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Environment Monitoring using Wireless Sensor Network for Agricultural Application

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Abstract: ***In today's life environment is crucial problem affecting life of human being and agriculture sector as well. The need for monitoring agricultural field and its environmental parameters to manage proper irrigation and maintain soil quality has brought the attention of technologist towards it. The exploding population, changes in temperature and reduced water availability has made it necessary to manage proper utilization of various resources required for farming and to control environment parameters as per requirement for each product as well. Emerging environment problems have great impact on Technology, Science, Social environment, and economical field. Globally this issue has raised many discussions for finding solution. Among various technological solutions, some of techniques are using Satellite system, Wireless network, Sensor network, and so on. This paper presents study results using Wireless sensor network, Internet of things, sensors, and Raspberry pi. The system is low-cost and low-power consuming system. This system is highly scalable in terms of number of sensors and type of sensors. With over a decay of research and development in wireless technology and sensor development, Wireless Sensor Network technology has been growing as efficient and economic solution for various application areas.***
Keywords: Agriculture, Environment monitoring, IoT, Raspberry Pi, WSN.

I. INTRODUCTION

With over a decay of research and development in wireless technology and sensor development, Wireless Sensor Network technology has been growing as efficient and economic solution for various application areas. Early work on wireless network and sensor network have been focused on the development of enabling technologies by addressing various challenges such as routing, communication, OS for sensor networks, and middleware[1][2]. The proper use of WSNs can reduce failure rate and increase efficiency in any industry. Environment monitoring system acquires data from environment and sent it to central system to generate signals, messages or any other output. The system is capable of monitoring or measuring parameters like temperature, humidity, pressure and quality of gasses like oxygen, CO2 etc. These parameters are important in applications like industry, Green house, weather forecasting and smart homes [3].

A. To design and develop environment monitoring system, here is the list of tools that can be used

1) *Wireless Sensor Network:* Wireless Sensor networks are cost effective and less failing systems. Wireless Sensor networks are also called as wireless sensor and actuator networks (WSAN) [4][5]. WSNs are spatially distributed autonomous sensors able to monitor physical conditions in deployed environment and transfer that data to locally installed system. Data transmission is done through network using transmitters. Wireless network was motivated by Military applications like surveillance. Now a day's WSNs are used in many applications like machine health monitoring, industry automation, security, consumer applications, environment monitoring, and so on.

The WSN is built of nodes from few nodes to several hundreds of nodes. All nodes are connected to each other through wireless network. Each node is connected to one or more sensors. Each sensor node has typically several parts/components like radio transceiver, a microcontroller, and a battery or an embedded source of energy. The topology for WSN vary from simple star network to and advanced mesh network [6][7].

The main characteristics of a WSN include:

a) Power consumption constraints for nodes using batteries or energy harvesting
b) Ability to cope with node failures (resilience)
c) Some mobility of nodes (for highly mobile nodes see MWSNs)
d) Heterogeneity of nodes
e) Scalability to large scale of deployment

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f) Ability to withstand harsh environmental conditions
g) Ease of use
h) Cross-layer design [8]

2) *Internet of Things:* The Internet of things is the network of physical devices, buildings, vehicles, equipments like sensors, software, and network connectivity to collect and transfer data. IoT allows remote object sensing and controlling. Objects can be integrated in existing networks. This integration results in more efficiency, accuracy and economic benefits. Use of IoT reduces human intervention in any application. IoT when used with sensors and actuators, the technology can be called general instance of cyber-physical system. Advanced connectivity across devices, services, and systems goes beyond machine to machine communication. The advanced connectivity covers a variety of protocols, domains and general as well particular applications. Applications covered by IoT include smart grid, smart homes, virtual power plant, smart cities and intelligent transportation system [9-23].

