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IoT based Smart Irrigation System

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Abstract: Automation in the field of agriculture has brought a new wave of development. The proposed model is based on IoT and its various applications. This system consists of three sensors integrated with IoT to provide the user with real time updates and control of the field. The various sensors used are soil moisture sensor, rain sensor and temperature and humidity sensor. All these sensors help in monitoring the values of important aspects of irrigation and agriculture. With the help of the proposed model, the user would not only be able to see the various sensor values in real time but also control the moisture level and the status of irrigation in real time as well. This model will not only help in preventing water-logging or drought, but will also increase the efficiency of the yield and conserve valuable energy.
Keywords: Smart irrigation, Soil moisture sensor, Rain sensor, IoT based irrigation.

I. INTRODUCTION

Farmers usually work on large pieces of land, and sometimes it becomes difficult to manage the irrigation level of the entire land, which leads to poor quality of crops. However, by switching to IoT based smart irrigation systems, the farmers will not only able to monitor and control the irrigation in their fields, they would also be able to maintain the exact amount of moisture level required by plants which will result in a higher yield of crops.[1] The system consists of three different sensors namely soil moisture sensor, which will monitor and detect the moisture content present in the soil. Then the temperature and humidity sensor (DHT11), which will detect the temperature and humidity values of the surrounding of the plants and the rain sensor, which senses rain, making it easier for the user sitting at a remote location to switch off the water supply when rain comes. All these sensors when used coherently make an efficient system which will automate the field of agriculture and increase the efficiency of irrigation system. The user can monitor and control his/her plants from a remote location and get real time updates in every few seconds. Due to its connectivity over the internet, it provides a certain ease of usage and maintenance. The main advantage of using this system is that by click of a button on your device you can control the water pump at any remote location, which facilitates the user and also make sure that plants maintain a proper moisture level.[3] The entire system is connected to the internet via IoT. The system is connected to the platform named Blynk, where the user can login on any device using his/her credentials and check the status of the system.

II. PROPOSED MODULE

The proposed module consists of 3 different sensors integrated with the NodeMCU ESP8266 board. The whole system is connected to the internet on a IoT platform named Bynk, which acts as an interface between the hardware and the user. The user is facilitated to check different values of various parameters like moisture level, temperature and humidity from any remote location with ease. [4]

A. The Block diagram

The entire system is divided in two main parts i.e., Input side and Output side. The input side consist of all the sensors and the power supply given to the system. One of the main functions of the input side is to collect, detect and observe the values of various parameters i.e., moisture value of the soil, temperature and humidity and the presence of rain. The input side collects all the data and values and sends the data to the NodeMCU Wifi module ESP8266, which controls the entire system. The ESP8266 is the main brains of the system and is responsible for sending various signals and commands to all the parts of the system. The input values received by the ESP8266 is processed, and according to the algorithm fed in it, it compares those values and then send the necessary signals to get the desired output.

The output side consist of the relay module, the IoT platform- Blynk IoT and a 5v DC pump. The NodeMCU microcontroller is integrated with Blynk IoT platform and all the values that are collected on the input side are displayed over Blynk, where the user can access the desired data from a remote location. According to the user's need, he/she can switch the water pump on and off. The block diagram for the system is shown below where the system is divided in 2 broad categories- Input side and Output side.[4]

