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Smart Irrigation Systems using Internet of Things for Smart Farming

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Abstract: This paper proposes an intelligent irrigation system with the assistance of the Internet of Things (IoT). IoT can be referred to as physical objects that can communicate and generate relevant data. This paper solves the problem of water wastage on farms by automating the irrigation system. The system has been developed using specific sensors such as temperature, soil moisture and humidity. Arduino micro-controller and Global System for Mobile Communication (GSM) are also used, providing reasonable handling. It uploads the data to the database and displays the readings on a web application. Finally, the sensor's reading values control a pump/motor. As a result, this paper automates the irrigation system by analyzing soil moisture and temperature, covering essential aspects such as labor, power consumption, reliability and cost.
Keywords: Internet of Things (IoT), Arduino, Global System for Mobile(GSM), web app, microcontroller, sensor .

I. INTRODUCTION

Utilizing the Internet of Things (IoT), any ranch can undoubtedly be modernized. This technology is utilized to modernize anything. The primary utilization of this technology is to robotize the manuals. Everybody is effectively computerizing their family and businesses nowadays. The large greenhouse ranches utilize this technology to deliver more[1].

Getting the ideal data at the ideal time is significant for running a homestead. Flighty conditions and customary cultivating practices probably will not give the ideal nature of the crop. Having a web effective stage that can give admittance to cultivate information whenever and any place can help deal with the homestead effectively and more productively. A firm associated with various sensors, once introduced in the homestead, can screen essential boundaries like temperature, pressure, moistness, climate conditions, soil boundaries, leaf wetness, Etc.

Shrewd cultivating is exceptionally well known these days[2]. To deliver more with less exertion, it comprises coordinating current advancements in conventional farming to raise the quality and the number of rural items. By utilizing this innovation, ranchers can undoubtedly satisfy their necessities, giving them the likelihood to screen and control their homesteads. As A "Shrewd Farm", a ranch is fit to play out a few activities on the double[3]. Consequently, savvy cultivating is fundamental to dealing with a large homestead and for better administration.

The expanded measure of water being poured non-convenient watering is the most severe issue for creating harvests that prompt wastage. Most of the time, permitting pretty much water in the field causes the obliteration of the crops. As, commonly far away from the field, ranchers cannot get appropriate homestead data and control the water system process. The weight of any individual would be facilitated to have programmed command over such boundaries and ideal observation. Low efficiency is caused by customary strategies like manual water systems overutilization of pesticides. Agriculture is reversed due to these conventional methods[4]—lack of comprehension of legitimate techniques and dealing with different yields like the water board.

Without much of a stretch, the issue of a water board can be settled with the assistance of a computerized miniature controller. Likewise, a pump/motor/engine/siphon can undoubtedly be controlled with the assistance of a micro-controller.

We are attempting to develop an intelligent IoT module by which farmers can get live data from their farms. Using these data(temperature, soil moisture, humidity) motor will be controlled automatically.

The motor will activate when the temperature, soil moisture value reach a certain point. An alarm will also go on when the temperature, soil moisture and humidity reach a certain point. In our task, we will utilize Arduino as a micro-controller.To read all the information and aspects of the field, we are going to use the Global system for mobile communication(GSM) in our module, which requires a Subscriber Identity Module (SIM) to operate[5]. At last, every one of the information and manual/programmed command over the water system framework is seen, and every one of the viewpoints is controlled with a web application.

The paper's construction is as follows: in section II review of the literature review is presented. The section III provides the information of proposed module. Then, section IV provides information about system design, soil moisture sensor, temperature sensor, humidity sensor, programmed motor control, implementation details and working methodology and web app. Finally, the Experimental Result and Analysis are presented in section V, and the conclusion and future work are in section VI.

II. LITERATURE REVIEW

Farmers did not care about soil moisture, water level, and the environment in the past times. For any problems, the farmers used to use pesticides or assume that some bugs are causing those problems, resulting in less crop production. If they could take the temperature, soil moisture and humidity into account, these problems would never arise. The farmers also assume if it is going to rain or not. They delay the irrigation process by assuming this, resulting in a problem. In most rural areas, farmers only follow their instinct. For example, the farmers randomly water their farms.