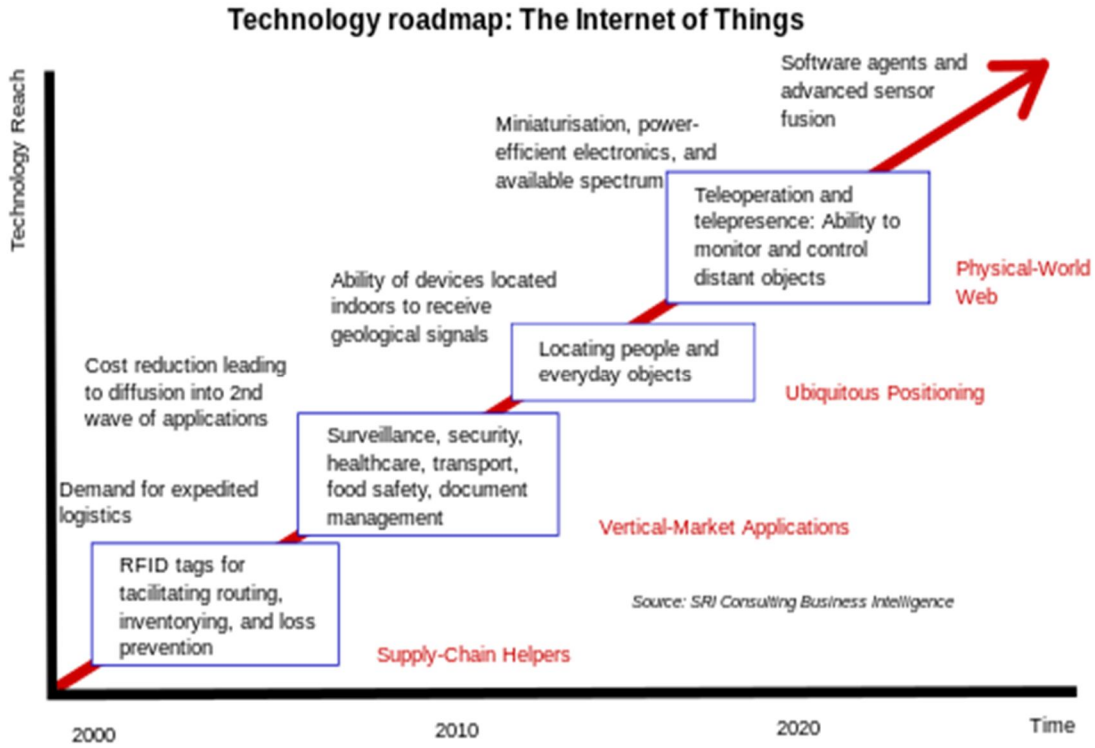

Fig. 1 Technology Roadmap: internet of Things[31]

3) *Raspberry Pi:* Raspberry Pi is an single board computer designed by Raspberry Pi Foundation to promote computer science teaching in schools and developing countries. Till date several models/generations of Raspberry Pi model have been released [24]. Some of the models are listed as follow, with release date in bracket [25][26]

a) First Model Raspberry Pi 1 Model B (Feb 2012)
b) Model A
c) Raspberry Pi 1 Model B+ (2014)
d) Raspberry Pi Zero (Nov 2015)
e) Raspberry Pi 2 (Feb 2015)
f) Raspberry Pi 3 Model B (Feb 2016)
g) Raspberry Pi 3 Model B (Jan 2017)
h) Raspberry Pi Zero W (28 Feb 2017)

4) *Arduino:* Arduino is an open source, computer hardware and software company, project, and user community. They designs and manufactures microcontroller kits. These kits are used for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[27] permitting the

manufacture of Arduino boards and software distribution by anyone.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++.

5) *Environment Parameters:* Using well established set-up of WSN and IoT sensors can sense physical world and do data acquisition. Physical environment can be monitored to read values of parameters like temperature, humidity, and so on. For each of the parameter, we need to install or connect a required type of sensor.

