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Environmental Condition Monitoring System for the Industries

Sriram. R[1], Shafaf. M[2], Vignesh Kumar. T[3], Vidhya. K[4]
[1]Student, [2]Associate Professor
Sri Ramakrishna Engineering College, Coimbatore-641022, TamilNadu.

Abstract – Nowadays pollution plays major role in creating health issues to all living organism. Mainly air pollution and water pollution has its own harmful effect to the nature. So this project mainly concentrates on designing microcontroller based toxic gas detecting and alerting system. Under normal condition environmental condition of specific locality were sensed and displayed each and every second in the LCD display. But it mainly focusing on hazardous gas detection if those gases exceed the defined level then an alarm is generated immediately and also an alert message (SMS) is sent to the authorized person through the GSM for taking proper action. The advantage of this automated detection and alerting system over the manual method is that it offers quick response time and accurate detection of an emergency and in turn leading faster diffusion of the critical situation
Keywords: Hazardous gas detection, Pollution control, alerting system, sensors, ZigBee, GSM.

I. INRODUCTION

Environmental pollution is a popular issue after World War II. It can be said that pollution is the result of our social development through the means of science. Thus environmental pollution has become the biggest problem to the human race on this planet. Since the onset of the industrial revolution, there has been a steady change in the composition of the atmosphere mainly due the combustion of fossil fuels used for the generation of energy and transportation. Air pollution and water pollution from industries plays major role in creating adverse effect to the organisms. People who works in industries are seriously affected by these pollutants because of the lack of proper management system. Keeping this issue in mind, this project works on monitoring the level of air pollutant and water pollutant in industries and send the corresponding database to pollution control board.

Fig.I.A. Industrial pollution

Usually, the main combustion products of vehicular engines, gas turbines, and steam power plant furnaces are carbon monoxides (CO), unburned hydrocarbon UHC and nitrogen oxides (NOx), sulfur oxides (SOx), and soot, in addition to volatile organic compounds (VOC) .

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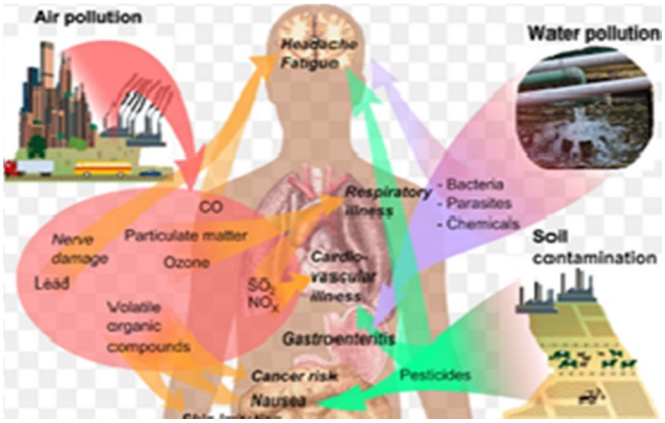
Fig. I .B. Health effects of pollution



Major health issues due to these pollutions are nerve damage, cardio-vascular illness, respiration problem, gastroenteritis, cancer risk, skin irritation, headache fatigue etc. In December 1952, London's Great Smog - led to the deaths of thousands of people. This event became one of the great turning points in our environmental history because it brought about a radical re-think in pollution control across the United Kingdom. This event further lead to the Clean Air Act, which may have had consequences even more far reaching than it originally intended. This act led to the change in fuel sources, and energy used by industries. Many citizens in major cities across the world suffered some type of health related problems due to excess toxins and pollution in the air. To keep this problem under the control the following module is designed.

II. SENSORS

Four types of sensors are included in this prototype, they are

A. Air pollution sensor

MQ135 is a hazardous gas sensor used for air quality control and is suitable for detecting NH_3, NO_X, alcohol, Benzene, smoke,CO_2 and other harmful gases. Its conductivity is low in clean air. When the target combustible gas exist, the sensors conductivity is higher along the gas concentration rising. Converts the change of conductivity into corresponding
Output signal of gas concentration.

