iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VIII **Month of publication:** August 2020

DOI: https://doi.org/10.22214/ijraset.2020.30831

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Biogas Management using IoT

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Abstract: ***Management of one biogas plant is done perfectly but when they are several biogas plants then management of these biogas plants are critical. To reduce complexity of manual management of plants IoT platform with cloud server of Raspberry Pi can be used where data of the several plants will be collected on a server in the form of temperature, humidity and pressure of the biogas plants. Here in proposed model temperature, humidity and pressure sensors are connected from one side to each biogas plant and from other side sensors will connected to NodeMCUs(ESP8266) where NodeMCUs will upload the data of each plant to the cloud server using IoT. This will also help to deploy this system in industry where the biogas management of several plants can be done using IoT.***

Keywords: Biogas, IoT(Internet of Things), Own Cloud, Raspberry Pi, NodeMCU(Node Micro Controller Unit), Sensors and MQTT(Message Queuing Telemetry Transport) Protocols.

I. INTRODUCTION

Biogas is the only source on which the world can survive in the future. Use of LPG(Liquid Petroleum Gas), firewood as energy production is harmful for environment in terms of environmental pollution and global warming, it also harmful for living organisms like humans, plant, animals and etc. Everyone need an eco-friendly fuel for energy production like “Biogas” it can be used as fuel for generation of electricity, for cooking and remaining waste material after gas production can be used as compost and compost is also useful for fertilization.

Nowadays, for a good biogas plant, biogas management is so difficult due to busy schedules of mankind. As world is growing fast, humans are not have time to concentrate on a particular work, they have several works as the world needs multitasking property from the humans. That’s why; such kind of model can be introduce as a system where management will done through the help of IoT on behalf of readings of temperature, humidity and pressure of the biogas plant and readings will be taken at anywhere. At in this project will use MQTT protocol techniques, self created IoT cloud (server), where raspberry-pi and NodeMCUs(ESP8266) with some sensors (temperature, humidity and pressure) are used to share information of biogas plant and many more sensors can be added as per required. Several plants can be managed by using NodeMCUs and one Raspberry Pi, where each NodeMCU will connect to each plant and then NodeMCUs publishes temperatures, humidities and pressures of biogas plants on the self cloud. Self cloud will created by using Raspberry Pi and that Pi will also do managing the readings of several plants.

As like of this proposed system there are several biogas plant management systems already been implemented and proposed between them some researchers used Ardiuno with some sensors[1][2][8][9][10], Ardiuno and NodeMCU with some sensors[5], Microcontroller and GSM modules with some sensors[4] and PIC microcontroller and GSM with some sensors[6][7]. Different thing in the proposed modelis that, model will use some sensors with NodeMCUs, high frequency computer Raspberry Pi for creating MQTT protocol based self/own cloud storage and it can manage one or more plant at a time on Raspberry Pi monitor or from android at anywhere which will made the system fast and fully IoT based.

II. RELATED WORK

Vinay V Hegde et al. at “IoT (Internet of Things) Based Efficiency Monitoring System For Bio-Gas Plants” Monitor the biogas through GSM module with Ardiuno and sensors for managing pH, temperature and pressure due to the architecture proposed which provide a scalable solution to monitor the usage statistics, and also crucial parameters to maintain the efficiency of the biogas plants.

Babar Noor et al. create “PROTOTYPE DESIGN OF SMART BIO-GAS PLANT FOR GENERATION OF ELECTRICITY”. Ardiuno with sensors for managing pH, temperature, pressure and electricity generation and some mechanical sections also used they conclude that the plant with better monitoring and control process will generate more electricity and in a less time.

Pramod Sahuaet et al “Automation in Biogas Plant for Enhancement of Efficiency and Safety” Author did mixing, digestion, recirculation, scrubbing, finally storage process takes place for make bio gas. For to enhance the gas production material changes of feed passage amalgamated with solar heating was incorporated and to avoid the digester failure, an automated system consisting of gauge, pressure switch, sensor, servo motor and actuator was proposed.

