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An Application of Received Signal Strength Indicator in Sea Border Detection and Ship Tracking System

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Abstract: ***Fishermen plays an important role in the development of fisheries and aquaculture sector. Further they will contribute to the Indian economy. The challenges attributed to the day-to-day activities of the fishermen are many. The extensive among this many includes the difficulties faced by them when they are in dilemma about the borders in the sea. They are often arrested or killed by the navy and their boats are captured by the border coastal guards when this borderland scenario is breached. There are many existing technologies with GPS and GSM to help them. But most of the time they are inaccurate and inefficient. As a key solution to these problems the sea border detection and ship tracking system using RSSI is developed. The technology proliferation of RSSI is used to provide location-based positioning and time details in all climatic conditions and even anywhere at any time.***

Keywords: RSSI (Received Signal Strength Indicator), GPS (Global Positioning System), GSM (Global System for Mobile Communications)

I. INTRODUCTION

Fisheries and Aquaculture plays a pivotal role in the development of the Indian economy. The benefactories added by the fishermen in this is often neglected and the difficulties faced by them in the work closure are countless. And the one among the many includes the border negligence during their navigation. Composing a case study, the sea border between the island like Sri-Lanka and Peninsula like India is considered. This border is called the Palk Strait. Its maximum width is 82 km, its minimum width is 53 km and its total surface area is 2500km. Crossing this border is often a serious offence. The people living in the coastal areas of these countries purely depend on fishing to meet their daily needs. Due to pure negligence of the boundary limits, the fishermen usually cross the sea borders adding to their threat to life. Once they cross the border, they get arrested or killed by the relevant navy and they are abducted and their boats are captured by the coastal guard on the border safety duty. In such situations, the lives of fishermen continue to be difficult. It is a major threatening issue and leads to a loss in both humans as well as their economic income. Moreover, they are helpless when emergencies arise during food and water scarcity. As a solution to these problems, this method is proposed. This will continuously monitor, track, alert and control the fisherman's activity from the remote station located on the shore.

II. LITERATURE REVIEW

There are several techniques used for sea border detection. The variation in measured RSSI signals is one of the major effects leading to significant detection and tracking error**.** In [1], RSSI signal strength can be applied in various applications such as patient monitoring, intrusion detection and tracking, human tracking through walls and monitoring in emergency situations. In most of the cases humans to be tracked may not be carry any device with radio component due to its weight or due to the effect of the electromagnetic interference. For the device free human detection RSSI value can be widely used because most wireless devices have RSSI circuits built in them. So, no any additional hardware is required. This will reduce the hardware cost and the energy consumption of the system. From [2],[3],[4] it is found that the multipath fading and the change in environment plays the greatest role in affecting RSSI signals. In some cases, the RSSI value gets fluctuated due to multipath effects. To avoid this many filtering methods like average method and weighted moving average method can be used. For improving the localization accuracy, the RSSI signals are filtered using the median method. The RSSI signals are having different characteristics. The paper [5], proposes a system to define the sea border virtually using computer indication for marine vessels and fisherman ‘s boat which utilize GPS modules. There are many sensing elements and communication topologies to establish multilateral communication between land and the marine vessel. Here the final system contains two modules namely: Border Intrusion Detection System and Dot matrix communication system. Border Intrusion detection system contains the GPS module and it automatically track the distance between the border and the current location of the boat.

In [6], an Embedded technology which uses GSM, LPC2148 Arm Microcontroller and RFID (Radio Frequency Identification) was used for helping the fishermen in crossing borders. Here the boat is identified physically and the information about the persons who are in the boat are also contained in the RFID tags. GSM is used for transmission and reception of signals that contain information about fishermen to identify their location. Wireless Sensor Networks are being widely used in difficult applications. Zigbee is one of the most widely used transceivers standard in wireless network. In [7], the detailed study of Zigbee Wireless standard IEEE 802.15.4 specification, Zigbee device types, the protocol stack architecture and its applications are discussed. Zigbee devices can transmit data over long distances [8] by passing data through intermediate devices to reach more distant ones creating a mesh network. In [9],[11] the Zigbee is designed and implemented for long distance wireless Data transmission system. This is done based on CC2530 and CC2591.After doing this output power of Zigbee is increased to +22 dBm and the receiver sensitivity by 6 dB. The paper [12] describes about the design and development of long- range wireless communication system based on LoRa technology for Indonesian fishermen.