It is assessed by prem prakash[6] that by 2050 the worldwide population will reach 9 billion.so, we want to comprehend present-day advances to develop more. There are multiple ways IoT and different innovations are being utilized to meet the demand. In[7], we learned that few out of every odd rancher could utilize or have an individual computer. So, Nayand Anand and puri Vikram utilized ESP32 miniature regulator and Blynk versatile application for live data. According to Vaibhavraj Raham and others, WSN incorporates the steering calculations, which gives modules like animal tracking, health following Etc.[8].There are more costly choices accessible in [9],[6], yet a large portion of the ranchers can say manage its cost.

Legitimate code,algorithm and configuration give more sustainability[10],[11].The blend of poly house and IoT gadgets is one more method for cultivating in a controlled manner. It safeguards the harvests from weighty rainfall, sun rays, storms Etc.[16].Motions identifiers are generally utilized in certain homesteads in which sensors distinguish uncommon development. The information is shipped off the server, which actuates some alert framework to unnerve way animals[12].

A few ranches use passages introduced with a gadget programming stage called &Cube[18]. The door utilizes a server called Mobius. The blocking of covering laves marked watershed algorithm is used[13]. For better livestock production, remote neck restraints are being utilized to discover the area of homestead animals[14]. The Sea-lice strategy is used to settle hydroponics issues like swarming [15]. For better shape and tones in sweet peppers, RGB-D sensors are used[16]. Monte Carlo reenactment is used to discover the age of some particular plant-like coconut [17].post-gathering is further developing quickly after utilizing brilliant farming[18,17].To measure the water stress in leaves, EM4325 UHF chips are generally used[19]. Deep learning procedures are being utilized to distinguish disease nutrients of crops[20]. The authors share edge hubs challenges that are looked at during significant distance transmission of information [21]. For gathering thermal and multi-spectral structures on a ranch UAV, 's can be used[22]. The disease that ordinarily assaults pants can undoubtedly be recognized by involving image processing[23].

Optimal precision in error detection can be accomplished without much of a stretch by utilizing reduce and Hadoop framework for IoT, big data, and a cloud[24]. Recently in many ranches, AI has been acquainted with keeping up with the development of ranch animals[25]. Many ranches utilize GPS-based controller drones to screen or forestall theft these days. These tasks are being performed by utilizing ZigBee modules with the miniature controller[31]. For the investigations of yield phenotyping, field research facilities are being utilized with present-day IoT technologies[26].In the late days, the relational database was utilized like MySQLl[27]. Nowadays, innovations like IBM[28] sensor cloud[29] offer great help to explicit IoT sensors. A few centre product stages uphold IoT significantly, like UBIDOTS, Xively, Thing Speak, open sense and sensor cloud.

III. PROPOSED MODULE

The paper proposes an intelligent IoT module for irrigation on a farm. The framework utilizes IoT innovation which primarily utilizes GSM and Arduino miniature controllers. By utilizing the IoT innovation, the module gives continuous information (temperature, soil moisture, humidity) and gives programmed commands over a motor. When the worth of the temperature, soil moisture, humidity arrives at a specific edge, the motor turns on automatically. The information is shown by utilizing web technology. Likewise, the motor can be controlled physically by utilizing similar technology. The exactness of the undertaking depends on the sensors. The complete venture depends on the worth accumulated by the sensors. MySQL[30] is utilized as a relational database for gathering information assembled by the sensors. The module of the project is as per the following

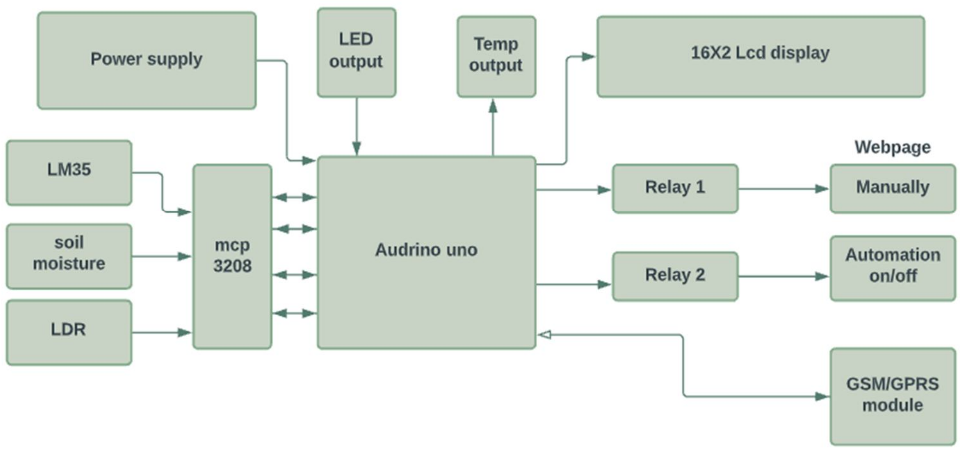


Fig. 1 Block diagram of proposed module

IV. COMPONENTS OF THE PROPOSED MODULE

The main components of the proposed module are described below:

A. *Arduino Miniature Controller*

In this paper, we are utilizing a variety of innovations like Arduino micro-controller, IoT sensors, web innovation Etc. We are utilizing Arduino as eight-digit CPU architecture, which is enough for this paper. Fig2 represents the framework for the proposed system. Arduino likewise gives more straightforward equipment and programming architecture. Moreover, Arduino provides 16MHz of handling power. The primary explanation for utilizing Arduino is that it is less expensive and needs less power, around 200Mw.

B. *Soil Moisture Sensor*

The water necessities of different yields are different. The globally utilized table can be utilized to decide the standard water prerequisite. The fundamental issue of oversupply on less water stock is addressed by utilizing advanced pins of Arduino[31].

The dampness sensor perusing contributes to the advanced pin introduced on the farm. Depending on the worth of the dampness sensor, the water system will turn on; consequently, that can likewise be controlled manually[32]. once the dirt arrives at the specific dampness esteem, the water system stops. The limit for soil dampness sensors is 200 bar. Anything under 200 turns naturally on the water system, and the client also gets an SMS alert. Additionally, the IoT module has a caution set that rings when the dampness goes under 200.

C. Temperature Sensor

The perusing from the temperature sensor additionally controls the water system. For example, the edge of the temperature is 50^0c; when the dirt temperature compasses to 50^0c, the motor will turn on, and the alarm will ring.

D. Programmed Motor Control

Arduino micro-controller is the core of the project. Therefore, the detailed audit about the association of the motor is as per the following.

The advanced pin of the micro-controller and the producer has been associated with the GSM module[43].

The contribution to the micro-controller is perusing each accessible sensor which worth controls the water system. For example, if the dirt dampness sensor esteem is under 200 or temperature sensor esteem is more than 50^0c, the engine/motor will turn on automatically. That can likewise be controlled physically by utilizing the web application.

The water supply will be as indicated by the crops. Firstly, the ranchers need to discover how much water is required for the homestead. Then keep that amount of water in the reservoir[44]. That tackles the issue of spilling over or less water utilization in the field. The pump/motor can easily be set near a river/canal or pond near the farm to tackle water shortage.

GSM is executed on the IoT module to peruse all the sensors data put on the field. The GSM module is a double band module with message situated and message terminated elements. Values, for example, soil moisture, temperature, humidity, pump/engine control, are observed by utilizing this GSM module[33]. GSM is expected to work correctly with Tx, Rx control pins and +5v of power supply. Therefore, chip GSM needs to give two different power supplies for the equipment and programming.

E. GSM

To control specific parts of the field from a distance with admittance to the web GSM module is fundamentally utilized in IoT systems. All the boundaries can be accomplished, and SMS are sent by utilizing the GSM module[34].

1) Value accomplished from soil dampness sensor
2) Value accomplished from the temperature sensor
3) Value of humidity
4) Status of the water system.

F. Implementation Details and Working Methodology

The module's primary purpose is to collect data using specific sensors and perform some operations according to those data. The proposed module is illustrated in figure1. The gathered data is also stored in a database and can easily be accessed by the web application.

The algorithm of the overall process:-

Step 1:start the process

Step 2:connect to the network

Step 3:Read the sensor values(temperature,soil moisture,humidity)

Step 4: if(temperature value >=50^0c OR moisture value < 200 bar) Turn on Motor

Step 5:End

As described in step1, first, the network gets established using the GSM module. After steps 1,2 and 3, the values are stored in a database for monitoring. The motor's automatic operation depends on the temperature and moisture value described in step 4. For example, if the sensor value of the soil moisture is less than 200 bar or the temperature is more significant than 50^0c, the motor automatically turns on. The proposed system was tested several times to ensure accuracy and performance.