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Suruchi Dedgaonkaret al. create "Biogas Monitoring System for Measuring Volume using Microcontroller and GSM" Working done using Arduino with pressure sensor and GSM module. For implement partially the monitoring system for biogas plants for controlling the activities of different contents in biogas plant.

Yatharth Kumar Sharma et al. work on "Enhancement of the Biogas System Application Using Solar Photovoltaic and IoT Based Automation" Working are done with Arduino, ESP8266, and booster pump. IoT based system is implemented to measure the run time of the booster pump and there by measuring the volume of the biogas consumption.

Sunil MP et al. at "Smart Biogas Plant" Biogas plant using PIC microcontroller with GSM and LCD display. These digesters help in two ways: one is to reduce waste and the other is to provide valuable energy.

Liston Matindife and et al. at "Fuzzy Logic System for Intermixed Biogas and Photovoltaics Measurement and Control" System work on PIC microcontroller with LDR, LCD, pressure sensor and etc.

1) A new biogas system fault detection and control strategy.
2) A comprehensive photovoltaic system fault detection and control strategy.
3) A biogas and photovoltaic system easily and quickly fixed by persons with no expertise at all in the respective fields.

W. Ait Ahmed et al. at "Biogas Control: Methane Production Monitoring Using Arduino" System work on Arduino with gas sensor. Graphical result of methane author getting in terms of gas detection.

Ilesanmi A. Daniyanet al. show "Development of a smart digester for the production of biogas" Working through Arduino with temperature, pH and pressure sensor. The methane gas was 54% which generated 5.24 kWh of electricity within 84 days.

III. PROPOSED SYSTEM

A. System Architecture

Figure 1. Shows the general architecture of the biogas management using IoT framework whose implementation includes following elements:

1) *Wireless Sensing Nodes* – Here the wireless sensing nodes are NodeMCUs and a Raspberry Pi where NodeMCUs are publish data on one side of cloud and Raspberry Pi which subscribed data at another side.
2) *Sensors* – Sensors are here temperatures, humidities and pressures.
3) *Cloud Based Server*- This is an application platform for IoT that receives, stores, displays and analysis the data provided by the various wireless sensing nodes in real time. It also notifies to the authorized person to take suitable action.
4) *Monitor of Raspberry Pi*– At the terminal of Raspberry Pi readings of temperature, pressure and humidity of the biogas plant are able to watch.

