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Asset Tracking and Management System

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Abstract: ***This abstract presents an overview of an IoT-based asset tracking and management system. The system utilizes Internet of Things (IoT) technologies to enable real-time monitoring and tracking of assets in diverse industries. Today, the growth of technology is rapid and provides all necessary and effective solutions for their requirements. One of the most important areas of concern is security. In this scenario, IoT asset tracking is developed to increase the safety of any valuable items. The Internet of Things technology (IoT) can track and monitor an asset in the outdoor and indoor environment. This empowers business and end-users with the information and opportunity to run their operations effectively and make educated decisions respectively.***

The management of assets is a critical process for businesses to ensure that they are operating effectively. The system provides organizations with valuable insights into the location and utilization of their assets. It highlights the advantages of adopting this technology such as improved asset visibility and enhanced security. Furthermore, the abstract explores potential applications of IoT-based asset tracking in sectors such as logistics, transportation, and inventory management. Overall, this abstract demonstrates the significance of IoT in revolutionizing asset tracking and management processes ultimately leading to cost savings.

Keywords: Asset tracking, GPS, GSM

I. INTRODUCTION

In today's rapidly evolving technological landscape, the Internet of Things (IoT) has emerged as a powerful paradigm, revolutionizing numerous industries and transforming the way we interact with the physical world. One significant area where IoT has shown immense potential is asset tracking and management. Traditional asset tracking systems often suffer from inefficiencies, limited real-time visibility, and inadequate security measures. However, the integration of IoT technology provides an innovative and comprehensive solution to these challenges.

The working of IoT-based asset tracking involves a combination of interconnected devices, sensors, communication protocols, and cloud-based platforms. The typical steps involved in the process are Asset Tagging , Data Collection , Sensor Communication , Data Aggregation , Cloud-based Processing , Real-time Monitoring and Alerts

II. RELATED WORK

The type of asset tracking used is based on RFID[1] (Radio Frequency Identification). Using paperwork in the process of dispatch and return might have several disadvantages such as dislocations, delay in updates and there is no guarantee that it would be error free.

Therefore, RFID based asset tracking came into picture. It uses RFID tag and RFID reader. Spartan company manufactured around 25,000 tags for testing and only 5 were failed. Phalanx is a software platform that uses Oracle database to manage and has 2 components (mobile device and server-based software). This software has data synchronization that supports fast feedback and update from systems and can easily switch to suitable quality of channel network.

The main problem is tag selection. Selecting right tag keeping considerations such as cost and appropriate technology is mandatory. The asset to be tracked is equipped with an RFID tag. RFID readers emit radio frequency signals and capture information transmitted by RFID tags.

The development and deployment of a real-time asset tracking system based on Wi-Fi technology in a hospital clinic setting. The system uses small Wi-Fi tags attached to mobile assets, such as medical devices and personnel, to track their location within the clinic. The system utilizes radio signals from wireless access points to estimate the location of the tagged assets with a resolution of within 1.5 meters.

The paper highlights the challenges in accurately tracking mobile assets in a dynamic medical environment and the potential benefits of wireless networking technology in addressing these challenges. It mentions that existing wireless tracking technologies, such as wireless sensors and RFID, often require costly dedicated network infrastructure, while a Wi-Fi-based system can leverage existing hospital 802.11 WLAN infrastructures, making it a cost-effective solution for asset tracking in healthcare environments.

The deployed system includes a web-based graphical interface and a data management system that allow for tracking and reporting the status of assets. It also provides alerts when an asset moves out of a designated area. Detailed logs of asset tracking information are available for archival purposes. The paper briefly surveys related works in indoor positioning systems, including trilateration, multilateralism , and location learning techniques. It discusses the application of these techniques in WLAN-based systems, wireless sensor-based systems, ultra-wideband (UWB) systems, and RFID-based systems. Overall, the deployment of the Wi-Fi-based asset tracking system in the hospital clinic environment demonstrates the feasibility and benefits of using Wi-Fi technology for real-time asset tracking in dynamic medical environments.

Advantages and disadvantages: The Wi-Fi based real-time asset tracking system offers several advantages for asset visibility in healthcare environments. Firstly, it is a cost-effective solution as it utilizes existing Wi-Fi infrastructure, eliminating the need for additional dedicated tracking networks. The system provides accurate location estimates with a resolution of within 1.5 meters, enabling precise tracking of assets and personnel. It offers real-time tracking capabilities, allowing for immediate updates on asset locations and reducing time wasted in searching. The system includes an alert system to notify users when assets move out of designated areas, preventing loss or theft. Detailed archival logs are available for retrospective analysis and compliance purposes.

