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Computerization in Home: Change in Way of Life

Tanay Reshamwala[1], Charmil Shah[2]
[1, 2]*Department of Information Technology, Universal College Of Engineering*, Mumbai, India

Abstract: ***The giant network and applications offered by a device tiny enough to be called "Dust", has revolutionized the way we live our lives. IoT has gained rapid access and application in a wide spectrum of applications ranging from a heart monitoring device to a sensor in hazardous factory locations saving lives further leaping on to home automation & managing vehicles on roads. Home automation has seen an increased usage in developed countries as most homes are equipped and controlled through IoT. The Internet of Things is a huge network of associated things and individuals all of which gather and share data about the manner in which they are utilized and about the environment around them. In today's modern technological era IOT has gained much admiration and is evolving at a very high pace. This paper lays out an idea of creating an IOT based Home Automation system. It illustrates the use of various hardware devices such as Arduino Uno, ESP8266 NodeMCU and some sensors along with software applications like the google firebase which is a realtime database to create a completely functional smart home. This project proposes a system where the home appliances can be controlled from the user's mobile application via the internet from any part of the world while other minor devices and their tasks are fully automated by the system. It even integrates voice commands to the system using Google's Voice Assistant system. The paper presents a very simple and cost effective system that can be easily implemented in any household.***

Keywords: ***Internet of Things (IoT), Arduino Uno, ESP8266 NodeMCU, Firebase, Dialogflow.***

I. INTRODUCTION

The world as we know it today is moving towards an era of complete automation wherein at a point of time in the future any task would not require any kind of human manual interaction or efforts. It would be like waving a magic wand to get your task done. Iot (Internet of Things) would be the the base of this so-called complete automation of the world. The Internet of things popularly known as IoT refers to connecting physical objects or devices to the internet and giving them the ability to exchange data with each other [1]. Since the last decade the advancement in Iot has been moving so fast that each and every task, be it petty or huge, can be automated easily and at an effectively low cost.

This paper aims to provide an insight into Home Automation or commonly known as smart homes. Smart homes are nothing but your regular homes but every appliance or task is automated using a set of software services, various types of sensors and hardware controllers. The home automation system involves automating the control of lightning, electrical appliances, heating and cooling systems, security, entertainment unit, irrigation, gardening, and the use of robotic bots for various house purposes. It basically enables your house to manage and maintain itself with no human interaction or nominal human interaction. It focuses on making human life luxurious and more comfortable [2]. Furthermore it even helps out in reducing the use of electricity as much as possible. Such facility and control not only provides better control locally and remotely but also caters to the needs of the elderly and disabled. It significantly improves the usability and functionality of any home.

This paper presents a home automation system where the user can control his basic home appliances like lights and fan using a mobile application from any remote location with the only requirement of having an active internet connection. It even includes the use of light and motion sensors to automate the ambience of the house. All of this is done using a microcontroller called Arduino Uno, a WiFi module called NodeMCU ESP8266, Google's realtime database - Firebase, LDR sensor, PIR sensor, and an android application. The system even integrates the functionality of voice commands using Google voice assistant, thus enabling the user to control the devices using its voice.

This project is just a concept that could be used for home automation. For years the technology has teased us that we can complete our chores just by giving out commands to computers or bots or large machinery. This project is just a small step towards that goal that we all dream of. The experimental setup for this home automation system is discussed in the next section.

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II. BACKGROUND AND RELATED WORKS

Domotic or commonly referred to as home automation [3] is referred to developing automation systems for houses. Such houses are known as smart homes. A smart home provides the user the ability to control and monitor his/her home appliances such as lightning, climate and entertainment systems. It might likewise incorporate home security, for example, access control and caution frameworks. When associated with the Internet, home gadgets are a significant constituent of the Internet of Things ("IoT").

Ishan Krishna and K. Lavanya [4], in their paper titled “Intelligent Home Automation System using BitVoicer”, have discussed the Intelligent Home Automation System using BitVoicer system. This consists of controlling the home equipment via voice commands through Bitvoicer software. The user has two ways out to control the home products – 1) automatic and 2) manual. Automatic consists of controlling of light fans completely by the microcontroller itself while in manual the user can control the home upon their choice. This system comprises various sensors like temperature sensors, humidity sensors, etc. which help in the automatic section of the projects.

Kabita Agarwal and Arun Agarwal [5] through their paper “Review and Performance Analysis on Wireless Smart Home and Home Automation using IoT”, proposed a system that controls home appliances like lights, a cooling system, and the main gate of the residence with the help of the microcontroller and a website. The proposed system also uses a security method of password and id to allow only authorized personnel to control the house equipment. The system consists of three layers 1) user interface i.e. the internet website, 2) middle layer which connects the UI with the microcontroller, and 3) the microcontroller scilicet wifi Arduino used here which controls the products upon the user.