II. LITERATURE SURVEY

Sheikh Ferdoush, Xinrong Li [28], worked on design of Wireless Sensor Network System using Raspberry Pi and Arduino for Environmental Monitoring Applications. The system designed by authors consists of open-source hardware platforms, Arduino, and Raspberry Pi. System structure was low-cost and highly scalable in terms of type and number of sensor nodes. They deployed system at the Department of Electrical Engineering office area of the UNT Discovery Park facility. The Temperature and humidity monitoring system deployed in this paper was designed with Arduino, Raspberry Pi, XBee, and a number of open-source software packages. The system was designed to integrate the gateway node of WSN, web server and database server into one single compact, low-power, credit-card-sized computer Raspberry Pi. The XBee module encapsulates the 802.15.4 radio transceiver and the ZigBee protocol stack. The complex mesh network is automatically formed without intervention from user application running on microcontroller board.

Er.Satvir Singh, Dr.Rajeshwar Singh [29] presented an system architecture to monitor and control environment parameters like temperature, humidity, and pressure. The system was so designed to provide features like monitor environment parameters and take some control action like switch devices ON/OFF from internet. The sensing nodes in system are used sense data and control nodes have been designed to initiate control action. The central monitoring was based on ARM11 Raspberry Pi board. Embedded C system was used to write Software of control node.

Nivedha.S, Shambavi.P, Abhirami.N, Jyothi.A.P, Darwin Britto.R [30] worked on a system design for Hazardous Environment monitoring using Wireless communication. The system was designed to perform data acquisition for parameters like temperature, current, voltage, fire, water level, and poisonous gas leakage. System architecture uses Raspberry Pi, RS232, microcontroller, shifter, encoder, decoder, android terminal or Linux terminal, Gas sensor, Temperature Sensor, Optocoupler for water level sensor, potentiometer. This paper describes the design and implementation of as WSN in industry monitoring using Raspberry Pi. System prevents people from dangerous gases, high voltage and high current.

Hwang J, Shin C, Yoe H [31] did study on an agricultural environment monitoring server system using Wireless Sensor Networks. The system was proposed for agricultural environment monitoring server system. The system was used to monitor outdoor agricultural production environment using WSN technology. The information collected is all about environment and soil information. System collects image information through CCTVs and collects location information through GPS modules. It was expected to increase crop yields and improve quality in agricultural field by supporting the decision of producers.

III. GENERAL SYSTEM ARCHITECTURE

Environment monitoring system, in general, is used to monitor various environment parameters with the help of sensor. Some communication media, like Wireless Communication, is needed to transfer sensor data. If we consider a general architecture that can be deployed for environment monitoring, then it will look like figure 2.

An environment parameter can be temperature, pressure, humidity, GPS location, or an Image. We can design a system to monitor all or any of these parameters as and when required. For monitoring purpose we need to install some sensors on each node. A node will interact with sensor and will transfer that data to controlling unit. A controller will receive data from each node and can take action depending on programming done. User can use Graphical user Interface (GUI) to manage all activities or to check data at any time. GUI can be designed using python, HTML,

CSS or any other language. Depending on sensor types, various monitoring services can be designed. To monitor and control services or action we can use Internet. Data acquired by sensors can be transferred over network by using web server or by using some SMS service. To provide energy, battery cell can be used.