However, there are also some disadvantages to consider. The system is dependent on the presence and coverage of Wi-Fi access points, which may limit accuracy and effectiveness in areas with limited or no Wi-Fi coverage. Signal interference from environmental factors and other devices can affect the accuracy of location estimation. The initial configuration and setup of the system, including the placement of access points, require expertise and effort. The system's coverage is limited to the range of Wi-Fi access points, and assets moving outside this range may not be accurately tracked. Privacy and security considerations need to be addressed to protect sensitive information and ensure data security.

Vehicle Tracking System (VTS) is a real time secured tracking system that displays the result on Google earth. It has a tracking module and display module. It consists of Microcontroller, XBee & GPS. Depending on location information, there are 2 types of tracking: Active & Passive tracking. Modern tracking systems use both combinations of tracking. The IEEE communication technologies operate in 2.4 GHz frequency with 250 kbps data rate over 16 channels. Transmission part has power supply, ceramic antenna (25 x 25mm with 9600 bps Baud rate), EEPROM, LED signal indicator. We get information as latitude, longitude, elevation & height. XBee module receives coordinates to PC and displays on Google Earth. The steps involved are as follows:

1) Analyze, design and install VTS.
2) Initialize power supply and code is dumped.
3) Arduino microcontroller processes the operations.
4) XBee monitors and receives information.
5) Tracked coordinates are displayed on Google earth.

In a ZigBee wireless network, there are primarily two types of tracking commonly used: device tracking and location tracking.

a) *Device Tracking:* Device tracking involves monitoring the presence, activity, and communication of individual devices within the ZigBee network. Each device in the network has a unique identifier, and the network coordinator or gateway keeps track of the devices and their status. This tracking can include monitoring device connectivity, signal strength, battery levels, and other operational parameters. Device tracking helps ensure the reliability and stability of the ZigBee network by identifying and managing device-specific issues.

b) *Location Tracking:* Location tracking focuses on determining the physical location of ZigBee devices within the network. This type of tracking is particularly useful in asset management, indoor positioning, and tracking applications. There are several methods to achieve location tracking in a ZigBee network:

- *Triangulation:* Triangulation involves using the signal strength measurements from multiple ZigBee devices to estimate the location of a target device. By analyzing the received signal strength indicators (RSSIs) from neighboring devices, the position of the target device can be approximated. Triangulation requires a network with a sufficient number of ZigBee devices to ensure accurate positioning.
- *Time of Flight (ToF):* Time of Flight is a technique that measures the time it takes for signals to travel between devices. By precisely measuring the time it takes for signals to reach different devices, it is possible to calculate the distance between devices. When combined with multiple devices, ToF can be used to determine the location of a ZigBee device.
- *Fingerprinting:* Fingerprinting involves creating a database of signal strength patterns and mapping them to specific locations within the environment. Each location is associated with a unique fingerprint of signal strengths from nearby ZigBee devices. By comparing the received signal strength patterns from the target device with the database, its location can be identified.

- *Anchors and Beacons:* In some ZigBee-based tracking systems, fixed anchor devices are strategically placed throughout the environment. These anchor devices emit periodic beacon signals with known locations. By measuring the signal strength and timing of these beacons, mobile devices within the ZigBee network can calculate their own position relative to the anchors.

A. Advantages and Disadvantages

1) Advantages of ZigBee Wireless Networks

a) Low Power Consumption: ZigBee operates on low-power wireless technology, enabling devices to have extended battery life. This makes it suitable for applications that require long-term, low-maintenance operation.

b) Cost-Effective: ZigBee technology is cost-effective and allows for the development of inexpensive wireless devices. The low-cost nature of ZigBee chips and modules makes it an attractive option for deploying large-scale wireless networks.

c) Mesh Networking: ZigBee networks utilize mesh networking, where devices can act as routers, relaying data between devices and extending the network's range. This self-forming and self-healing capability increases network reliability and coverage without the need for complex infrastructure.

d) Low Latency: ZigBee networks provide low latency communication, making them suitable for applications that require real-time or near-real-time data transmission, such as home automation, industrial control systems, and healthcare monitoring.

e) Interference Tolerance: ZigBee operates in the 2.4 GHz frequency band, which is also used by other wireless technologies such as Wi-Fi and Bluetooth. ZigBee incorporates mechanisms to mitigate interference from these technologies, ensuring reliable communication even in crowded wireless environments.

