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"Microcontroller Based Smart Helmet for Coal Miners Safety"

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***Abstract:** This paper tends to the supervision system of miners in order to detect hazardous events that occur in the mining environment. The problem addressed in this paper include gas poisoning, helmet removal and object fall which can sustained a life threatening injury. In mining industry harmful gases like SO2, CO and NO2 occurs which can causes suffocation. Death of minors mainly causes due to object fall if proper treatment is not provided .Helmet removal is also a dangerous. This paper tends to develop a wireless sensor network to monitor real time situation of underground mines from base station. It gives surveillance with early warning intelligence of harmful gases. So to detect all these, we are using air quality sensor, accelerometer, Infra-red (IR) sensor. These are connected to the RF module. This module does all processing and also controls wireless communication between separate helmet using Contiki operating system. Microcontroller AVR-ATMEG 16 is used as analog to digital converter. All sensors have some threshold value if they cross that value then buzzer will automatically on and status will display on LCD.*
***Keywords:** Mine Safety, Wireless communication.*

I. INTRODUCTION

India is known for its extensive and diverse mineral resources and big mining industry. Generally minor's safety is most important issue in mining industry. Every year, thousand of minors die and get injured. The main reasons for accident are object fall, helmet removal by minors and presence of dangerous gases. The purpose of mining safety helmet is to protect minors head against heavy object fall. There is no any special technology added to the helmet by which supervisors can get information whether fellow minors has encounter a hazardous event. Considering all these problems, a classic model of smart helmet is to be develop to detect all hazardous events in the mining environment. The proposed model is small enough to fit into the safety helmet and keep going sufficiently long while running on battery power. The system is to be modified without changing its physical structure. The additional weight must be kept to a base [1].

The hardware component include helmet remove sensor ,collision sensor, air quality sensor, data processing unit, wireless transmission and alternating unit and the software use here are WinAVr and sinaprog. This project uses microcontroller AVR ATMEGA-16 to convert audio signal into digital one. The system use RF module for transmission of wireless data from underground mines to the base station. Bluetooth and Wi-Fi are also wireless system but the range of both the system is limited to few distances. Wi-Fi is sometimes use in mines but it require cabling that can be damaged [5]. So, the RF module is used .This module transfer a data of baud rate 9066 bit/sec within the range of 50m to 100m.

Solving the problem of miners removing their safety equipment was a challenge, taken that any new safety equipment that is not lightweight and non-distracting, will just be removed, like all the other safety equipment. As the helmet is the only safety gear miners tend to keep on, this is where the new safety equipment was added on to. Three sensors were used, an accelerometer, air quality and an Infra-red (IR) sensor. These were used either to detect if a miner has experienced a bump to the head or removed his helmet and surrounding air quality. The three sensors were connected to a RF module. The whole system was analyzed throughout the design process in order to keep the power consumption to a minimum as the system is running on battery power. Different sensors were considered for each separate component in order to keep the power level as low as possible. In order to explain the entire system and the alternatives of each component, the system will be explained component by component. The system consists of six components, helmet remove sensor, collision sensor, air quality sensor, data processing unit, wireless transmission and alerting unit.

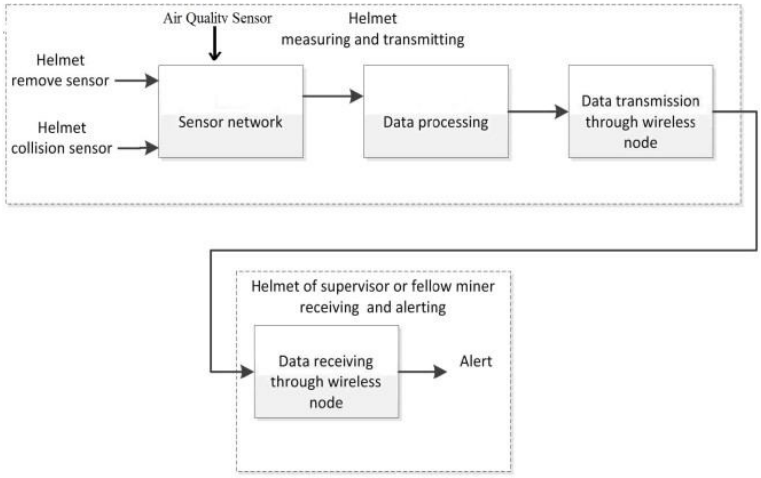

Figure 1 represents the block diagram of the smart helmet for mining safety. The developed prototype mining safety model is shown in Figure 2. The developmentof the prototype complies with the IEEE 21451 standard [12].