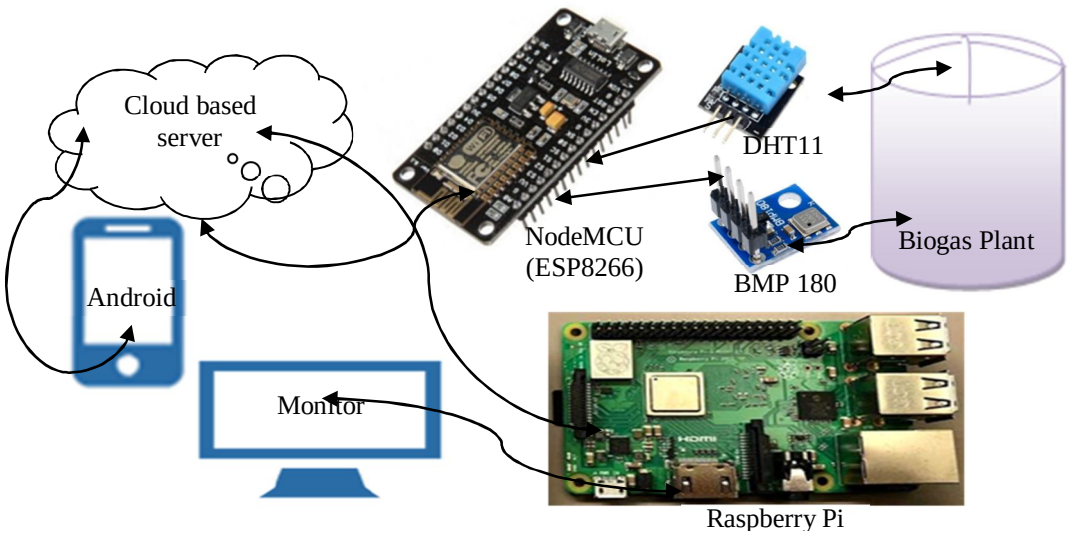

Figure 1. System Architecture of Biogas Management Using IoT

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B. Block Diagram

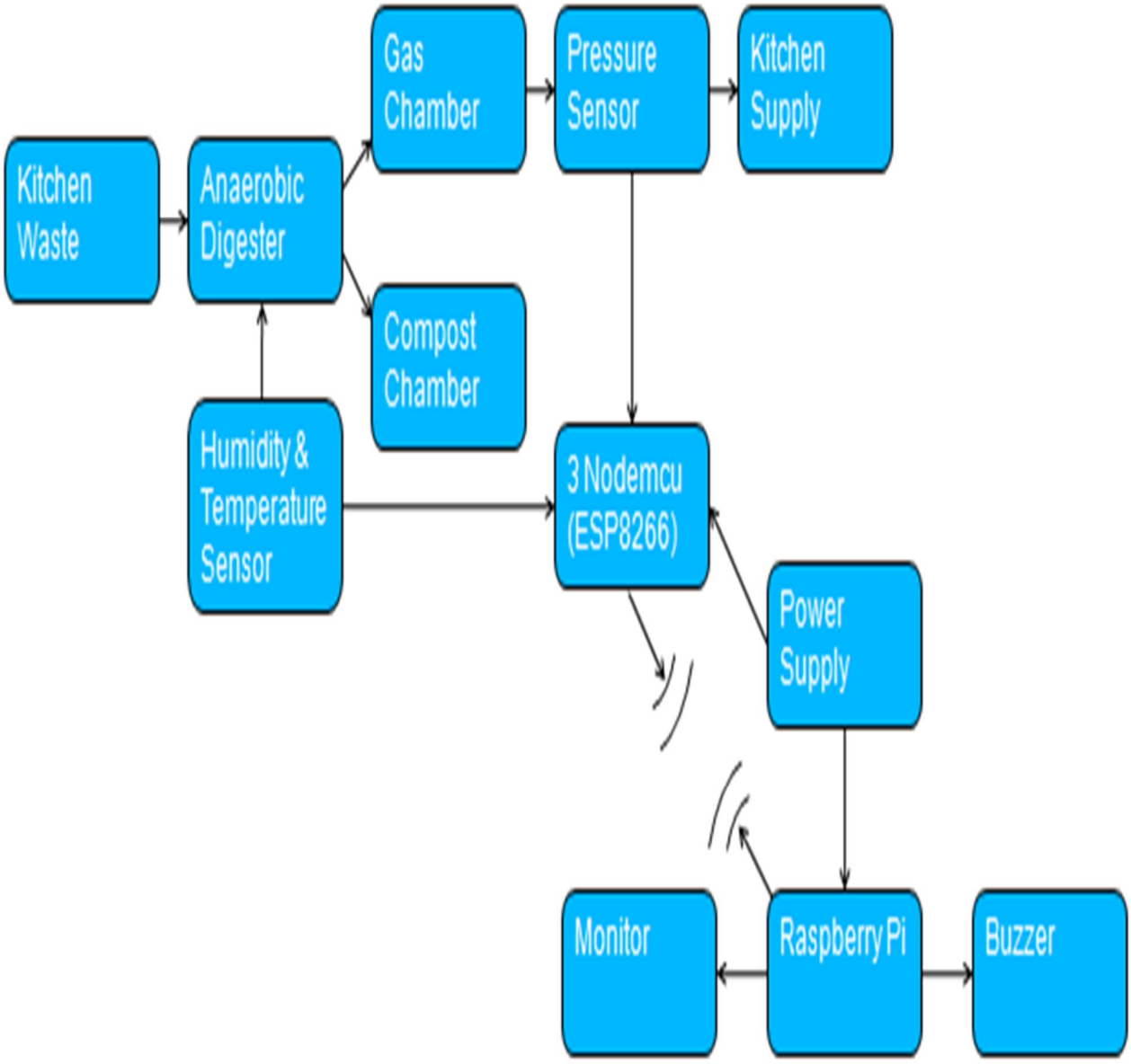

Figure 2. Block diagram of Biogas Management Using IoT

The block diagram of the IoT based biogas management system is shown in Figure 2. It basically consists kitchen waste where from waste will putted into anaerobic digester where humidity and temperature will reads by humidity and temperature sensor by using NodeMCU, anaerobic digester have also two sections which are compost chamber and gas chamber where compost chamber collect compost and gas chamber will used for store the gas where at gas chamber's pipe pressure sensor will connected for measure the pressure of gas when the gas will release from gas chamber to kitchen supply.