2) Disadvantages of ZigBee Wireless Networks

a) Limited Data Transfer Rate: ZigBee has a relatively low data transfer rate compared to other wireless technologies. It is designed for low-bandwidth applications that prioritize power efficiency and long battery life over high-speed data transmission. This limitation makes ZigBee less suitable for applications that require large data transfers, such as high-definition video streaming.

b) Limited Range: ZigBee networks typically have a limited range compared to other wireless technologies like Wi-Fi. The range can vary depending on environmental factors and the number of devices acting as routers within the network. In larger deployments, additional routers may be required to extend the network coverage.

c) Complex Network Setup: Setting up a ZigBee network can be more complex compared to other wireless technologies. Configuring devices, establishing network parameters, and ensuring proper device coordination require technical expertise and careful network planning.

d) Limited Device Compatibility: ZigBee devices may not be compatible with devices using other wireless protocols. Interoperability between ZigBee and other wireless technologies may require additional gateway devices or bridges, adding complexity to the system.

e) Security Considerations: Like any wireless network, ZigBee networks are susceptible to security risks such as unauthorized access, data breaches, and device tampering. Implementing robust security measures, such as encryption and authentication protocols, is crucial to safeguarding ZigBee networks and the data they transmit.

III. PROPOSED WORK

IoT-based asset tracking with Arduino, GSM modem, and GPS antenna enables real-time monitoring and location tracking of assets. The system uses Arduino as the central processor, GPS antenna for accurate location data, and GSM modem for communication. By integrating these components, the system tracks assets location information to a centralized platform, and offers features like geo-fencing and theft prevention. It enhances operational efficiency and security while providing valuable insights for effective asset management.

The GSM modem with SIM900A is a communication device that integrates the SIM900A module, enabling GSM (Global System for Mobile Communications) connectivity. It is commonly used in IoT projects, allowing devices to communicate over cellular networks. The SIM900A module supports quad-band GSM/GPRS frequencies, enabling communication in various regions. It can send and receive SMS messages, make voice calls, and establish TCP/IP connections for data transmission. The modem interfaces with microcontrollers like Arduino through serial communication, providing a wireless communication capabilities. It is widely utilized in applications such as remote monitoring, IoT-based solutions, home automation, and asset tracking, where cellular connectivity is crucial.

Arduino Uno is a popular microcontroller board widely used in electronics projects. It is based on the ATmega328P microcontroller, providing a user-friendly platform for prototyping and programming. Arduino Uno offers numerous digital and analog input/output pins, allowing connection to various sensors, actuators, and other electronic components.

It can be programmed using the Arduino IDE (Integrated Development Environment), which simplifies coding tasks. The board is powered via USB or an external power supply and can communicate with other devices using serial communication.

NEO-6M is a compact GPS (Global Positioning System) module commonly used in electronic projects. It features a built-in GPS antenna and uses the NEO-6M GPS chipset. The module receives signals from multiple GPS satellites to determine accurate position, velocity, and time information. It communicates with microcontrollers, such as Arduino, via serial communication, providing real-time GPS data. The NEO-6M module operates at low power and offers high sensitivity and fast time-to-first-fix performance. It is widely utilized in applications such as navigation systems, asset tracking, geolocation-based projects, and outdoor positioning.

The working of the components in an IoT-based asset tracking system using Arduino, GSM modem, and GPS antenna is as follows:

1) *Arduino:* The Arduino acts as the central processing unit of the system. It receives data from the GPS antenna and communicates with the GSM modem. The Arduino board is programmed to gather GPS data and process it for further actions.
2) *GPS Antenna:* The GPS antenna receives signals from satellites orbiting the Earth. These signals contain information about the asset's precise location, including latitude, longitude, and altitude. The GPS antenna forwards this data to the Arduino for processing. The 4 pins of the NEO 6M chip is TX, Rx, VCC, Gnd.
3) *GSM Modem:* The GSM modem facilitates communication between the asset tracking system and a remote server or a mobile device. It uses the cellular network to transmit data, such as GPS coordinates and other relevant information, in real time. The GSM modem can send SMS messages or establish a TCP/IP connection to transmit data.

The proposed system has many advantages like

a) Real-time visibility
b) Improved asset utilization
c) Enhanced operational efficiency
d) Theft prevention and recovery
e) Maintenance optimization
f) Supply chain optimization

Though there are challenges of privacy and security concerns and initial infrastructural development and implementation, the system working goes as the 5 Volt power supply to the GSM module is established after the connection of transmitter and receiver with the Arduino. The Arduino also specifies the input and output for NEO-6M. Once the Arduino IDE dumps the code into the board. The GSM modem has to show led glowing at DC power and status of the sim inserted must be active. A SMS is sent to the tracker's number which consists of the google map link as the sim pushes data into the cloud. The tracker can access the location by clicking on the provided link.