Fig.II.A.1.MQ 135 Sensor

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It has 4Pins: AO-Analog output, DO-Digital output, GND-Ground, VCC-Power supply. Detecting range of 10ppm to 1000ppm

Fig.II.A.2. Structure and Configuration of MQ 135

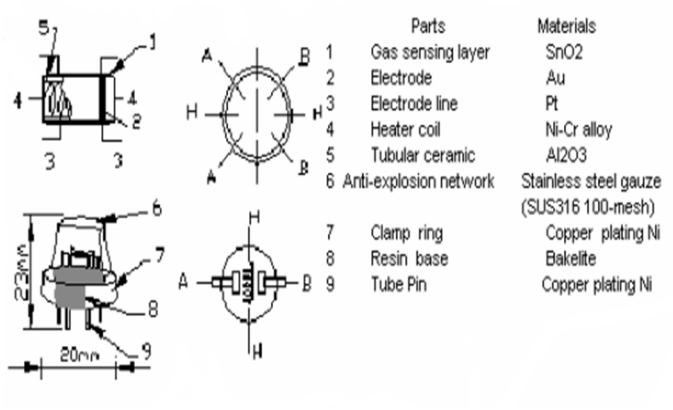
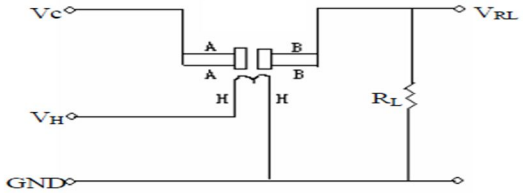


Fig.II.A.3.Basic test loop



The Fig.II.A.3 is basic test circuit of the sensor. The sensor need to be put 2 voltage, heater voltage (VH) and test voltage (V).VH used to supply certified working temperature to the sensor, while VC used to detect voltage (VRL) on load resistance (RL) it is in series with sensor. The sensor has light polarity, need DC power. VC and VH could use same power circuit with precondition to assure performance of sensor. In order to make the sensor with better performance suitable RL value is needed. Power of sensitivity body is given by:

$Ps=Vc2\times Rs/(Rs+RL)2$

B. pH Sensor

pH sensor is used to measure the pH value. Thus the modern pH electrode is a combination electrode composed of two main parts: a glass electrode and a reference electrode as shown in Fig II.b.1.pH is determined essentially by measuring the voltage difference between these two electrodes. At the tip of the electrode is a thin membrane that is a specific type of glass that is capable of ion exchange. It is this element that senses the hydrogen ion concentration of the test solution. The reference electrode potential is constant and is produced by the reference electrode internal element in contact with the reference-fill solution that is kept at a pH of seven.

Fig. II. B.1. Typical pH Gas Electrode

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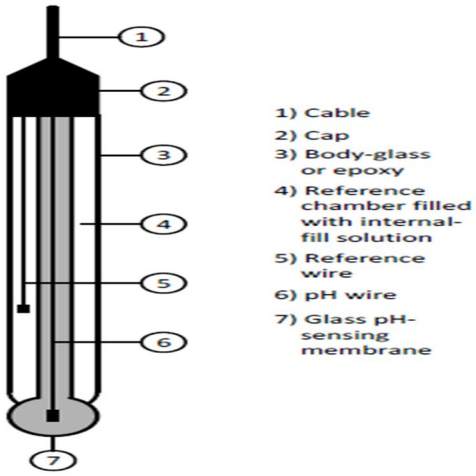


The pH electrode is a passive sensor, which means no excitation source (voltage or current) is required .Because the electrode's output can swing above and below the reference point, it is classified as a bipolar sensor. It produces a voltage output that is linearly dependent upon the pH of the solution being measured. The source impedance of a pH electrode is very high because the thin glass bulb has a large resistance that is typically in the range of 10 MΩ to 1000 MΩ. This means that the electrode can only be monitored by a high-impedance measuring device.