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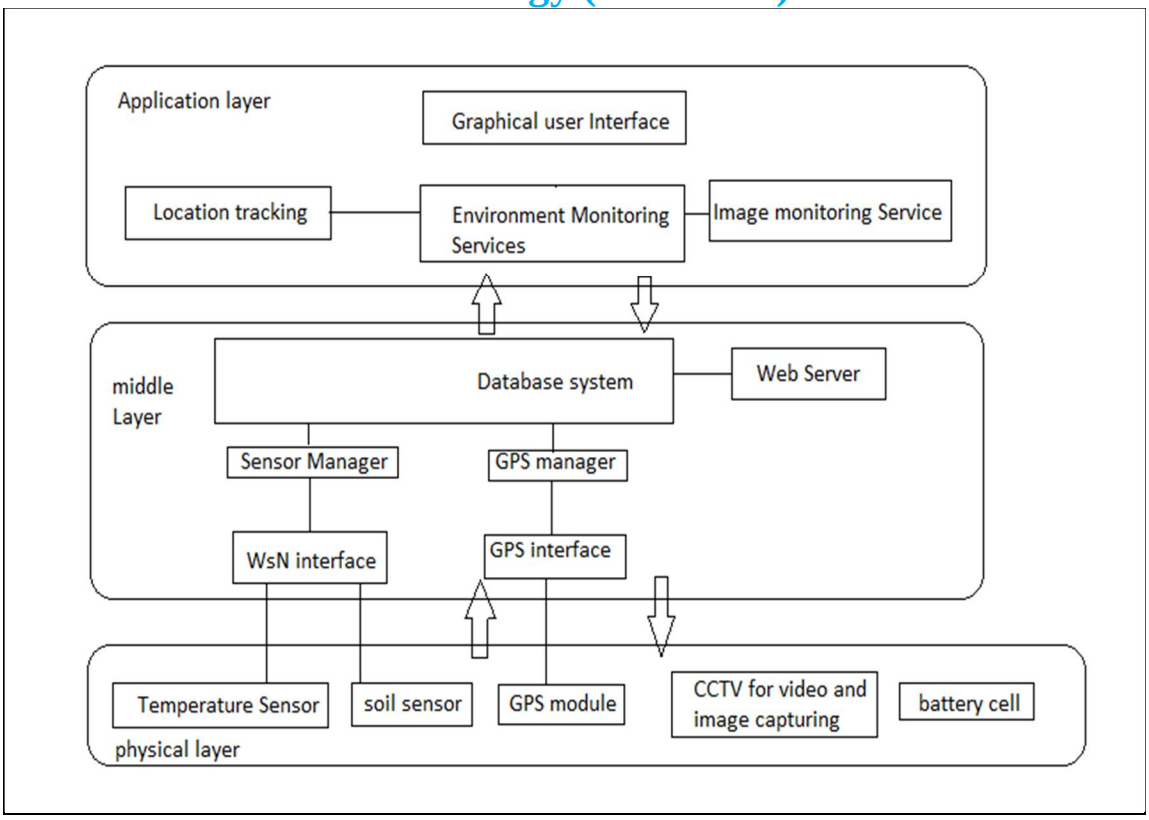

Fig. 2 General architecture for Environment Monitoring System

IV. HARDWARE IMPLEMENTATION

We tried to implement proposed system based on system architecture shown in fig.2. System implementation done by us is shown in Fig. 3.