Shrikrushna Khedkar and Dr.G.M.Malwatkar [6] developed a home automation application using Raspberry Pi and GSM as given in their paper “Using Raspberry Pi and GSM Survey on Home Automation ". It shows controlling of home appliances using SMS services with the help of Raspberry Pi. Raspberry Pi is a low cost tiny computer about the size of a deck of cards that has all the capabilities of a desktop from playing high-definition games and videos to browsing the internet or creating spreadsheets and presentations. It uses the Python programming language for its operations. The GSM (Global System for Mobile communication) is a digital mobile telephone system which can send text messages to the required authorities as per the application.

John Jaihar et al [7] in his paper titled “Smart Home Automation Using Machine Learning Algorithms”, put forward the use of concepts of different machine learning algorithms along with computer vision to shape together a smart learning automated system that controls lighting, sound and other devices based on the user’s emotion. It detects human facial expressions and adjusts the environment conditions accordingly. It contains three modes of operation, namely, manual mode, automatic mode and emotion recognition mode.

Shradha Somani et al [8] focused on building a wireless home security system as shown in her paper titled “IoT Based Smart Security and Home Automation”. Security over a network is achieved using AES encryption. Security of the house is achieved by sending notifications to the user using the internet in case of any trespasser and it can also ring an alarm if required. Home automation is done by using appropriate sensors installed around the house. Raspberry pi is used as a server and controller. It has the task of controlling electrical appliances and providing authentication and security to users.

To overcome the shortcomings faced in the papers of Ishan Krishna et al [4] and Kabita Agarwal et al [5] we propose a system that uses an android application rather than a website, thus enabling a quick and easy usage for the client and used the Google Voice Assistant which is which is pre-installed in most android phones rather than using a BitVoicer software, thus making its implementation secure and simple. The system also overcomes the weaknesses faced by Shrikrushna Khedkar [6] that uses a GSM based system. Systems that use GSM face certain limitations such as limited rate of data transfer, bandwidth lag and electronic interference. These limitations can be overturned by using an internet based system as described in this paper. The proposed system rather uses Google’s Firebase and a wifi module which empowers the client to control his home system from any remote location in the world making it more reliable and cost effective.

III. PROPOSED SYSTEM

There are several limitations in the existing home automation systems. In some of them it requires the user to manually send an SMS message, while others require the user to be in the vicinity of his/her wifi range. Also there are times when the user forgets to turn OFF the electronics at home when he/she leaves. This leads to unnecessary wastage of electricity which leads to a surge in power bill. Through this project we have proposed a system that lets a user overcome these differences and make the automation system more comfortable and convenient.

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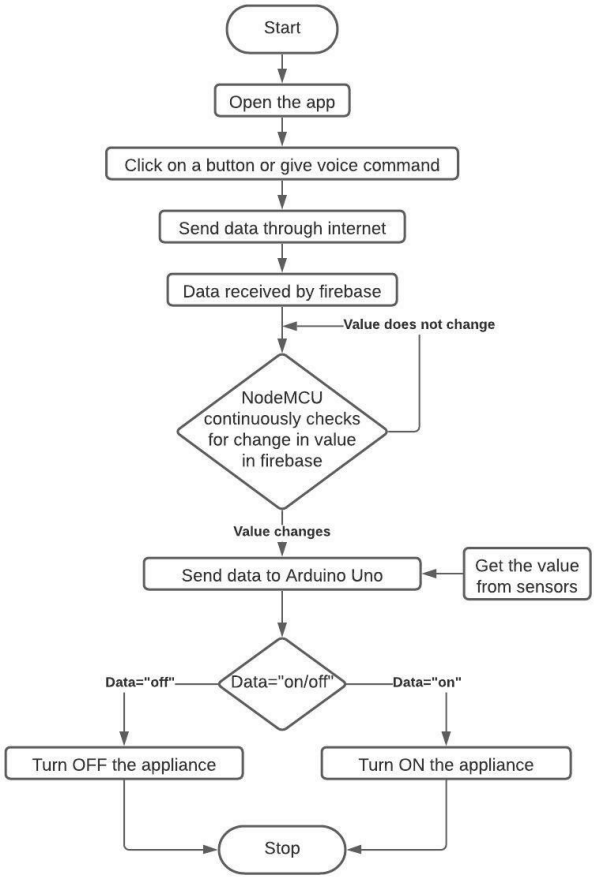

Fig 1: Flowchart of the System

Fig. 1 above shows the flow of the automation system. This paper proposes a system where the user will be able to control his/her home appliances with just a mobile device from any part of the world with the only requirement of having an active internet connection. The system also uses LDR AND PIR sensors, commonly known as light and motion sensors respectively. The LDR sensor helps to detect the light levels while the PIR sensor is used to detect any motion, be it human or non-human, that may have occurred in a designated area or room. Thus with these sensors merged into our system the user will no longer need to use his phone to turn ON any appliance. The user will only need to turn ON the appliance for once and then the sensors will likewise incorporate home security, for example, access control and caution frameworks. When associated with the Internet, home gadgets are a significant constituent of the Internet of Things ("IoT") which automatically control the appliance depending upon the ambience of the room. The light and fan will only work if it senses any motion in the room, plus the intensity of the light to be emitted will be automated depending upon the natural rays that may fall on the house. For example, during the evening when sunlight is scarce, the light from the bulb will be dimmed to a minimal level while during the night the bulb will be set to its maximum intensity or as required by the user. Thus making the basic appliances, like the fan and bulb, in our house completely automated with no sort of interaction from the user.