II. RELATED WORK

A. C. J. Behr, A. Kumar and G.P. Hancke, "A Smart Helmet for Air Quality and Hazardous Event Detection for the Mining Industry**",** IEEE 2016.A smart mining helmet was developed that is able to detect three types of hazardous events such as danger level of hazardous gases, miner helmet removing, and collision or impact (miners are struck by an object). The hazardous events were classified as a miner removing the mining helmet off their head. An off-the-shelf IR sensor was then used to successfully determine when the helmet is on the miner's head.

B. Ge Bin, LI Huizong, "The Research on ZigBee-Based Mine Safety Monitoring System" , 2011 IEEE. In this paper the research method of Mine Safety Monitoring System based on ZigBee is elaborated, and the hardware design of ZigBee sensor node and system software design are discussed. The self-organizing routing algorithm for ZigBee networks and the gateway design and systems integration are also studied. ZigBee-based Mine Safety Monitoring System can achieve a variety of safety factors of production, and underground environment (such as gas, temperature, humidity and other environmental indicators) for monitoring, controlling mine production, safety management to provide a good basis for decision making.

C. Tanmoy Maity, Tanmoy Maity, **"**A Wireless Surveillance and Safety System for Mine Workers based on Zigbee", 1st Int'l Conf. on Recent Advances in Information Technology | RAIT-2012 | 2012 IEEE This paper addresses a cost-effective, flexible solution of underground mine workers' safety. A module of MEMS based sensors are used for underground environment monitoring and automating progression of measurement data through digital wireless communication technique is proposed with high accuracy, smooth control and reliability. A microcontroller is used for collecting data and making decision, based on which the mine worker is informed through alarm as well as voice system.

D. Abhijeet Kumar Student Member IEEE, 1Harish Kumar Member IEEE, 1V.N. Pandey, 2D.K.P Singh, 3S.K. Chaulya "Gas Monitoring and Power Cut-off System for Underground Mines", 2012 7th IEEE Conference on Industrial Electronics and Applications (ICIEA).In this paper proposed gas monitoring system plays a vital role in monitoring the gases in the mines. This work includes designing and implementation of a system that continuously monitors the concentration of methane (CH4) and carbon-monoxide (CO) gas in the underground mines, which automatically cuts off the power supply of the particular zone in an underground mine, when the concentration of CH4 exceeds more than the permissible limit decided by the user. For better accuracy, we propose the cross checking of the concentration of the gases from two or more sensors. The present work is devoted on the designing part of the sensor circuit which is dedicated for the better safety environments and need of the miners and mining area.

E. CHENG Qiang, SUN Ji-ping, ZHANG Zhe, ZHANG Fan, "ZigBee Based Intelligent Helmet for Coal Miners", 2008 IEEE1National Key Lab of Coal Resources and Safety Mining, China University of Mining and Technology, Beijing 100083,China,A cost effective ZigBee-based wireless mine supervising system is presented in this article. This scheme used intelligent helmets as voice terminal and ultra-low-power nodes of wireless sensor network. The programme adopted ZigBee wireless technology to build wireless sensor networks, realized real-time surveillance with early-warning intelligence on

methane, temperature, humidity in mining area, and used speech communication to reduce potential safety problems in coal production.

F. Shabina.S, "Smart Helmet Using RF and WSN Technology for Underground Mines Safety**",** 2014 International Conference on Intelligent Computing Application. The design provides three modules, namely helmet module, localizer module, and control room module. The helmet module comprises of various sensors, microcontroller, antennas, encoders, decoders, etc. The helmet module acts as an intelligent, low power node in the wireless sensor network. The control room module contains antennas, PC, decoder, etc. The sensors are used to measure the variations in the temperature, humidity, pressure, fire and take decisions for required actions based on the measured data to ensure the safety of the underground mine workers. The RF technology also ensures the localization of the mine workers for their safety in a dangerous working platform. Thus the proposed system ensures safety and a reliable wireless communication inside the underground mines.