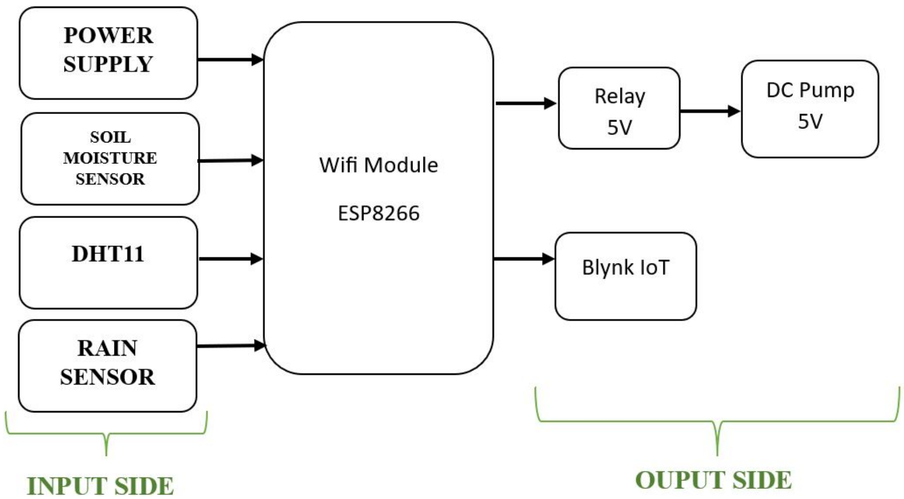

Figure 1: Block Diagram of the system

B. *Hardware Design and Implementation*

The component used in the hardware design of the present work has been tabulated in table 1.

TABLE I List of Hardware Components

S No.	Name	Quantity
1	Soil Moisture sensor	1
2	Temperature and Humidity sensor	1
3	Rain sensor	1
4	Sugar cube Relay	1
5	ESP8266 Microcontroller	1
6	Battery	1
7	DC Pump	1

C. *Soil Moisture Sensor*

The soil moisture sensor is majorly categorized into 2 categories based on its working i.e capacitive and resistive. The one used in this system is resistive. The resistive soil moisture sensor has 2 probes as shown in the figure. The sensor is placed 3 or 4 inches in the soil such that the probes are covered with it. Electric current flows between the two probes and the resistance between them is measured and value of moisture content is found. When the moisture content in the soil is high, the current flows easily i.e., the resistance is less which implies towards high moisture content. When the soil lacks moisture, the resistance between the two probes is high due to which the current does not flow easily, hereby indicating a low moisture content. The resistive soil moisture sensor has 4 pins namely:- Analog pin, Digital pin, Ground(GND) pin and V_{cc} pin. [8]

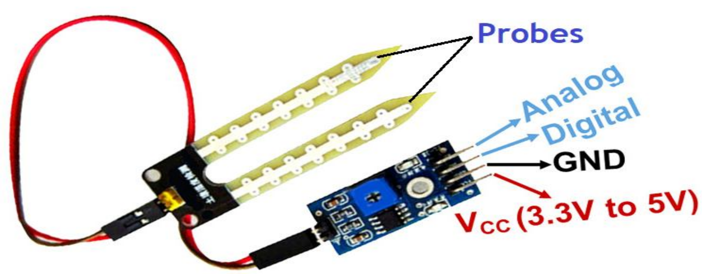

Figure 2: Soil Moisture sensor

D. Rain Sensor

A Rain sensor consist of 2 parts- a sensing pad and a sensor module. This sensor works as a switch, which is normally open. When the rain falls on the sensing pad, the switch closes. The sensor module reads the data from the sensing pad and converts it into digital/analog output, according to the need of the user. The sensor module consists of 4 pins namely- GND (ground), V_{CC}, D_O, A_0. The rain sensor is an important component of the smart irrigation system, as it sends the data to the ESP8266 microcontroller, which in turn sends alerts to the user via the IoT interface. The user can easily know about the status of rain and plan the irrigation accordingly.