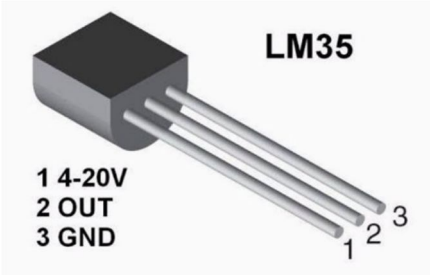
Fig.II.B.2.Typical pH Meter sensor

C. Temperature sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Fig.II.C.1.LM35 sensor



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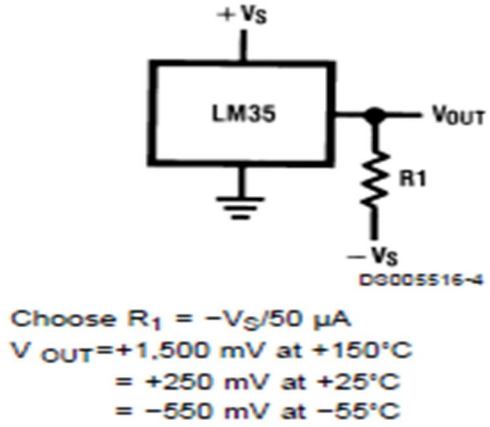


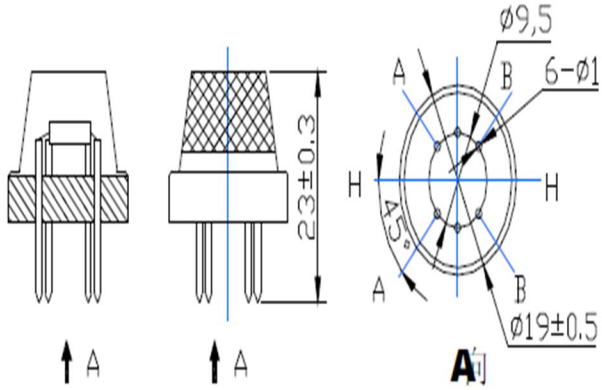
Fig. II. C.2.Basic Centigrade Temperature Sensor

D. Gas sensor

The Grove-gas sensor (MQ5) module is useful for gas leakage detection (in home and industry).It is suitable for detecting CO, H2, LPG, CH4 and Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensors can be adjusted by using the potentiometer. Then output voltage increases when the concentration of gases increases. Structure and configuration of MQ-5 gas sensor shown in Fig.II.D.2. This sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-5 have 6 pins, in which 4 of them are used to fetch signals, and other 2 are used for providing heating current. Resistance value of MQ-5 is difference to various kinds and various concentration gases. So using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 1000ppm H2 or LPG concentration in air and use value of Load resistance (RL) about 20 KΩ(10KΩ to 47KΩ).It is sensitive to gases such as LPG, natural gas, coal gas.

Fig.II.D.1.MQ-5 Gas sensor

Fig II.D.1.MQ-5 Gas sensor configuration



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III. HARDWARE SYSTEM DESIGN

Block diagram of the proposed system:

The hardware components are:

A. Transmitter End

1) MSP 430G2553
2) Sensors
3) GSM
4) ZIGBEE
5) LCD
6) Buzzer

B. Receiver End

1) MSP 430G2553
2) LCD

Fig. III. a TRANSMITTER

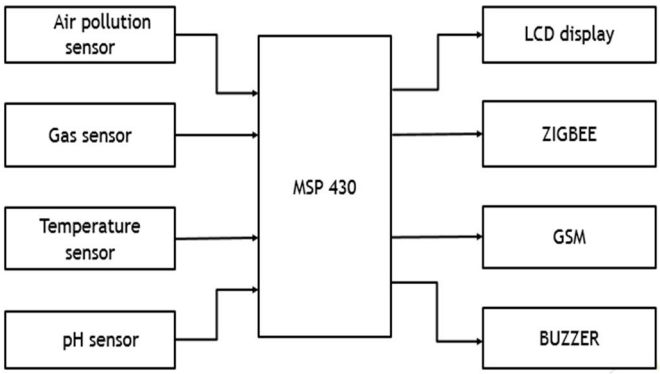
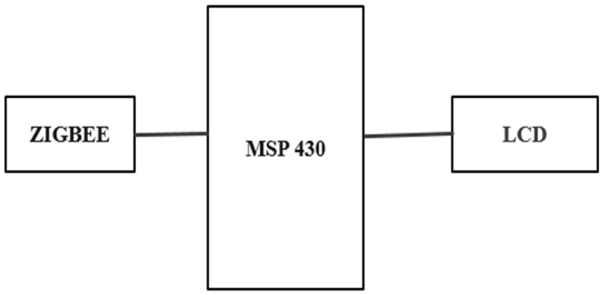