III. PROPOSED WORK

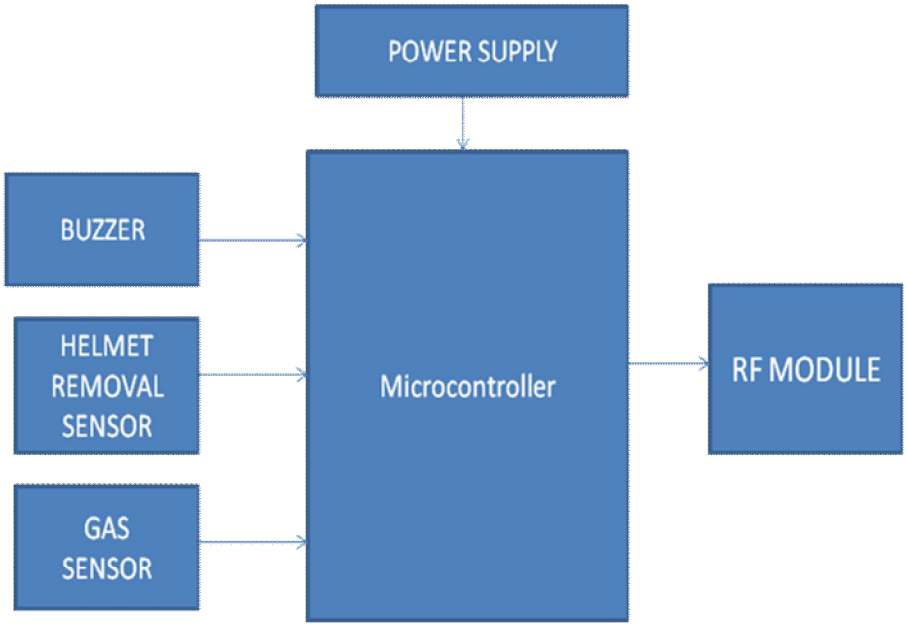

Fig.1. Block Diagram of Transmitter

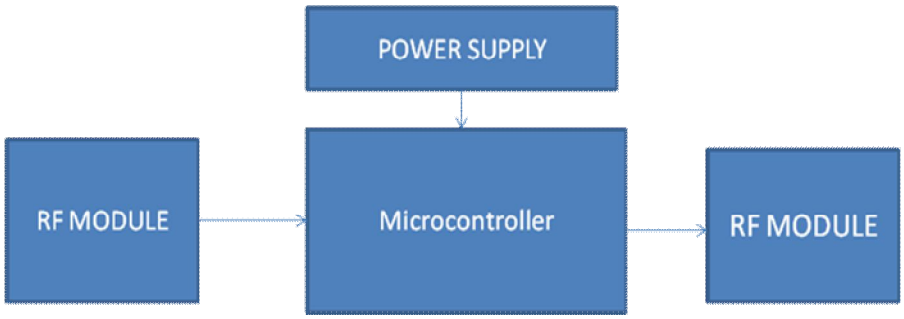

Fig.2. Block diagram of Repeater

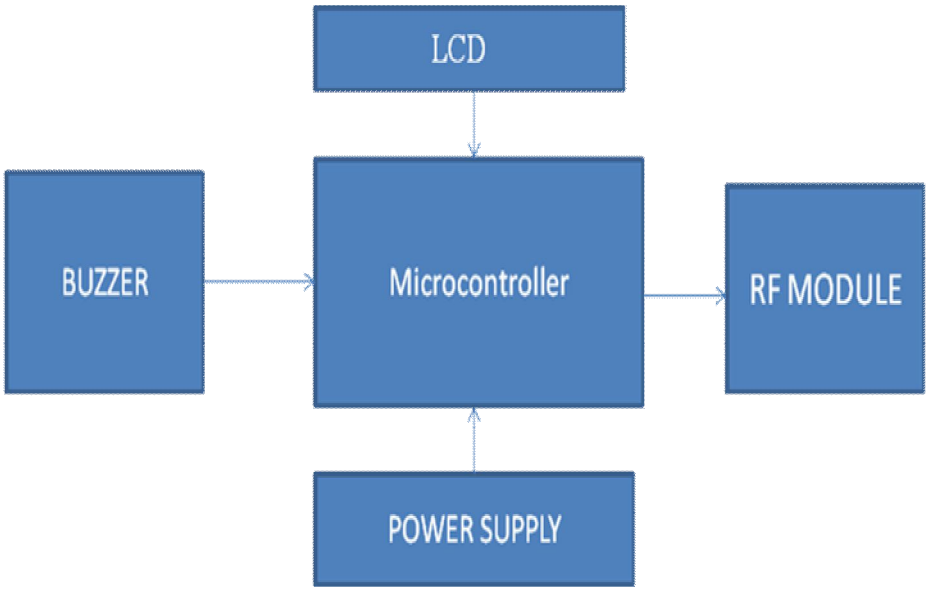

Fig.3. Block Diagram of Receiver

Fig (1) shows the block diagram of transmitter. The transmitter is placed in helmet which senses the signal if any catastrophe occur then send the signal to the repeater .The block diagram of repeater is shown in fig 2.The receiver which is also called as monitoring station which receives the signal generated at helmet unit. The various parameters related to helmet unit is display on 16 x2 LCD screen. Figure 3 shows the block diagram of receiver. The helmet section consists of gas, Collision and helmet removal sensors, RF receiver, LCD Display, and RF transmitter for communication microcontroller AVR ATmega-16 is used [1]. Input to the microcontroller Collision, gas, helmet removal sensors outputs, LCD, RF Module. Output pins of the controller are connected to LCD display and RF module as shown in the fig.1. MQ-5 is the gas sensor used which has the sensitive material CO, LPG, CH4.
The receiver section receives the data and displays it in the LCD Display Device shown in fig.3. An RF receiver is given at the input section and it is used to receive RF signals transmitted by RF transmitters at the coal mine. The receiver section receives the data and displays it on LCD.

A. Sensor Network

1) *Collision Sensor:* A piezoelectric sensor is use as a collision sensor. A piezoelectric sensor is a device which used the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force and converting them into an electrical charge.