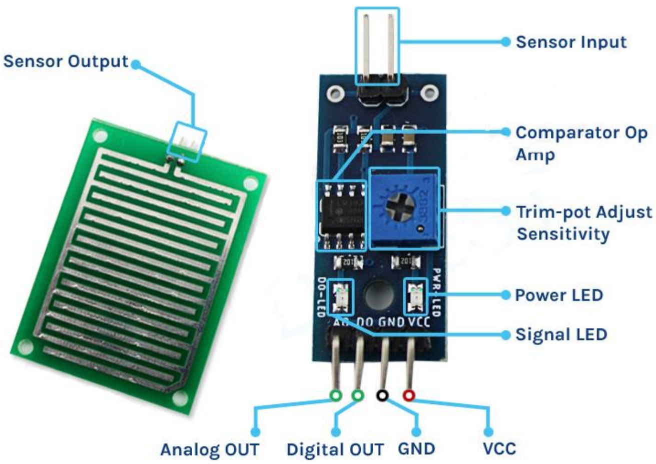

Figure 3: Rain sensor

E. DHT11 (Temperature and Humidity sensor)

DHT11 is a low-cost sensor which measures both humidity and temperature of the surrounding. In agriculture, it is important for some plants to have a proper level of temperature and humidity maintained in order for healthy growth. DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.[2]

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. [2]

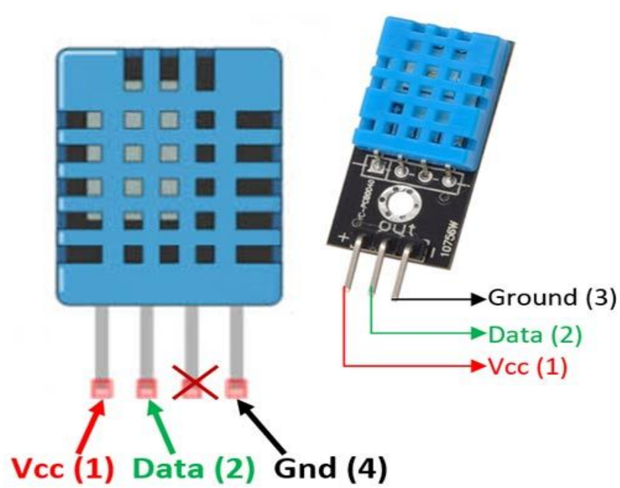

Figure 4: DHT11

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F. Sugar Cube Relay

A sugar cube relay is a switch which is used to isolate 2 different circuits electrically, whilst connecting them magnetically. The relay (switch) opens and closes according to the necessary conditions. A sugar cube relay has 5 pins: - 2 coil pins, a NO (Normally Open) pin, a NC (Normally Closed) pin and a COM pin.

A relay is very important in the working of the whole system, as it controls the working of the dc pump.

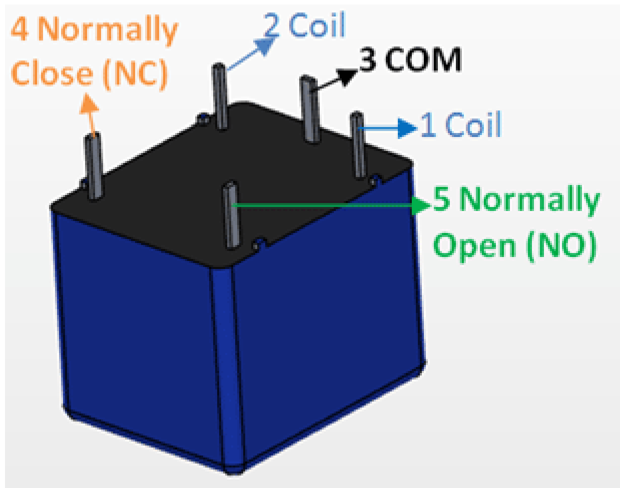

Figure 5: Sugar Cube Relay

G. ESP8266 Microcontroller

The Wifi module or ESP8266 is the main brains of the entire system. The Wifi module collects all the data from the different sensors, and sends the data to the user via internet on the Blynk platform. There are many pins present on the board like: -

1) Power pins- There are 4 power pins i.e., V_{IN} pin and three 3.3 V pins.
2) Ground pins- There are 4 ground pins present on the board.
3) I2C pins- These include the SCL and the SDA pins. It is used to connect I2C peripherals and support both I2C master and slave devices.
4) GPIO pins- There are 17 GPIO pins which have different functions.
5) ADC- One ADC pin is present on the board.
6) UART pins- The microcontroller has 2 UART pins, UART 0 is used for data communication, whereas UART 1 is used for data logging.
7) SPI pins- There are 2 SPI interfaces present on the board (SPI and HSPI)