Fig. III. b. RECEIVER



1) MSP 430: The MSP430G2553 are ultra-low-power mixed signal microcontrollers with built-in 16-bit timers, up to 24 I/O touch-sense-enabled pins, a versatile analog comparator, and built-in communication capability using the universal serial communication interface. In addition the MSP430G2553 have a 10-bit analog-to-digital (A/D) converter. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1 µs.

a) FEATURES:

i. Low Supply-Voltage Range: 1.8 V to 3.6 V
ii. Ultra-Low Power Consumption
iii. Active Mode: 230 µA at 1 MHz, 2.2 V
iv. Standby Mode: 0.5 µA
v. Off Mode (RAM Retention): 0.1 µA

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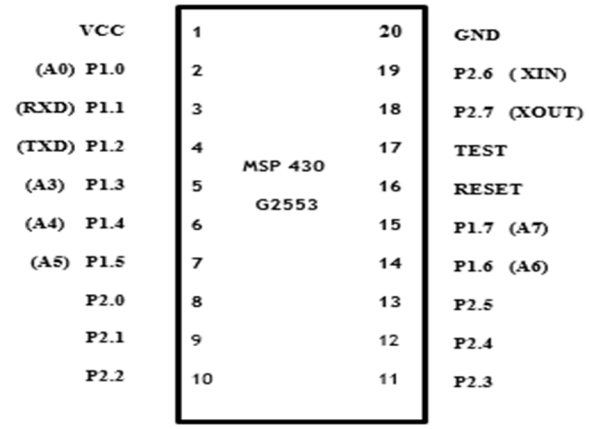
The connections are

- Pin 1.0 :Air pollution sensor
- Pin 1.3: pH sensor
- Pin 1.4: Temperature sensor
- Pin 1.5: Gas sensor
- Pin 2.0:Buzzer
- Pin 1.2: connected to relay for performing switching operation between GSM and ZigBee
- Pin 2.1
- Pin 2.2
- Pin 2.3
- Pin 2.4

  } LCD
- Pin 2.2: Relay ON pin

Fig.III.A.1.Pin diagram



2) *GSM:* GSM (Global System for Mobile Communications, originally *Groupe* ***Spécial Mobile***), is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones. It became the de facto global standard for mobile communications with over 80% market share. The GSM standard was developed as a replacement for first generation (1G) analog cellular networks, and originally described a digital, circuit switched network optimized for full duplex voice telephony. This was expanded over time to include data communications, first by circuit switched transport, then packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS). GSM networks operate in a number of different frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G). Most 2G GSM networks operate in the 900 MHz or 1800 MHz bands. GSM-900 uses 890–915 MHz to send information from the mobile station to the base station (uplink) and 935–960 MHz for the other direction (downlink), providing 124 RF channels (channel numbers 1 to 124) spaced at 200 kHz. Duplex spacing of 45 MHz is used. There are eight radio timeslots (giving eight burst periods) grouped into what is called a TDMA frame. Half rate channels use alternate frames in the same timeslot. The channel data rate for all 8 channels is 270.833 kbit/s, and the frame duration is 4.615 ms. The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900.

3) *Zig-Bee:* The explosion in wireless technology has seen the emergence of many standards, especially in the industrial, scientific and medical (ISM) radio band. There have been a multitude of proprietary protocols for control applications, which bottlenecked interfacing. Need for a widely accepted standard for communication between sensors in low data rate wireless networks was felt. As an answer to this dilemma, many companies forged an alliance to create a standard which would be accepted worldwide. It was this ZigBee Alliance that created ZigBee. Bluetooth and Wi-Fi should not be confused with ZigBee. Both Bluetooth and Wi-Fi have been developed for communication of large amount of data with complex structure like the media files, software etc. ZigBee on the other hand has been developed looking into the needs of communication of data with

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simple structure like the data from the sensors.