2) *Gas Senor:* Sensitive material of CO, CH4, and LPG gas sensor is MQ5, which with lower conductivity in clean air. When the target LPG (Liquefied Petroleum Gas) exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-5 gas sensor has high sensitivity to LPG, and has good resistance to disturb of gasoline, smoke and vapors. The sensor could be used to detect LPG with different concentrations; it is with low cost and suitable for different applications.
3) *Helmet Sensor:* Helmet Sensors is designed to be attached to the inside a helmet. The sensor provides an immediate wireless transmission to your transmitter and receiver that the player has experienced a head impact that could result in a concussion. This takes the guess work away from determining when to take a player off the field and seek medical advice.

B. Microcontroller

1) *Avr Atmega-16:* In this project, we will learn How to convert an analog signal to digital signal using the Analog to Digital Converter of AVR ATmega16 microcontroller. The AVR ATmega16 has an inbuilt 8 channel, 10 bit analog to digital converter. Here, we will first convert a 5V signal and then a 0V signal with a reference voltage of 5V of ADC. After each conversion, the analog to digital converter of ATmega16 will give a 10-bit value for each signal (5V and 0V).These outputs of the analog to digital converter are displayed in a LCD display. When a 5V signal is converted, the output of analog to digit02al converter is 0x3ff (1023) and when 0V signal is converted, the output is 0x00 (0).

C. Rf Module

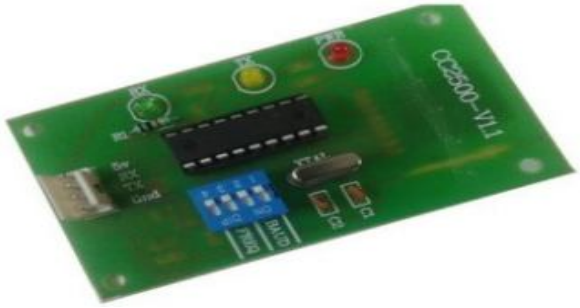

Fig 4: CC2500 trans-receiver

D. Features

1) It supports Multiple Baud rates.
2) Works on ISM band (2.4 GHz) which is reserved internationally.
3) Supports multiple frequencies within the same band rate thus avoiding data collision.
4) No complex wireless connection software required.
5) Designed to be as easy to use as cables.
6) No external Antenna required.
7) Works on 5-9v DC supply.