G. Web App

Firstly, there is a landing page on the web app. On the landing page, there are specific components like the project Features and login options are provided. After clicking the log in button from the menu, it takes to the log in part of the website, asking the user to provide the required id and password. After providing the required id and password, it takes the user to the page where soil moisture, temperature, humidity is shown. On this page, we can also manually control the irrigation system. The page also contains a data button that shows the data in tabular form with the proper time and date. Finally, by clicking the logout button, the user can log out.

IV. EXPERIMENTAL RESULT AND ANALYSIS

The feasibility of practical applications is verified by implementing the proposed system in various situations. The proposed method provides crucial parameters such as humidity, temperature, and soil moisture. Data measured by the proposed module is considered observed data, and data taken from the internet is regarded as actual data. In figure 2, the actual module of the proposed system is shown. This experimental data and actual data are taken on March 4, 2022. The actual data was taken from https://www.timeanddate.com/weather/india/greater-noida. Using the following equation, the percentage of error between the actual and experimental information is also defined.

Error percentage=((actual data - observed data)/actual data)) * 100 ;[35]

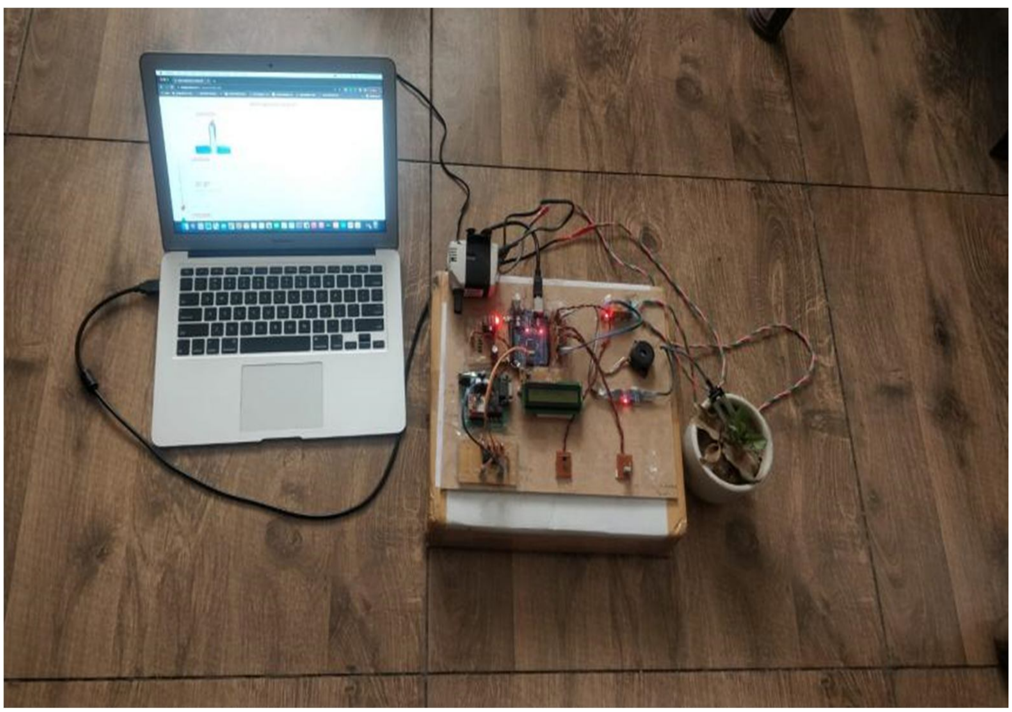


Fig.2 Representation proposed module

In table1, the proposed system's data of soil moisture are shown as we cannot get soil moisture data from the internet without an analog device. The observed result from the proposed system and the actual temperature measurement from the internet is shown in table2 and the humidity measurement in table3, where the error percentage is also represented. The difference between actual and observed data is represented graphically in the Fi.3 (a-b).Fig.3(a) represents the difference between the observed and actual temperature data graphically. Due to lack of sensitivity or technical problems, the proposed system provided different humidity measurements than the actual data.

TABLE I: Soil moisture estimated by proposed module.

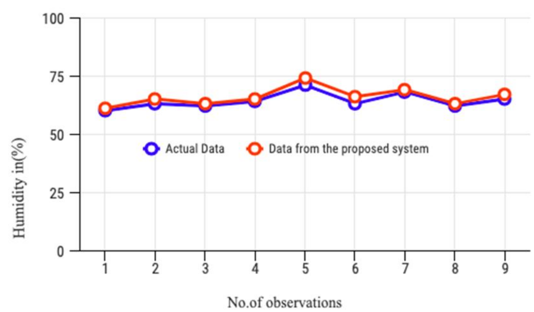
No. of observations	Data from the proposed system(bar)
1	172
2	171
3	180
4	176
5	174
6	171
7	168
8	165
9	164

TABLE II: Temperature estimated by analog machine and proposed module.