The pressure sensor will be also connected with NodeMCU. NodeMCU (ESP8266) need power supply of 3.3V minimum to operate, NodeMCU will helps to connect humidity and temperature sensor and also pressure sensor to the own IoT cloud and at other side of IoT cloud the system uses Raspberry Pi. Raspberry Pi gets subscribed data on the terminal of monitor of Raspberry Pi through the using MQTT protocol techniques from own IoT cloud, The buzzer will connect with Raspberry Pi where Raspberry Pi buzzing the buzzer when the temperature, humidity and pressure of plant will vary or goes low.

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C. Hardware and Software Description

1) Hardware Description: The proposed hardware details of the project are two types:

a) At in mechanical terminology (non-technical): Digesters, gas chambers and compost collectors.

- Anaerobic Digesters: Anaerobic digesters will be needed for breaking kitchen waste in slurry form.
- Gas Chambers: Gas chamber swill needed for collection of gas.
- Compost Collector/Chambers: It will need for collect the compost, where from compost will usable for fertilization.

b) At in electronics terminology (Technical): Temperature and humidity sensors (DHT11), pressure sensors (BMP180), NodeMCUs (ESP8266), Raspberry Pi 3 model B+, SD card 16-32 GB, for own cloud router, and external hard drive in TB if storage need more above 16-32 GB.

- *Temperature and Humidity Sensors (DHT11):* This sensors will required for collecting temperatures and humidities information of the digesters which helps to manage digesters where temperature and humidity should be according to bacteria need.

Specifications:
Supply Voltage: +5 V
Temperature range :0-50 °C error of ± 2 °C
Humidity :20-90% RH ± 5% RH error

- *Pressure Sensors (BMP180):* Pressure sensors will be used for measuring the gas pressure in hectopascal(hpa).

Specifications
Supply Voltage: +1.8 to 3.6 (VDD) and 1.62v to 3.6(VDDIO)
Pressure range 300 to 1100hpa
Interface: Digital

- *NodeMCUs (ESP8266):* Here NodeMCUs will be used to connect the temperature, humidity and pressure sensors where this NodeMCUs publishes data on server as per schedule of timewill require.
- *Raspberry Pi:* In the project Raspberry Pi will connected to several NodeMCUs through IoT cloud where Raspberry Pi publishes subscribed data on monitor by using own cloud and that can be accessible from smart phones also. Raspberry Pi consist SD card for running the OS and Raspberry Pi will be also used as to create self cloud.

2) Software Description: Arduino Software with NodeMCU board is required for programming NodeMCUs. NodeMCUs can run program of temperature, pressure and humidity sensors for acquisition of data of the biogas plants and for Raspberry Pi programming with according to link of Raspberry Pi cloud setup will done through the software helps (http://www.chris-cunningham.co.uk/uni/2019/cloud-server-raspberry-pi-3) the software details and cloud setup is:

a) Downloading and installing NOOBS and Raspbian – the easiest part.
b) Installing a LAMP server (LAMP – Linux OS will be Raspbian, Apache as the Web server, MySQL as the database management system and PHP as the scripting language) – this takes a while and is the start of a pile of terminal commands!
c) Getting Ready to Install OwnCloud Installing OwnCloud 10.
d) Mounting an external HDD for additional capacity.
e) Enabling SSL for external access.