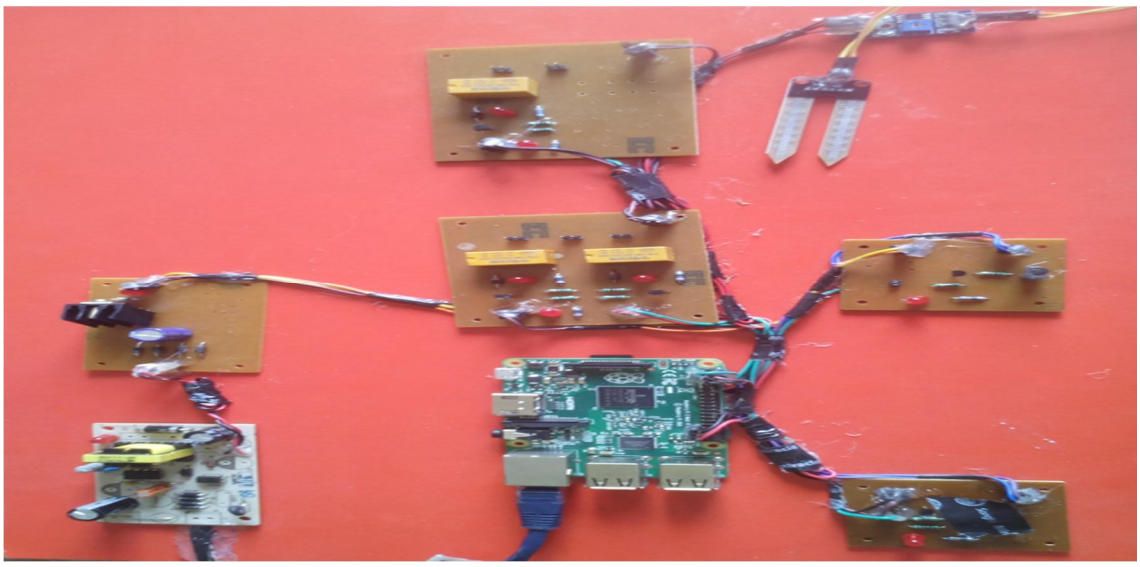

Fig. 3 System Implementation

V. RESULT

System implementation as shown in fig.3 will generate result in the form of email. When soil becomes dry/weight, when temperature changes occur, or changes in light intensity will result in new email. Sample screenshot of emails is shown in fig.4.

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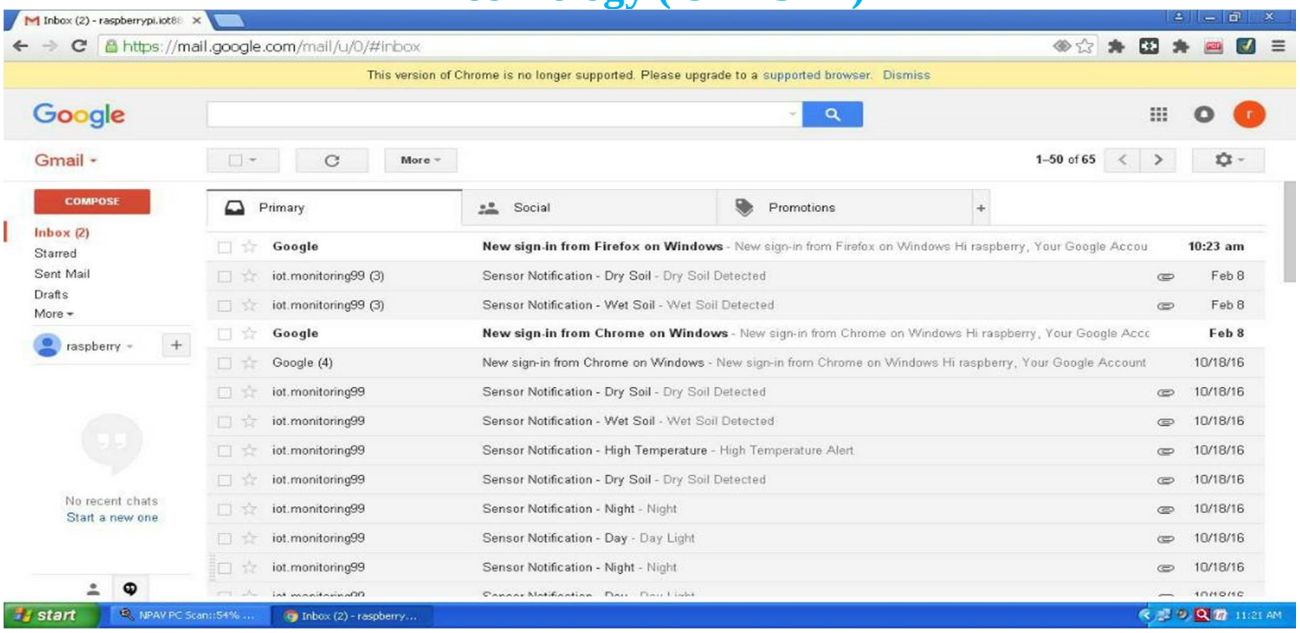