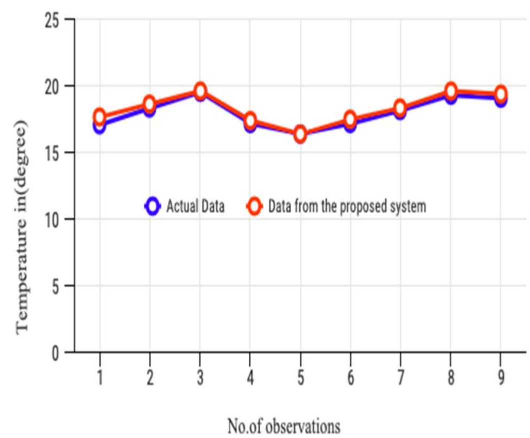
No. of observations	Actual data(bar)	Data from the proposed system(bar)	Percentage of Error (%)
1	17.02	17.60	3.29
2	18.27	18.57	1.64
3	19.45	19.55	0.50
4	17.11	17.33	0.28
5	16.32	16.32	0.0
6	17.11	17.43	1.87
7	18.08	18.28	1.10
8	19.23	19.55	1.61
9	19.01	19.32	1.63

TABLE III: Humidity estimated by analog machine and proposed module.

No. of observations	Actual data(bar)	Data from the proposed system(bar)	Percentage of Error (%)
1	60	61	1.63
2	63	65	3.17
3	62	63	1.61
4	64	65	1.56
5	71	74	4.23
6	63	66	4.76
7	68	69	1.47
8	62	63	1.61
9	65	67	3.08



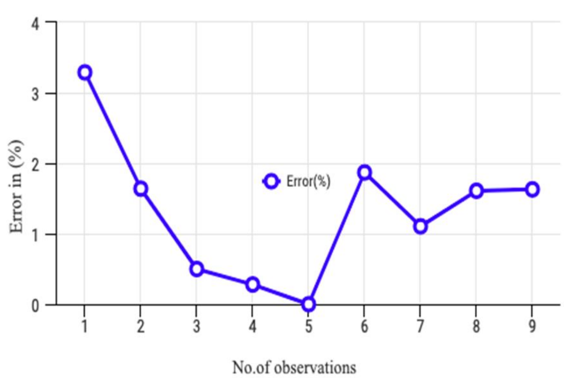
a) Temperature



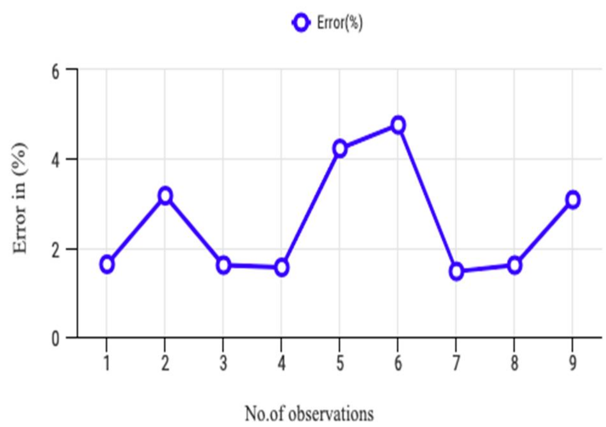
b) Humidity

Fig. 3 Actual data and proposed data a) temperature b)humidity

The error percentage of temperature is shown in table2, and the graphical representation is also shown in figure.4(a). The maximum error percentage of temperature is 3.29%, and the average percentage is 1.32%. Finally, the humidity error percentage is shown in table3 and the graphical representation in 4(b). The maximum error percentage of humidity is 4.76%, and the average percentage is 2.56%.



a) Temperature



c) Humidity

Fig. 4 Error percentage of the proposed module a)temperature b)humidity

V. CONCLUSION AND FUTURE WORK

This work proposes an intelligent farming module that uses (Internet of Things) IoT technology, mainly (Global System for Mobile Communication) GSM and micro-controller. The accuracy of the project relies on the sensors. The total project and working of the project rely on the values of the sensors. By using this module, farmers can quickly get real-time data of the farm (temperature, soil moisture, humidity)from anywhere. When the temperature, humidity, soil moisture value crosses the threshold, the motor turns on. The data can be accessed through the web app. The motor can also be controlled manually by using the web app.