Fig.C. Zig-Bee

IV. SOFTWARE DESCRIPTION

A. *µVision® IDE*

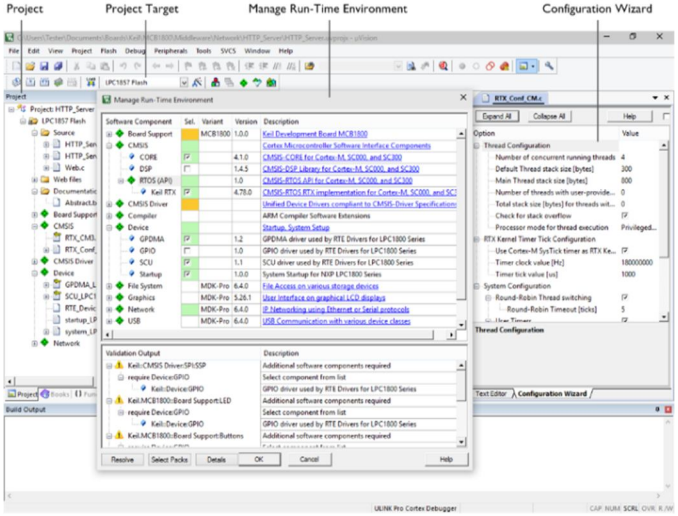
The µvision IDE combines project management, run-time environment, build facilities, source code editing, and program debugging in a single powerful environment.

µVision is easy-to-use and accelerates the embedded software development. µVision supports multiple screens and allow you to create individual windows layouts anywhere on the visual surface. The µVision Debugger provides a single environment in which it can be tested, verified and optimised the application code. The debugger includes traditional features like simple and complex breakpoints, watch widows , execution control and provides full visibility to device peripheral.

B. *µVision Project Manager and Run-time Environment*

With the µVision Project Manager and Run-time Environment software application can be created using pre-build software components and device support from software packs. The software components contains libraries, source modules, configuration files, source code templates and documentation. Software components can be generic to support a wide range of device and applications

Fig.IV.B.1._µVision® IDE:



1) The project window shows application source files and selected software components. Below the components the corresponding library and configuration files are found.
2) Projects support multiple targets. They ease configuration management and may be used to generate debug and release builds or adoption for different hardware platforms.
3) The Management Run-Time Environment window shows all software components that are compatible with the selected device.

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Inter-dependencies of software components are clearly identified with validation message.

4) The Configuration Wizard is an integrated editor utility for generating GUI like configuration controls in assembler, C/C++,or initialization files.

V. WORKING DESCRIPTION

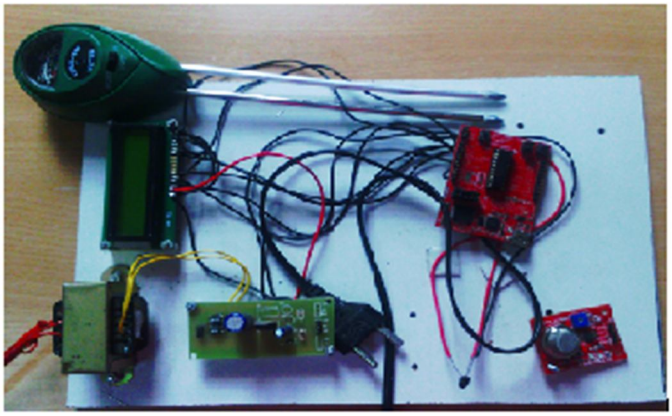
A. Step 1: The sensor detects the corresponding changes in the environment and converts them into analog signal due to its semiconductor property.

B. Step 2: The analog signal from the sensors fed to the Analog pin of the controller MSP 430G2553 where it is converted into digital value and displayed in LCD.

C. Step 3: The data send to the LCD placed inside the industry for workers clarification through ZigBee. Whereas data transmitted to the receiver end (Pollution control board) via GSM and displayed on the LCD. Note: MSP 430G 2553 has single transmitter pin so relay is used for performing switching operation between the ZigBee and GSM connection.

D. Step 4: In coding itself pre-defined value is assigned when the sensor value cross that limit automatic alarm is generated for alerting the workers.