Fig. 4 output

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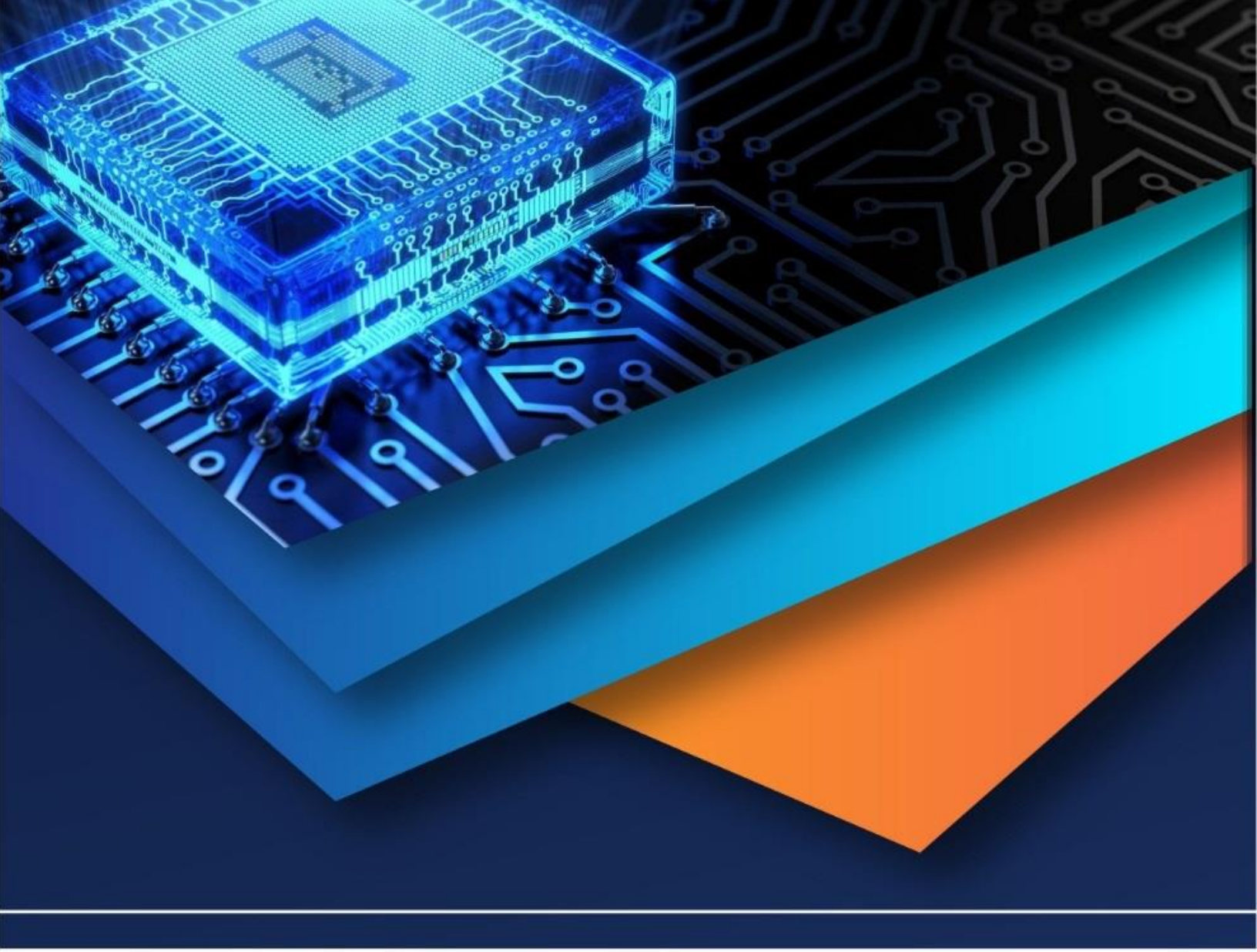

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