Working together, the GPS antenna provides accurate location information to the Arduino, which then utilizes the GSM modem to send this data to a centralized server or a mobile application. Users can access real-time asset tracking information, enabling them to monitor assets, track their movements, and take necessary actions based on the received data.

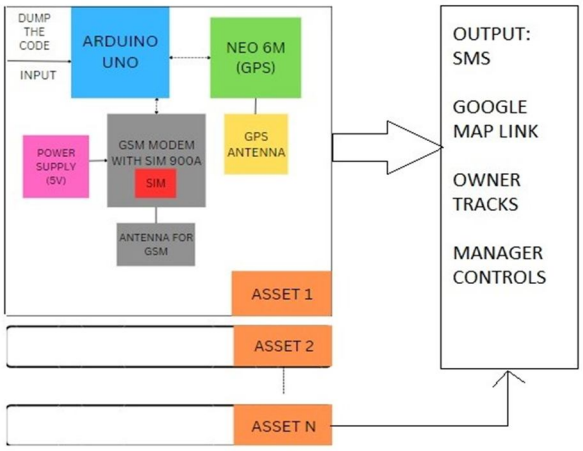

Fig.1. Block Diagram of Asset Tracking & Management system.

The above block diagram explains about the working and operation of Asset tracking and management system having the components like Arduino Uno, GSM Module, GPS Antenna.

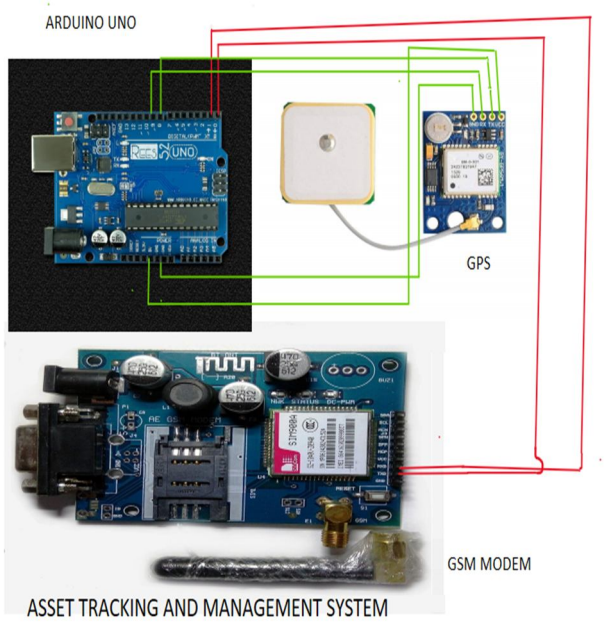

Fig.2. Asset Tracking & Management system

IV. RESULTS

Implementing an IoT asset tracking and management system enhances asset visibility, improves operational efficiency, optimizes asset utilization, enables proactive maintenance, and enhances security. It provides real-time and accurate tracking, streamlines workflows, and reduces manual efforts. The system also improves asset lifespan, minimizes downtime, and maximizes ROI through informed decision-making. Additionally, it enhances security with real-time tracking and geo-fencing capabilities, reducing the risk of asset loss or theft. With the power of IoT technology, organizations can unlock new levels of operational efficiency, cost savings, and improved decision-making, ultimately driving productivity and maximizing the value of their assets.

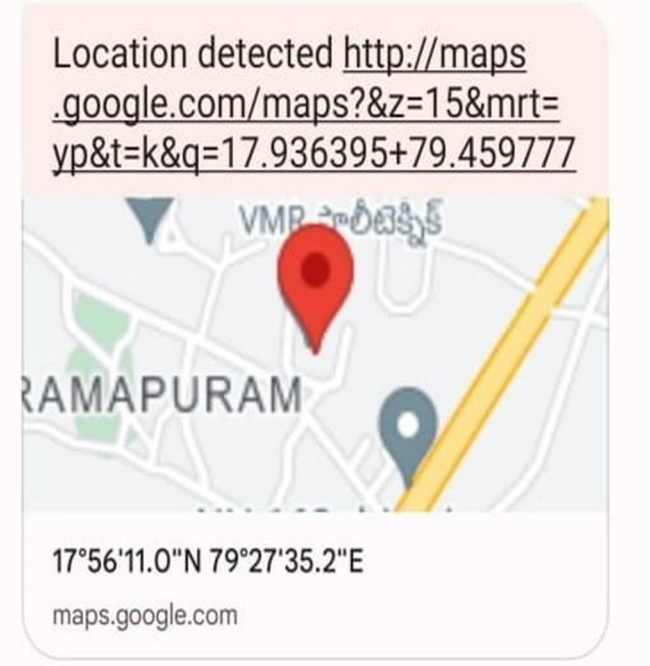

Fig.3. Google Map link sent via SMS.