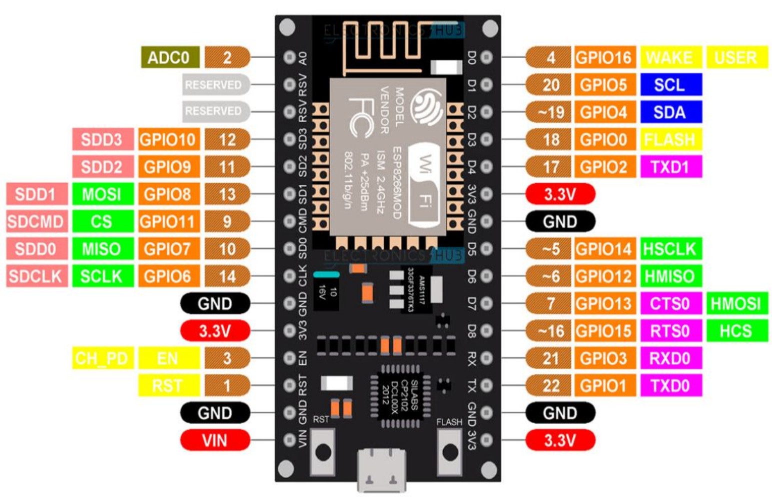

Figure 6: Pin Diagram of ESP8266 Microcontroller

IV. WORKING OF SYSTEM

A. Design of Project

On the basis of working, the entire system has been divided in 3 main sections i.e., Sensor section, Control section and IoT section.

1) Sensor Section

This section comprises of 3 sensors i.e., soil moisture sensor, rain sensor and DHT11 sensor.

The soil moisture sensor used works on the resistance principle i.e., it measures the electrical resistance of the soil between the two probes. The probes are made of such a material that they can withstand the corrosion by moisture content. When the soil is dry i.e., the moisture content is low, the resistance between the two probes is high and when the soil is wet, the conductivity of the soil increases and thus the resistance between the two probes decreases. The sensor is connected to a circuit which measures the resistance and converts it into a signal which can be used to indicate moisture level of the soil. This value of the moisture is read by NodeMCU microcontroller and is communicated over on the internet and displayed on the Blynk webpage, where the user can see it.[7]

The rain sensor is used to send notifications when it rains. The sensor has a plate which has nickel coated on it in form of lines. The sensor works on the principle of resistance. When there is no rain, the resistance is high and thus we get a high voltage in result. When it rains, the water falls on the sensor and the resistance decreases. This results in lower voltage.

The DHT11 sensor is used for measuring temperature and humidity of the air around it. Measuring humidity can be done using the DHT11 sensor's capacitive humidity sensor. As the moisture in the air changes, the capacitance of the sensor changes, which is then converted into a humidity reading. To measure temperature, the DHT11 sensor uses a thermistor. A thermistor is a type of resistor whose resistance changes with temperature. The DHT11 sensor's thermistor is made of a ceramic material with a negative temperature coefficient, which means its resistance decreases as the temperature increases. By measuring the thermistor's resistance, the temperature can be calculated using an equation or a lookup table. The DHT11 Sensor combines the temperature and humidity readings into a 40-bit data stream, which is sent to microcontroller to be decoded and converted into actual temperature and humidity values.

The design for the project is shown below.