D. Proposed System Process

The flow chart shows the process flow structure of biogas plants where biogas management using IoT will be done easily. In the process of flow chart: the first input system will be biogas plants, then temperature, pressure and humidity processes sensors data on NodeMCU controllers after that NodeMCUs processes that readings on the cloud server where from it goes to Raspberry Pi, then Raspberry Pi process that sensors data on own cloud storage by checking the temperature, humidity and pressure by variable ‘x’, where A and B will be constants of predefined limits of the readings of sensors, if the limit will crossed then buzzer will buzzing, means when buzzer will buzz someone have to full fill the requirements of the biogas plant, If limit not crossed by variable ‘x’, then system will continues its work, minutes wise sensors reading will collecting on Raspberry Pi’s cloud storage.

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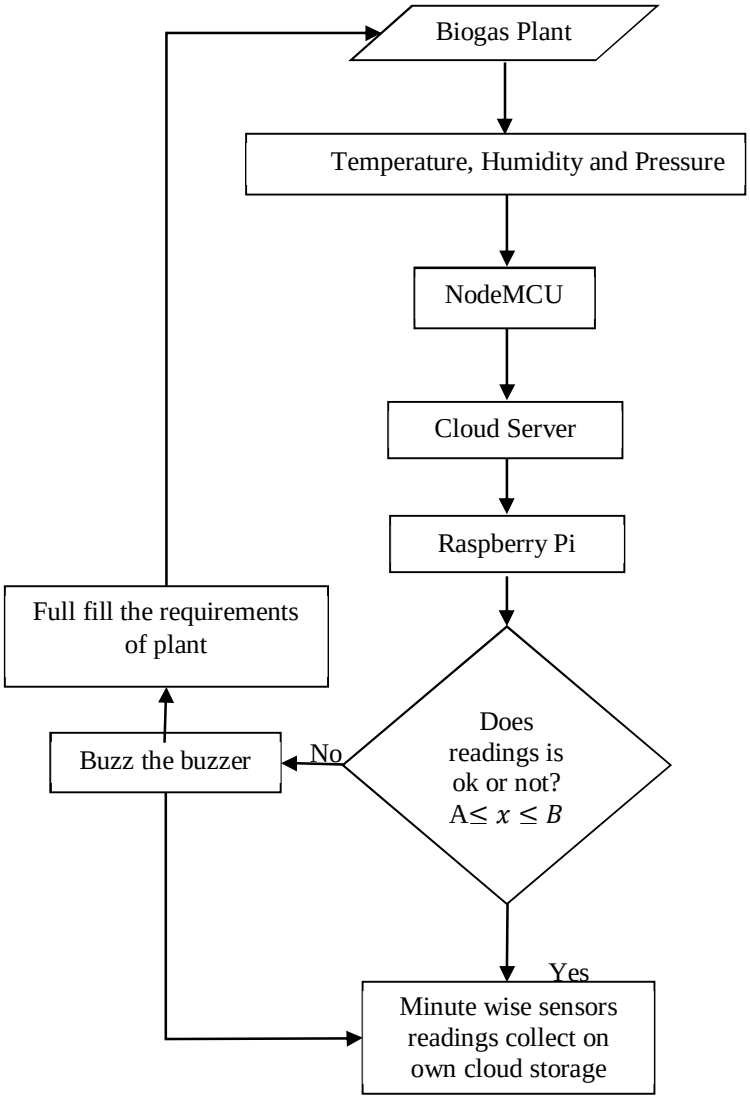

Fig 3.8 Flow Chart

IV. RESULTS AND DISCUSSION

As per thinking, people want to do everything in short time and effort less work for earn more money, that's why world accepting several technologies for do these works which gives them more earning in short time. For this introduce a proposed model which uses latest technology for managing the biogas plant. IoT technology will used in this plant which will helps to show the readings of temperature, pressure and humidity of that plant and it will done from online watching by Raspberry Pi or by smart phone. This online watching helps to provide more production of biogas and also let the people do alternative work, due to this technology as thinking people will able to get more money and less work in this project definitely world accept this technology that's why research is able to say that, proposed project model has future scope.