Fig.4. Location detected via Google Maps.

V. CONCLUSION

In conclusion, the IoT-based asset tracking and management system utilizing Arduino, GSM modem, and GPS antenna offers numerous benefits for efficient asset monitoring and management. It provides real-time visibility into asset location, leading to improved utilization and operational efficiency. The system enables theft prevention, maintenance optimization, and supply chain optimization, while ensuring regulatory compliance. However, privacy and security concerns and initial infrastructure development and implementation challenges should be addressed. Overall, this system enhances asset tracking and management capabilities, empowering organizations with valuable insights for effective decision-making and streamlined operations.

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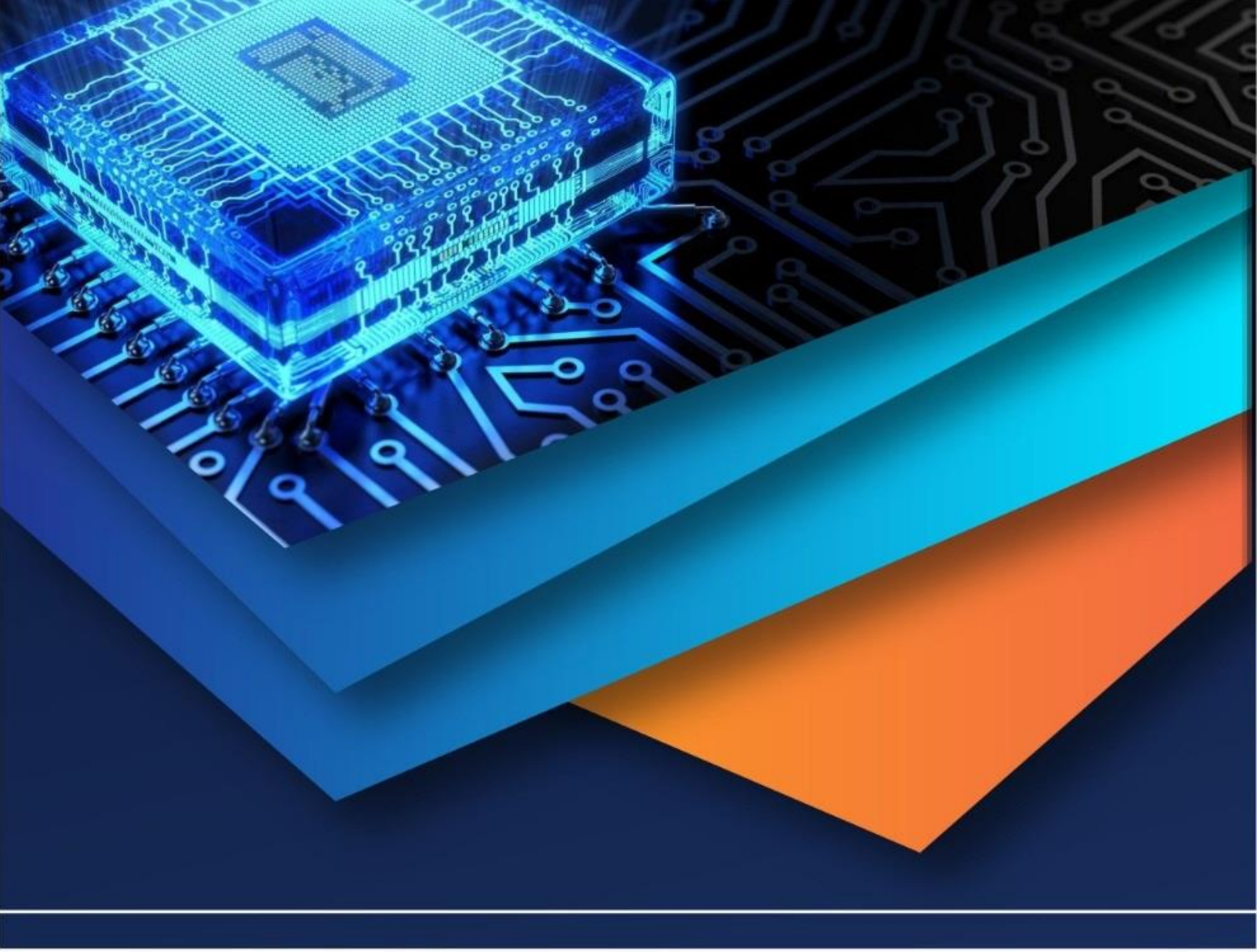

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