In future, we can also implement the below technologies:

1) To cut down the cost more effectively, we could use solar energy wind energy.
2) We could also include weather prediction.
3) Access rainwater removal module can be installed.
4) Drones can be used to monitor a large farm.

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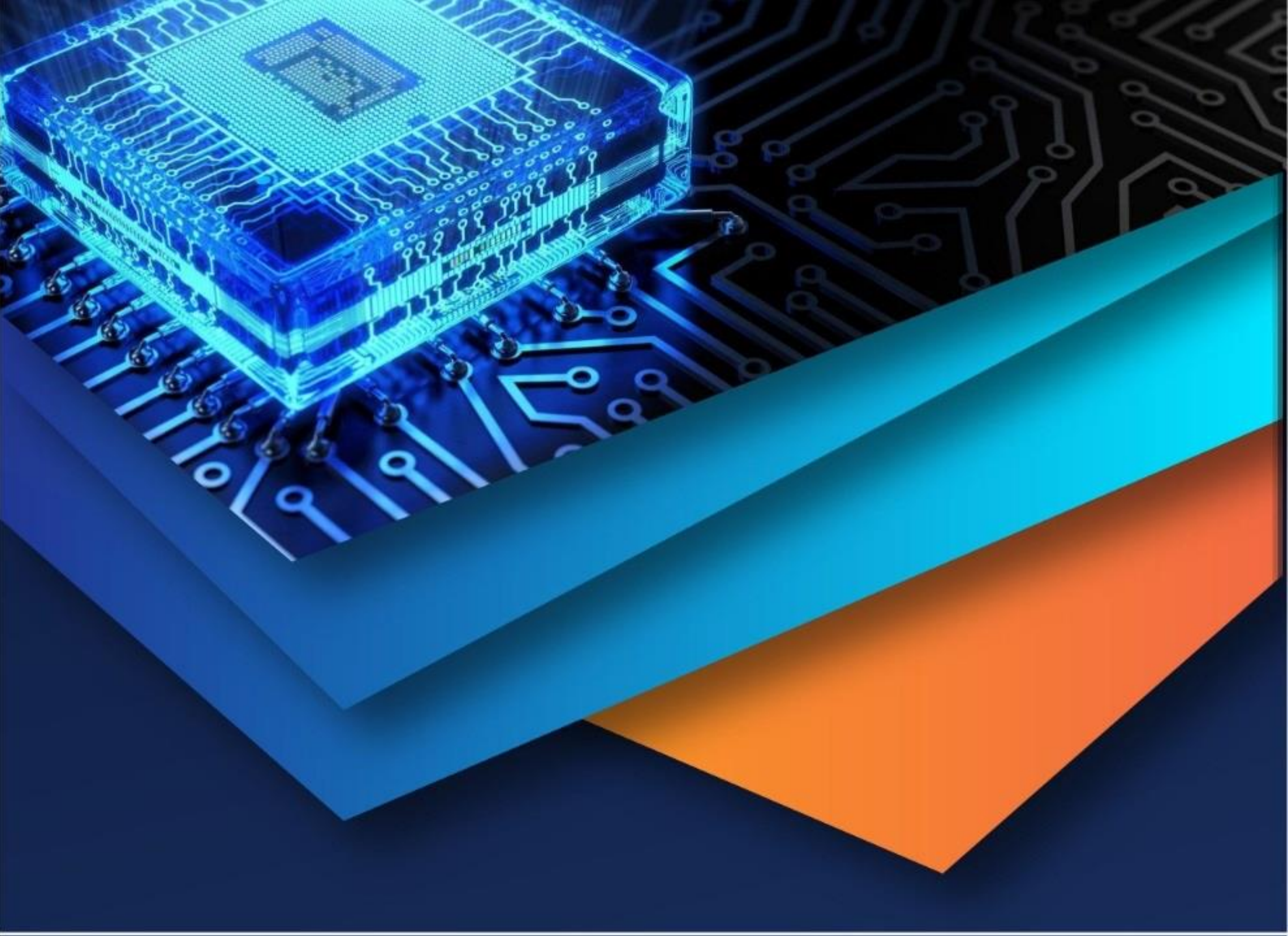

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