E. Rf transmitter

This is 2-channel Radio Frequency Transmitter specially tuned with its RF Receiver part in carrier frequency. Each zone is set with one channel and transmits their presence to moving Helmet RF Receiver unit.

F. Rf receiver

This is also a 2-channel RF Receiver specially tuned with its counterpart RF Transmitter in carrier frequency. When vehicle enters into any zone that zones RF signals are received by this unit. Thus depend upon the channel signals it receives from transmitting end that channel output of RF Receiver goes HIGH. This HIGH signal is fed to Microcontroller chip through Buffer & Driver and Switching stage for further processing.

IV. CIRCUIT DIAGRAM:

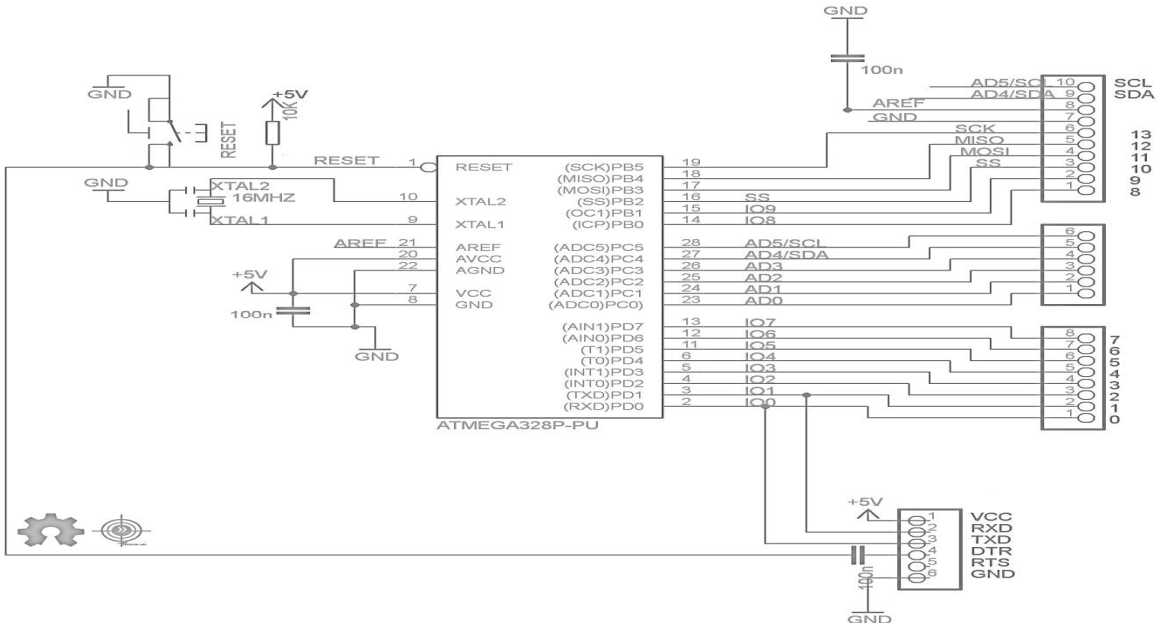

Fig 5 Circuit diagram of Transmitter

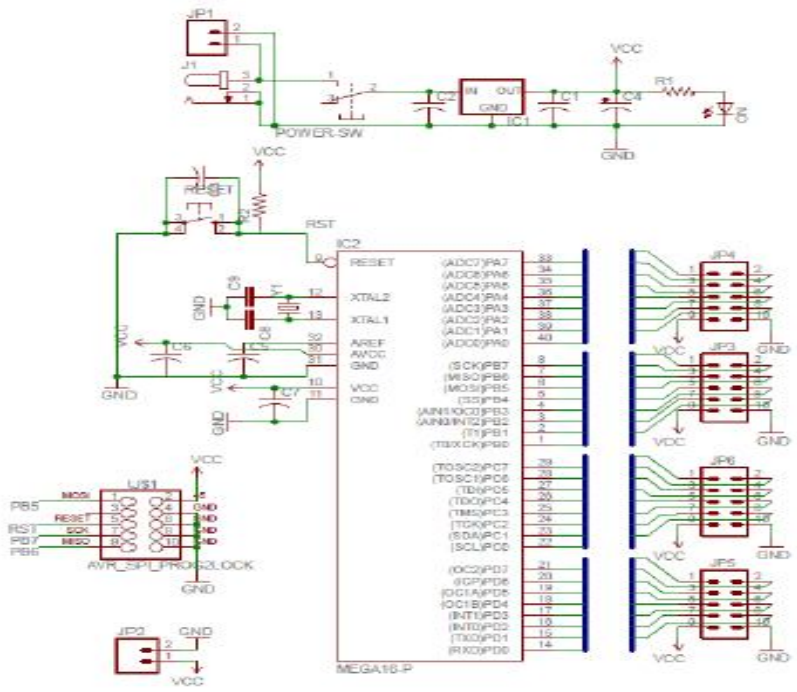

Fig 6: Circuit diagram of Repeater

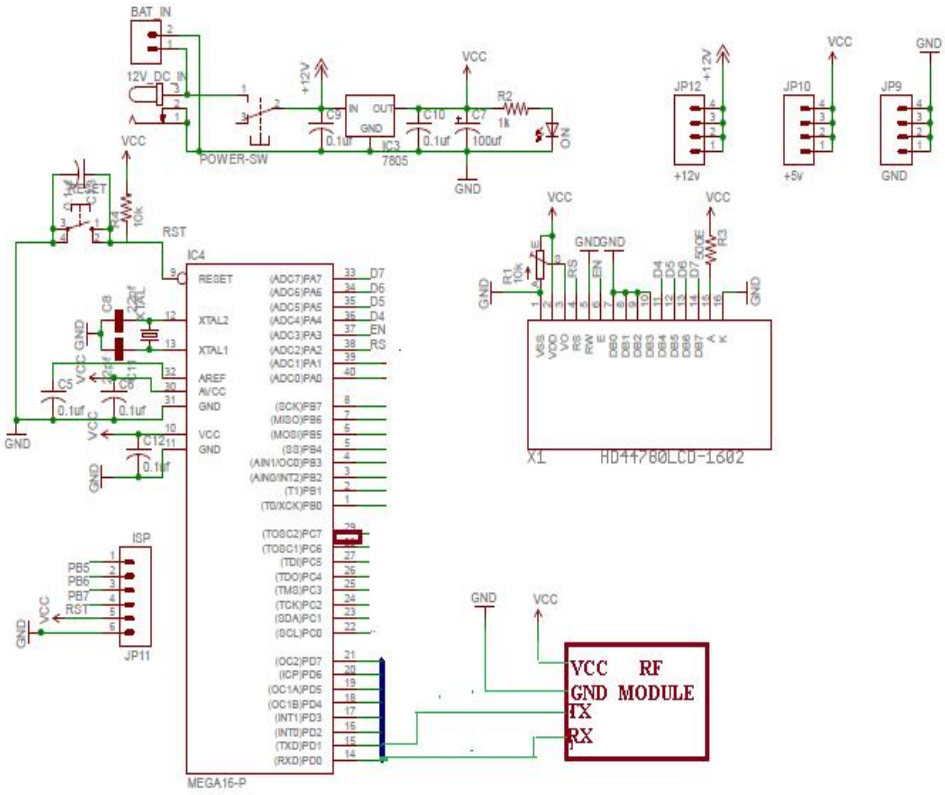

Fig 7: Circuit diagram of Receiver

V. CONCLUSION

In this proposed a smart helmet is to be developed that is able to detect dangerous events like harmful gases, object fall and helmet removal by miners. Air quality sensor is use to detect harmful gases, IR sensor is use to check helmet removal, accelerometer is use to measure force by which miners struck by object. So using this safety equipment more safety to the miners can be provided.