III. EXISTING METHOD

There are different technologies developed for helping the fishermen during their safe navigation..From this one of the method is selected as existing method to compare the proposed method.

In the Existing method Global Positioning System, Global System for Mobile Communication and Wireless networks are used for addressing the sea border crossing issue. This is used as an alert system for fishermen. This will give an alert when the boat/ship crossed beyond the country's border. The marine GPS [10] receives the longitude and latitude values of geographical location and converts them into desired data message. The Global System for Mobile communication will send the latitude and longitude values as the data message to the base station located on the on the shore. The positions are compared with the latitude and longitude positional database values. If the boat is found beyond the border, then an alert is generated along with a message.

A. Disadvantages of Existing Method

1) In this method, a GPS receiver is used which can only determine the latitude and longitude and indicate the position of the ship.
2) Due to multipath electromagnetic interference, the GPS signal gets affected.
3) GPS chip is power-hungry which drains the battery in 8-12 hours.
4) It is a half-duplex communication.
5) This method is not able to send any information such as weather alert, border alert from the seashore.
6) The people on the ship are not able to communicate in their emergencies like the need for food, water etc.
7) Live monitoring of the boat is not possible

IV. PROPOSED METHOD

In this method, the sea border detection and ship tracking are done based on the RSSI value. The Received Signal Strength Indicator (RSSI) measures the amount of power present in a radio signal. From this value, the signal strength received on an antenna is obtained. By measuring the signal strength at the receiving antenna, we can determine the quality of a communication link.

A. RSSI (Received Signal Strength Indicator)

RSSI is defined as ten times the logarithm of the ratio of the power of the received signal and a reference power.ie,RSSI $\propto$ 10 log P/Pref . This equation shows that the RSSI is directly proportional to the logarithm of power.The power of a point source will dissipates as it moves.The relationship between power and distance is that power is inversely proportional to the square of the distance travelled.

ie,RSSI $\propto$ log $(1/distance^2)$.From this relation it can be writtern as RSSI$\propto$ -log distance.

Thus the measured RSSI is plotted against log of distance to obtain an inverselinear relationship.From the plotted graph the receiver node can estimate the distance at which a sending node would be located.

$$RSSI = -K\ log\ D + A$$

$$D = 10^{\left[\frac{(A-RSSI)}{K}\right]}$$

K is the slope of the standard plot.

A is the constant.