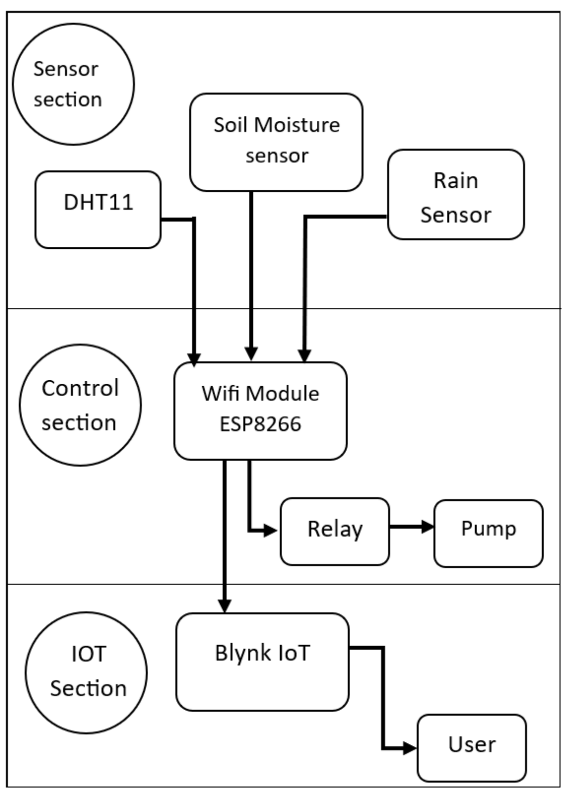

Figure 7: Design of the project

2) Control Section

This section comprises of the NodeMCU module which is the brains of the entire system, the relay and the dc pump. The ESP8266 is not only used for storing the code, but also for transmittance of data over the internet using wifi. The NodeMCU module is responsible for collecting the data from the sensors and transmitting it over the internet to the Blynk webpage. It also receives instructions and commands from the blynk platform and turns on the water pump accordingly. The relay is used as a switch and is used to turn on and off the water pump accordingly.

3) IoT Section

It comprises of the Blynk webpage and provides a user-friendly interface, where the user can interact with the whole system and get informed about the real time values of various sensors and can take action accordingly. The IoT platform not only provides a friendly interface but also provides push notifications when the moisture dops below a set threshold value. The threshold value can be set according to the requirement of the user. Also, when it rains, the user is alerted via push notification through Blynk.

B. Algorithm of the project

The project uses Arduino Uno platform for development of the code used for the project. The code specifies different threshold values (which can be altered according to the user) for rain sensor and soil moisture sensor. When the value of the sensor drops below the threshold value, the user gets a push notification on his/her device, which will alert the user to take necessary action. This process not only maintains a proper moisture level in the soil, but also alerts the user to switch off the irrigation in case of rainfall, so as to reduce water wastage.[5]

The flowchart for the proposed system is shown below.

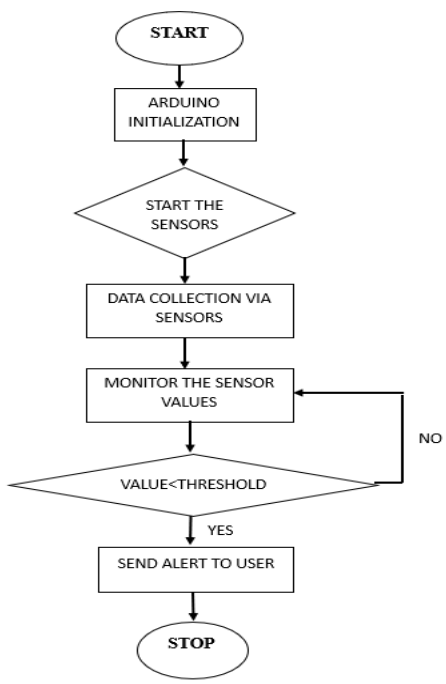

Figure 8: Flowchart for algorithm of system

V. CONCLUSION AND FUTURE SCOPE

IoT based smart irrigation systems are not only automating the entire agricultural industry, but will also revolutionize the irrigation aspect. The sensors when integrated with ESP8266 and Blynk platform provide a system which automates irrigation and updates the value of various parameters in real-time. This system not only prevents over and under irrigation, but also leads to a moisture-controlled growth of plants of higher quality. Irrigation and IoT linked together give a promising technology which will alter the efficiency of agriculture on a large scale. Adoption of this technique will help address the problem of water shortage, climate change, limited space and expensive labour.

Integrating IoT based systems with advanced technologies like blockchain, machine learning and artificial intelligence will not only expand the horizons of usage of this system but will make it more advanced and efficient.