VI. FUTURE SCOPE

A few attributes of the system can be enhanced. The processing speed of the system can be improved to allow for more accurate accelerometer measurement. The IR sensor can be improved to work within the helmet by not triggering because of reflections. The system can be improved by adding more measuring devices to check the miner's blood pressure and heart rate. Gas concentrations can also be measured.

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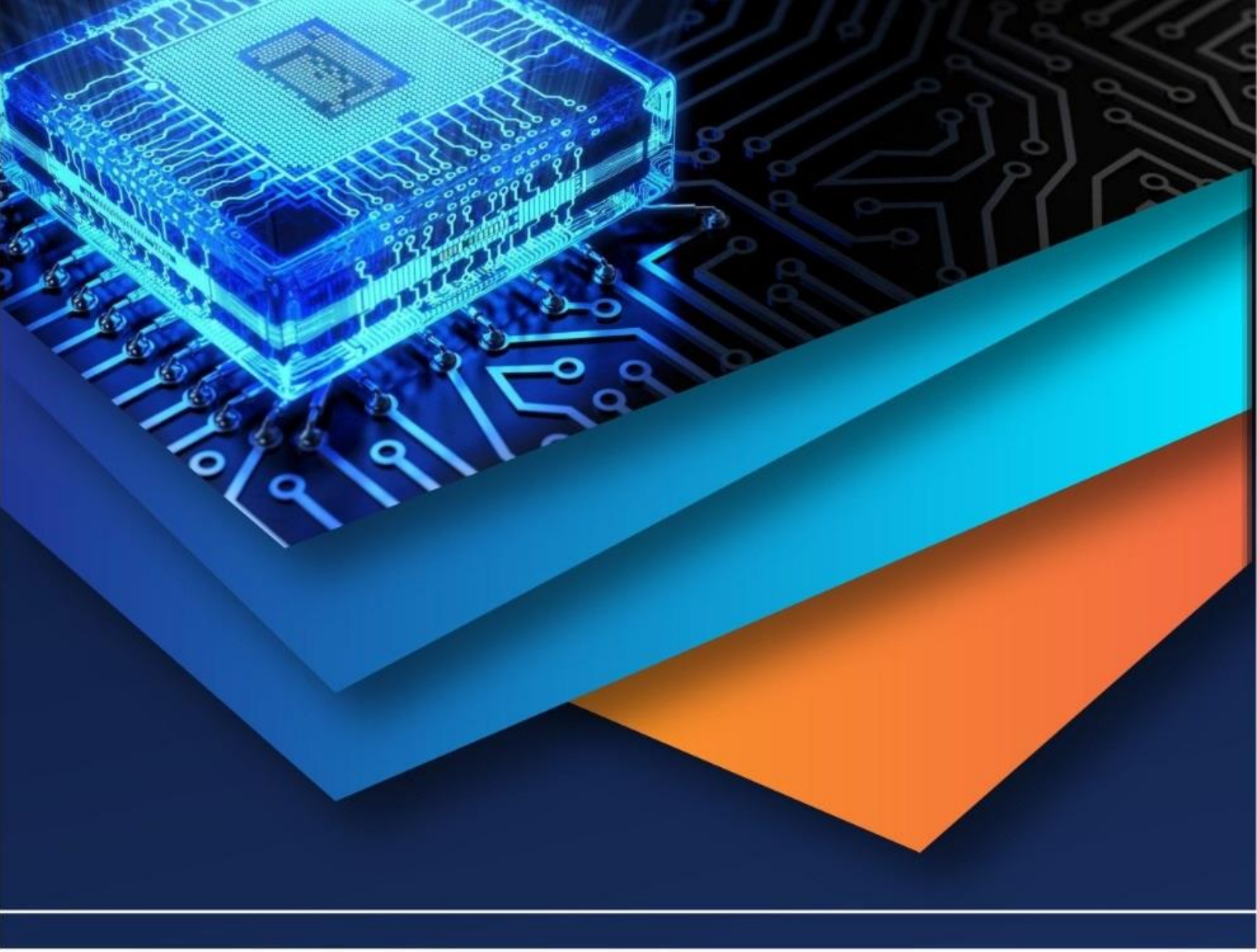

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