B. Block Diagram

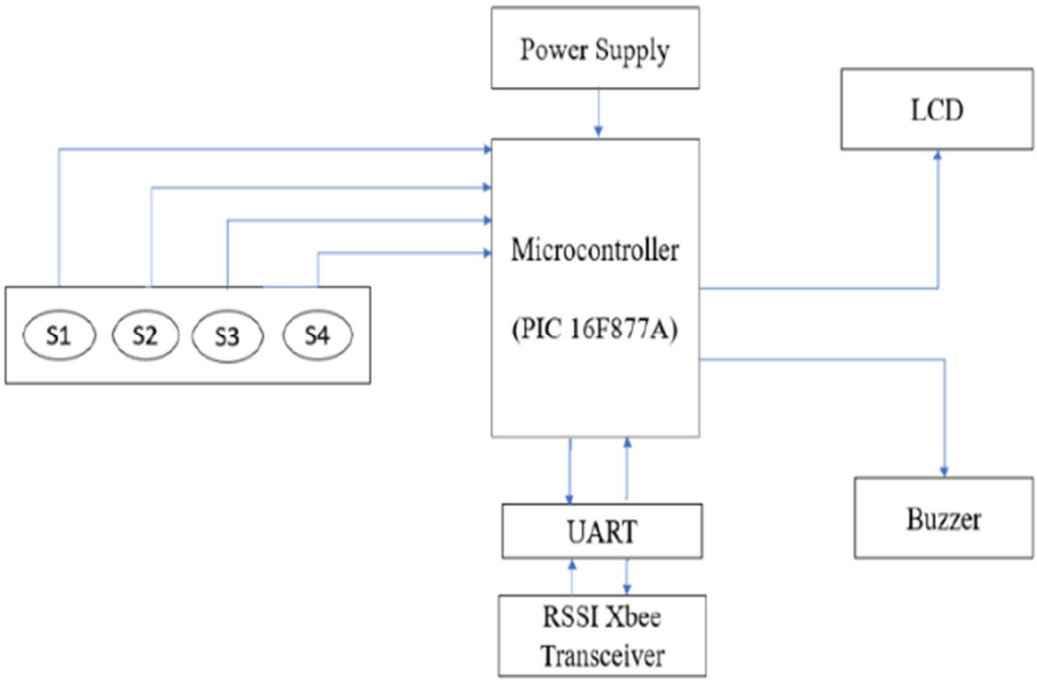

Fig 1:Block Diagram of the unit inside the ship

Fig 1 is the block diagram of the unit placed inside the ship. When a transmitter is moved closer to a receiver, then the strength of the transmitted signal at the receiving antenna increases and vice versa. This concept is used to track the ship. The RSSI value is measured in dBm. A greater negative value in dBm indicates that the signal is week.The unit inside the ship consists of a PIC microcontroller and an Xbee transceiver module is connected to it. The PIC microcontroller is connected to the RSSI Xbee transceiver through UART, because the RF module transmit and receive data serially. Four emergency switches are connected to it. Both LCD and buzzer is interfaced to the microcontroller.

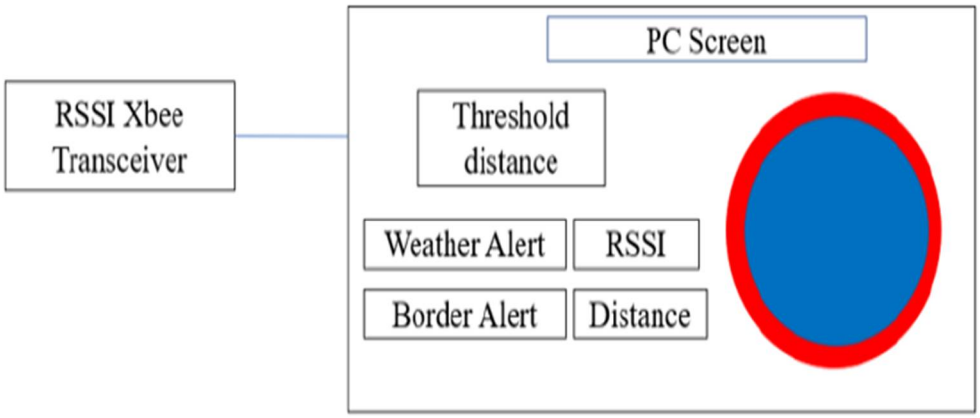

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Fig 2: Block Diagram of the unit in the seashore

Fig 2 is the block diagram of the unit placed in the seashore. This consists of the RSSI Xbee transceiver unit which is connected to a PC.

C. *Hardware Requirements*

1) *PIC16F877A Microcontroller* – It is one of the most advanced microcontrollers from Microchip. This microcontroller is widely used in industry because of its low price, a wide range of applications, high quality and ease of availability.it consists of 40 pins. In this 33 are input/output pins. its operating voltage is 2 to 5V.