VI. PROTOTYPE



VII. RESULT

Table VII.A.1.Output Measured in Normal Environment

SENSORS	MEASURED OUTPUT VALUES
TEMPERATURE SENSOR	33°C
GAS SENSOR	CO: 7 ppm
AIR POLLUTION SENSOR	CO_2 : 400 ppm
pH SENSOR	pH Level: 8

VIII. CONCLUSION

This project mainly concentrate on people health who works on industries because they have high chance for the continuous exposure to the hazardous gases. To prevent their health proper monitoring system should be designed. Keeping this in mind this module works on measuring the environmental condition in and around the industries. Considering the implementation this prototype is cost effective.

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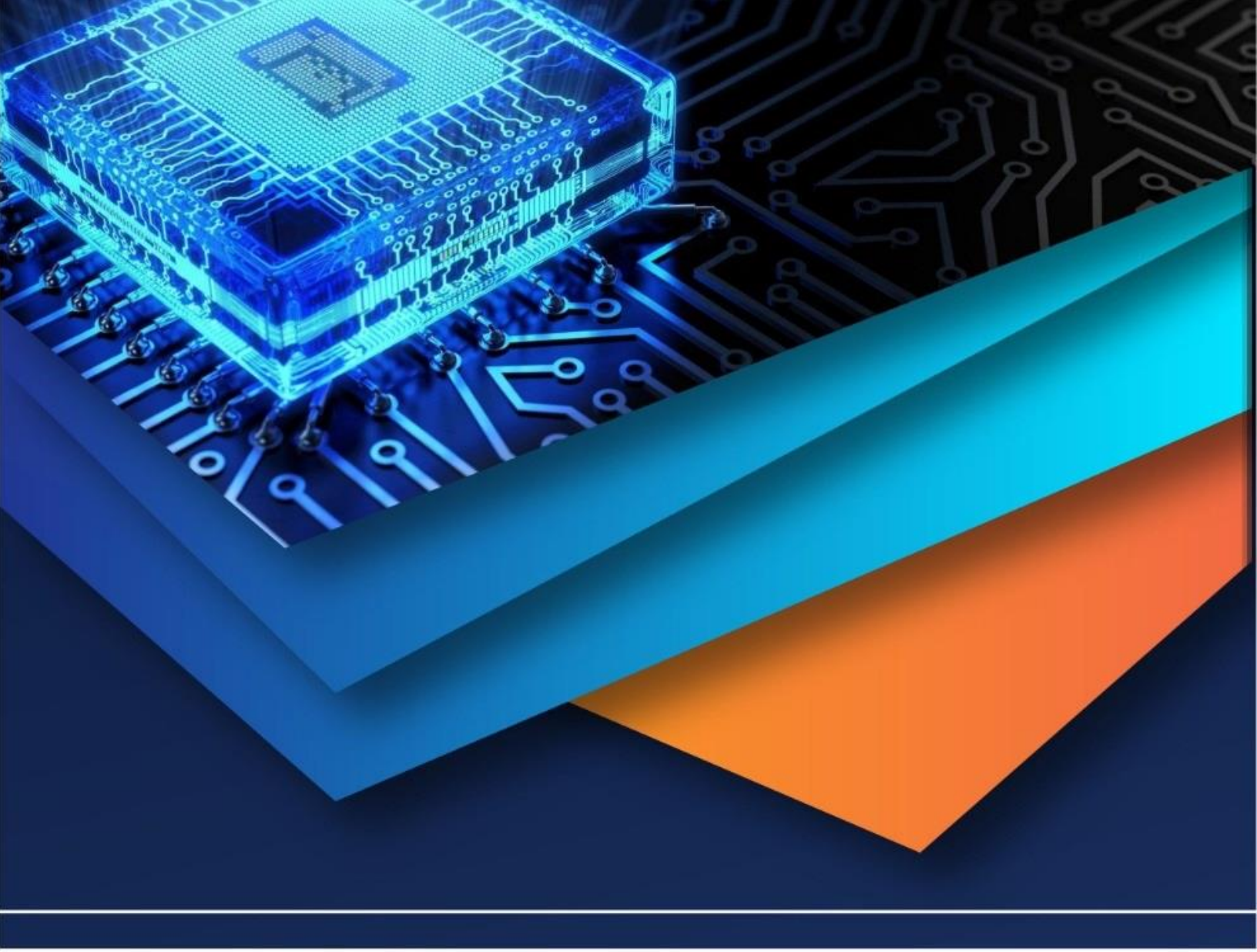

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