V. CONCLUSION

In this paper the system development of Biogas Management using IoT is proposed. The various parameters of Biogas Plant like temperature, humidity and pressure can be monitored and controlled efficiently using IoT. It can also generate more biogas as compare to traditional biogas system, at a same time several plants are managed by using NodeMCUs and one Raspberry Pi. The IoT creates self cloud server from using Raspberry Pi and stores data online. No need to subscribe other cloud servers which are based on premium, as using self cloud server the system can more protective in terms of data security.

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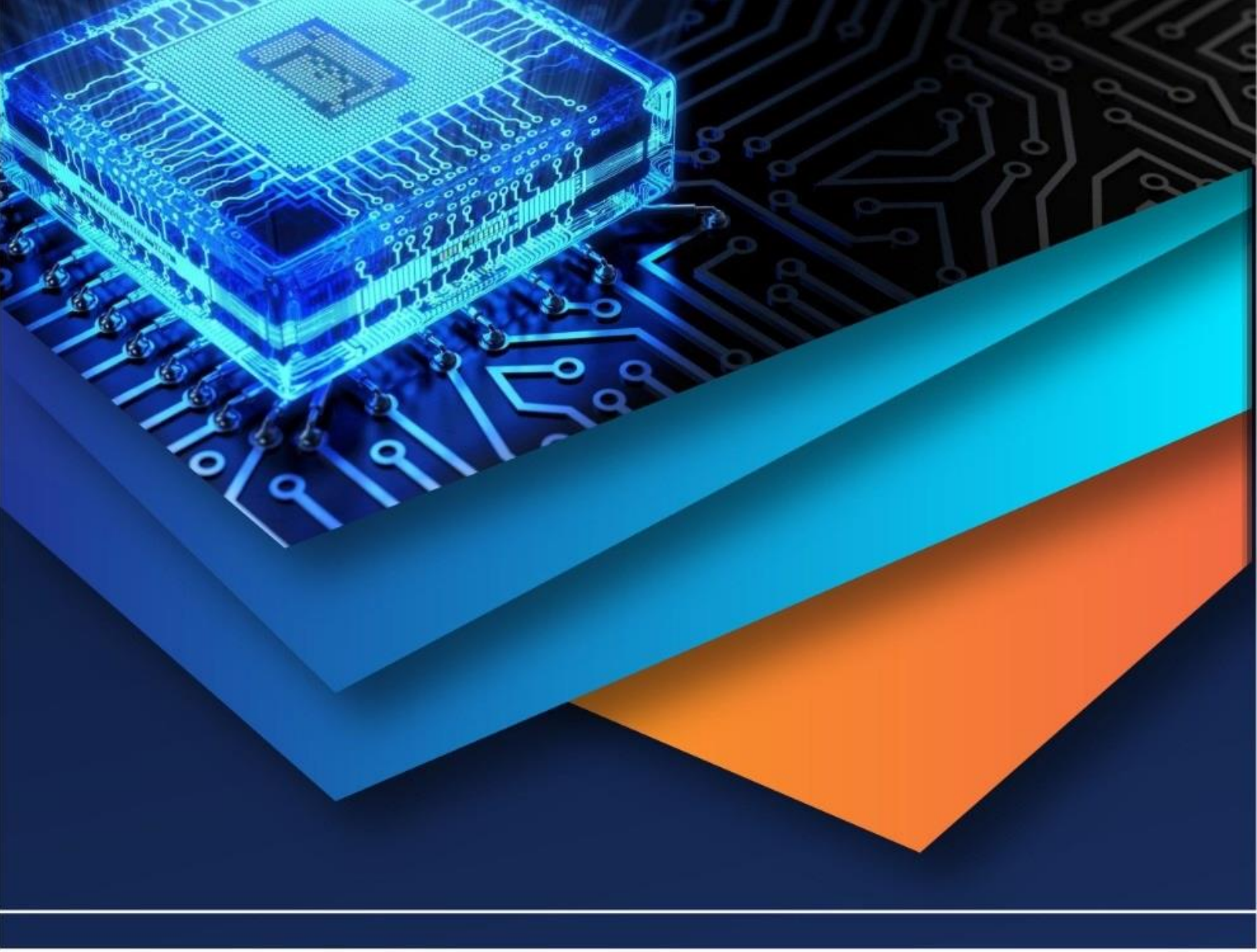

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