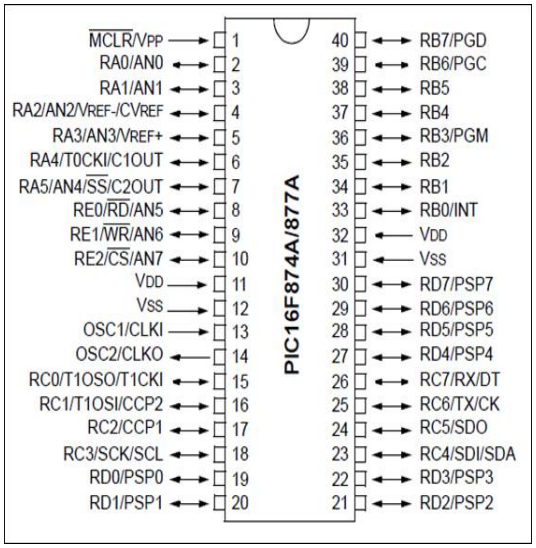

Fig 3: Pin diagram of PIC 16F877A

2) *TICC2530 Xbee Transceiver* – The CC2530 is a true system on chip (SoC) solution for IEEE 802.15.4 Zigbee and RF4CE applications.it enables robust nodes to be built with a very total bill of material costs. The CC2530 combines the excellent performance of a leading RF transceiver with an industry-standard enhanced 8051MCU, in-system programmable flash memory,8KB RAM and many other powerful features. For developing this prototype only, we are using this module. For higher ranges other long range RF modules can be used for obtaining the RSSI values.

Fig 4: TI CC253O RF Module

3) *16X2 LCD* - A Liquid Crystal Display is a flat-panel display or other electronically modulated optical devices that use the light-modulating properties of liquid crystals combined with polarizers. Here, it is used to display the border alert and weather alert at the ship side.
4) *Buzzer* - A buzzer or beeper is an audio signal device, which can be mechanical, electromechanical or piezoelectric. Here the buzzer is placed at the shipside and it produces a beep sound when the boat crosses the sea border.
5) *Power Supply*- A Power Supply unit converts AC to a low-voltage regulated DC power for the internal components of the system.
6) *Switches*- Four switches are interfaced to the microcontrollers RB0, RB1, RB2, and RB3.When pressing this key from the boat side it will display like food, water, fire and emergency on the PC.

D. Software Requirements

1) *MPLAB IDE*- It is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment or IDE because it provides a single integrated "environment" to develop code for embedded microcontrollers. Here the code for the ship side is developed in MPLAB.
2) PICkit3-Programmer- It is a simple, low-cost circuit debugger that is controlled by a PC running MPLAB IDE software on a windows platform. The program is dumped into the PIC microcontroller using PICkit.

Fig 5: PICkit programmer

3) *Visual Basic*-It is a tool that helps to develop windows Graphic User Interface (GUI) applications.