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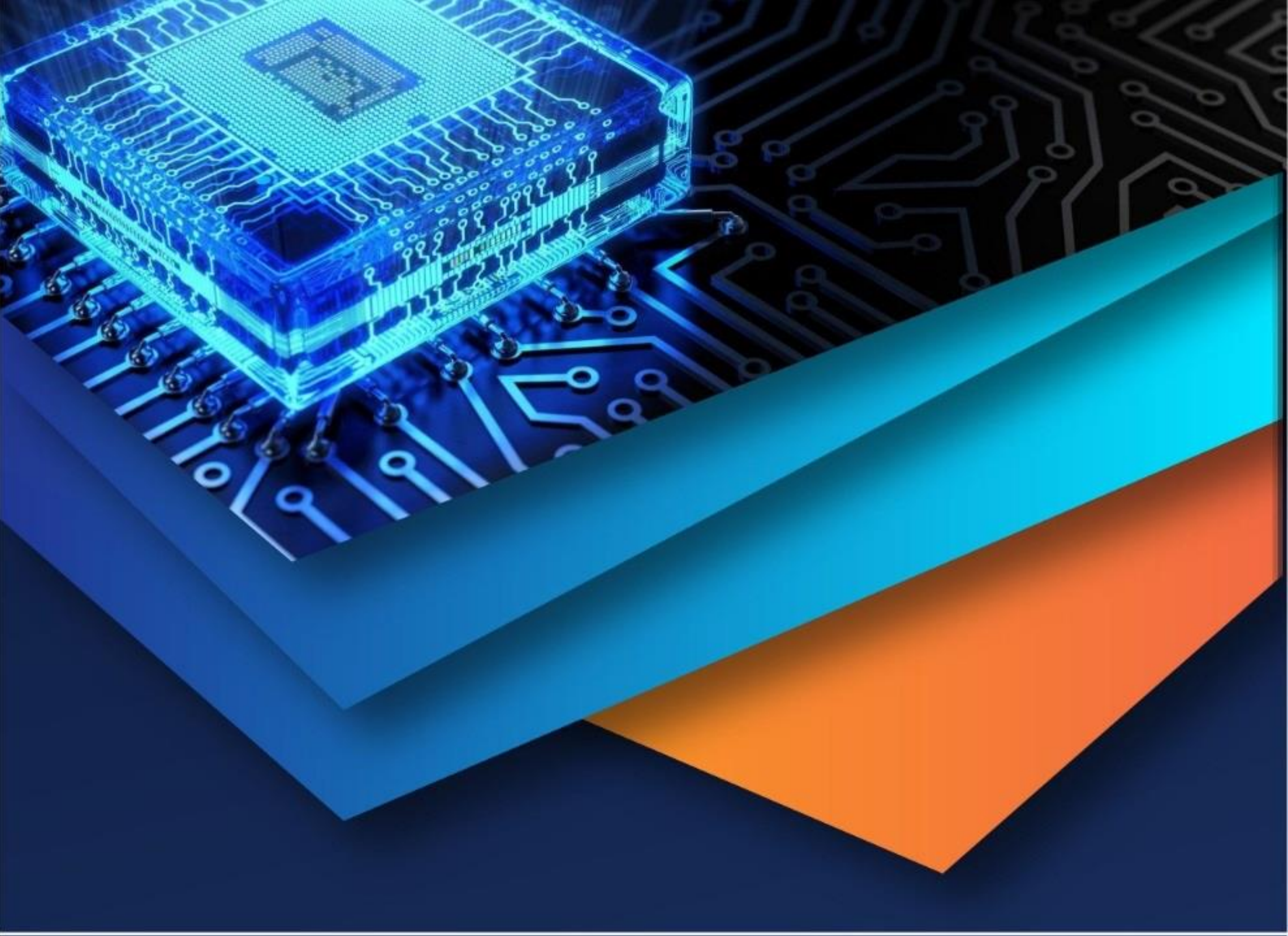

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