontroller. It provides a simple and user-friendly interface for program development using embedded C or Arduino programming language.
2) Embedded C Programming Language: The system logic and control operations are written in Embedded C, which allows efficient hardware interaction and control of the servo motor and key-operated input.
3) Proteus or Tinkercad (Simulation Software) [Optional]: Simulation tools like Proteus or Tinkercad can be used to test and verify the circuit connections and program logic virtually before implementing the hardware.
4) Driver Software (for Arduino USB Interface): Required for establishing communication between the Arduino board and the computer during code uploading and serial monitoring.

IX. ADVANTAGES

1) Ease of Use: The system allows effortless operation of the two-wheeler stand, reducing manual effort
2) Time-Saving: Quick deployment and retraction of the stand save time for riders.
3) Enhanced Safety: Prevents accidental tipping or improper parking of the vehicle.
4) Durability: Reduces wear and tear caused by manual handling of the stand.

5) User-Friendly: Simple key-operated control makes it accessible for all users.
6) Automation: Minimizes human error and ensures the stand is properly engaged every time.
7) Compact Design: Integrates easily with most two-wheeler models without major modifications.

X. APPLICATIONS

1) Personal Two-Wheelers: Can be installed on motorcycles and scooters for everyday use.
2) Vehicle Rental Services: Enhances safety and convenience for rental bikes.
3) Parking Lots: Helps in organized parking and reduces accidents due to improperly parked vehicles.
4) Fleet Management: Useful for delivery or courier services to ensure all vehicles are securely parked.
5) Two-Wheeler Manufacturing: Can be integrated into new models for enhanced automation features.
6) Public Transportation Hubs: Ensures quick and safe parking for users in bus stations or metro areas.

XI. CONCLUSION

The "Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control" successfully demonstrates an efficient, reliable, and user-friendly solution for automating two-wheeler stands. The system enhances safety by preventing accidental tipping and reduces manual effort, making it convenient for everyday use. By integrating Arduino-based control with a key-operated mechanism, the project ensures precise operation and security. This automation approach not only simplifies the parking process but also showcases the practical application of electronics and microcontroller technology in improving daily life. Overall, the project meets its objectives and provides a foundation for further enhancements, such as incorporating wireless control or advanced sensors for smarter functionality.

XII. FUTURE SCOPE

The Smart Two-Wheeler Stand Automation System Based on Arduino with Key-Operated Control has significant potential for future development and improvements. This system can be enhanced to include advanced automation and safety features, making it more convenient and user-friendly. In the future, the system can be integrated with IoT technology, allowing remote control and monitoring through smartphones.

Additionally, sensors could be upgraded to detect obstacles or vehicle stability automatically, ensuring safer usage. Solar-powered or energy-efficient designs can be implemented to make the system environmentally friendly. This technology can also be adapted for other types of vehicles, such as electric scooters or bicycles, expanding its usability. Overall, the system has the potential to improve parking convenience, reduce accidents, and contribute to smart vehicle management in urban areas.

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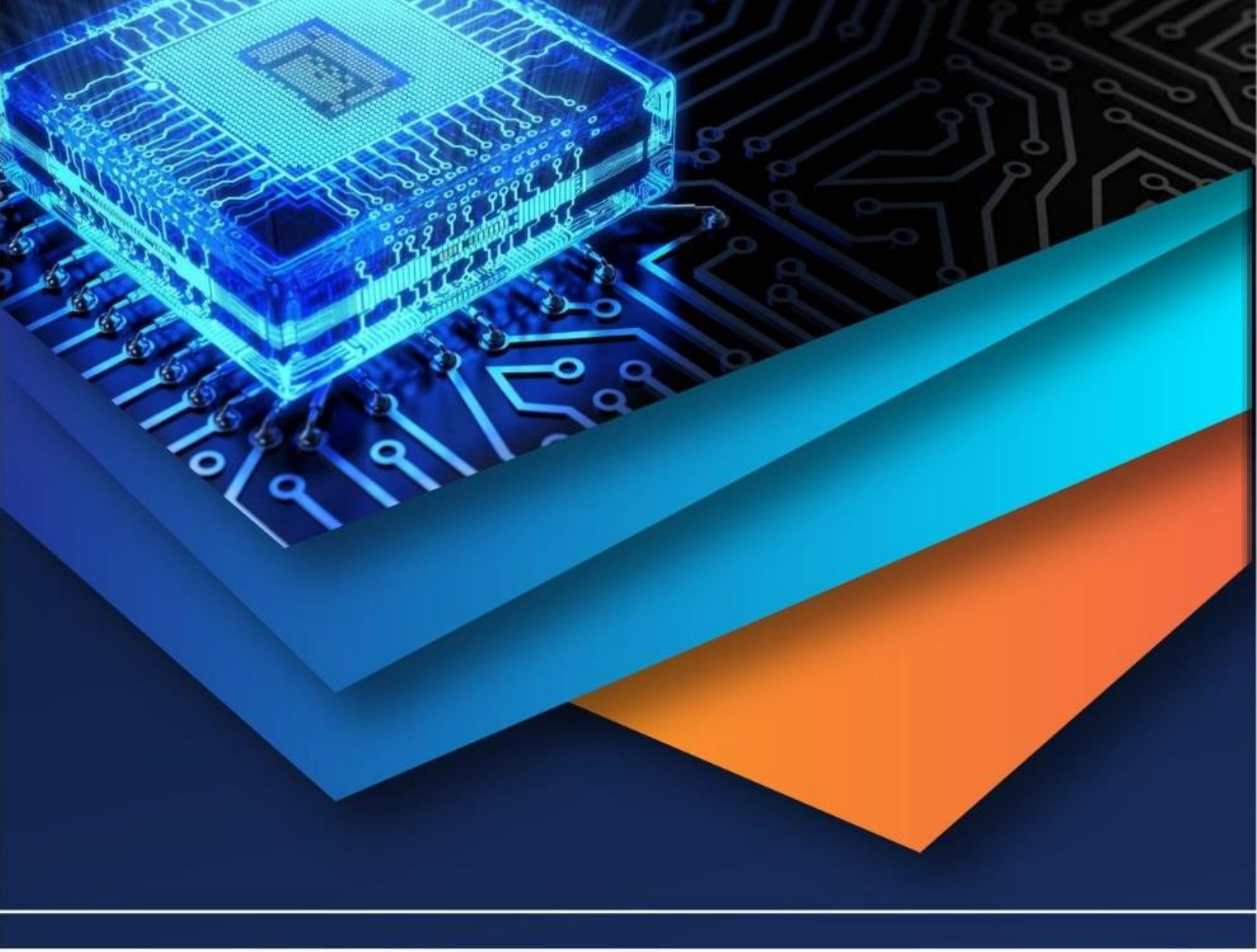

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