E. Working

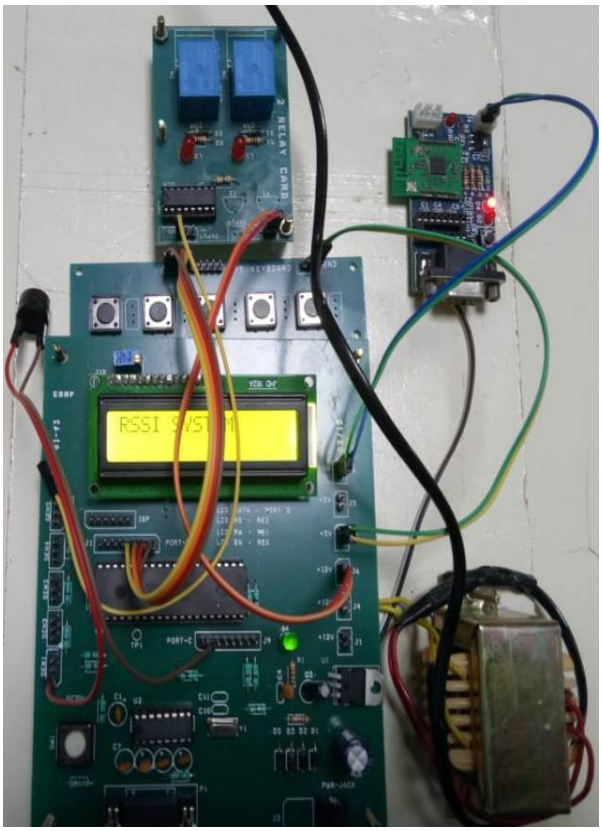

Fig 6: Prototype of the proposed method

The proposed system consists of two units. One is placed in the ship and the other unit is placed at the seashore connected to a PC. Here the ship is tracked based on the RSSI value. When the ship is moved far away, the RSSI value will be a greater negative value. This shows that the strength of the received signal is getting reduced and if the RSSI value crosses the threshold value the buzzer will be on. This indicates that the boat has crossed the border and must return soon. Moreover, there are four switches, that can be used by the fisherman for their needs such as food, water and also in emergencies like fire. The boat can be monitored in live through the PC, therefore weather alert and border cross alert can be given to the fishermen.

V. RESULTS

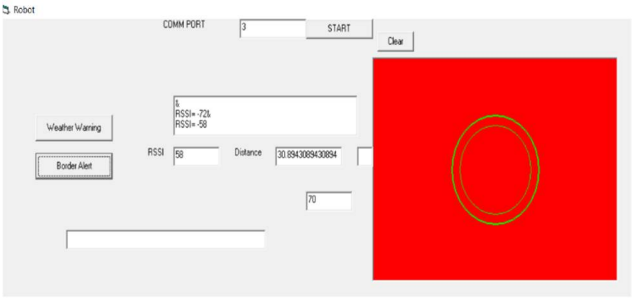

Fig7: The result when the boat crosses the border

Fig 7 is the result obtained when the boat crosses the threshold RSSI value. This result is obtained at the PC. Here the threshold value is given as minus 70dBm. When the RSSI value crosses the threshold then the buzzer will be on and a border alert can be given to the fishermen.

Fig 8: The weather alert indication is displayed on LCD

Fig 8 shows that the weather alert can also be given to the fishermen during the bad weather conditions. This result is displayed on the LCD screen at the ship side.

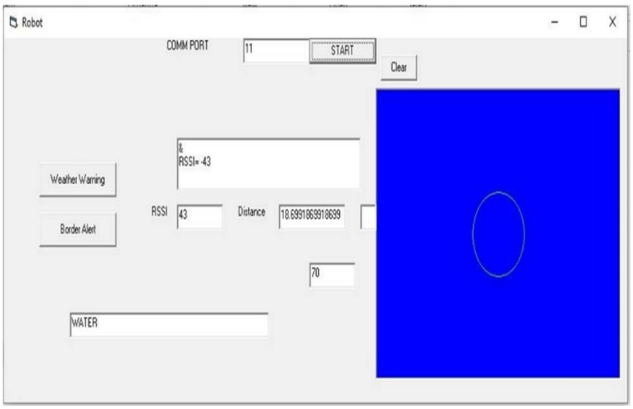

Fig 9: The result obtained when the fishermen is in need for water

Fig 9 shows that the result obtained in pc when the input is the need of water.

VI. CONCLUSION

The Fishermen earns their livelihood by catching and selling fish. Their life is very tiring and dangerous, especially at the sea border. Due to carelessness or without knowing the border they can be caught by the other country's coastal guards. As a solution to this problem, the developed sea border detection and ship tracking system will monitor the boat and protect them from crossing the border. The proposed method has many advantages as compared to other existing method. This system is more reliable and immediate response in emergency situations. Since, it is a full-duplex communication the fishermen can also inform their emergency needs to the seashore.

VII. FUTURE SCOPE

The developed prototype can be implemented in real-time with more accuracy and in a long range of communication. This can be further modified in to a fully assessed application in the near future. Many other features like audio assistant can also be implemented.

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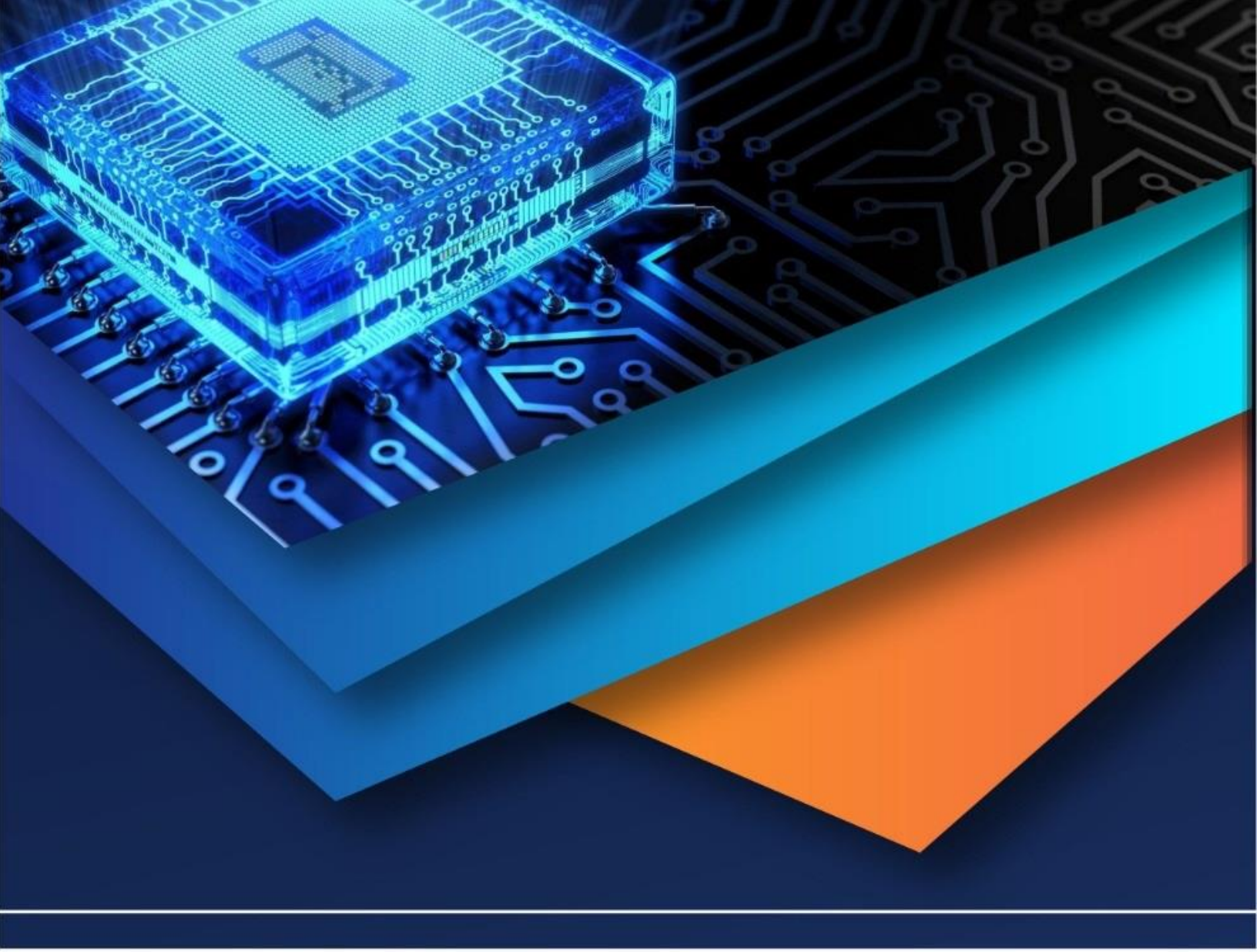

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