The core components used in this project are given below:

1) *Arduino Uno:* It is a microcontroller board developed by Arduino.cc and based on the ATmega328P chipset. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It is generally utilized in embedded projects and normally acts as the cerebrum in electronic devices. The hardware consists of a microcontroller along with other electronic components which can be programmed using the software to do almost any task.[9]

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2) *NodeMCU:* The NodeMCU is based on ESP-12 module and includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems. It is used as a WiFi module in order to connect the Arduino Uno Board to the Internet. It is a low cost open source IoT platform [10].
3) *Google Firebase:* Firebase provides a real-time database and backend as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored in Firebase's cloud. It provides libraries that enable integration with Android, iOS, Javascript, Java, Objective-C, Swift and NodeJS applications.
4) *Dialogflow:* Dialogflow is a natural language understanding stage that makes it simple to plan and incorporate a conversational UI into your portable application, web application, device, bot, intelligent voice response framework, etc. It can analyze different sorts of input from clients, including text or sound information sources. It can likewise react to clients in two or three different ways, either through text or with synthetic speech [11].

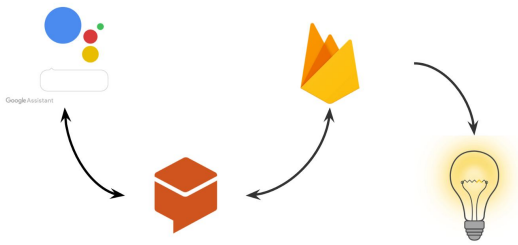

Fig 2: Process flow using Diaglogflow [12]

Fig. 2 represents the process flow of the system when the user turns on/off an appliance using voice assistant. It depicts how Dialogflow acts as a medium between Google Firebase and Google Assistant. Dialogflow works on natural language processing and is backed by Machine Learning [14]. It takes voice commands as an input as converts it into useful actions. The actionable data is then sent to other software systems, Firebase in our case, as required by the developer.

IV. SYSTEM ARCHITECTURE

Our proposed framework design is displayed in Fig 3. The framework comprises Android application, Firebase, Arduino chip and Node MCU where the Arduino is associated with relays which assumes an imperative part where it interfaces the arduino with the home machines which are lights and fans.

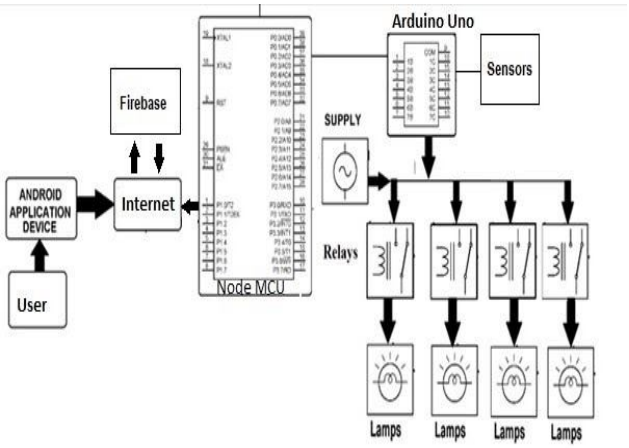

Fig 3: System Architecture

Furthermore, Arduino are additionally associated with sensors who provide the request in the programmed mode either to turn the home machines or not. Home robotization is the remote and controller of various parts of a living space like lighting, temperature, security, amusement, and so on The proposed framework outfits a robotized, voice-controlled, and toggle control based home automation system using a microcontroller called Arduino Uno and ESP8266 NodeMCU wifi-module. Here Arduino Uno is utilized as it gives the least expensive approach to mechanize a program. This program assists the client with working their home contraption effectively through their mobile phones with voice orders or by means of the UI on the portable application.

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This system chips away at three pieces:-

1) The First layer or the upper world to the system has 2 options:

a) Client application or UI

b) Google Voice Assistant

The client has 2 alternatives, he can send his commands through the android application or by means of the inbuilt google voice assistant on his phone.

2) The second is the middle layer which helps to communicate the user application with the backend part, here in this system as a middleware communication we have used Google Firebase and NodeMCU module. The firebase is a real-time database where it helps to communicate between the application UI and the NodeMCU which is the wifi module. The NodeMCU acts like a Middleware between the firebase and Arduino Uno which is a microcontroller. After the user sends his commands through the application UI or via the google voice assistant, the new value is reflected in Google's Firebase. The NodeMCU on its part keeps checking the values put away in Firebase and sends the new value, if change in an entity is seen, to the Arduino Uno.

3) The last one is the backend or the non-eye for the client which is the Arduino Uno microcontroller and the different sensors introduced, which helpin actual manipulation and control of the appliances.The Arduino Uno, after receiving the values from NodeMCU, reads the value from different sensors and accordingly controls the appliance in question along with its intensity.

The proposed system offers three ways for controlling the lights and fans which are as follows:-

a) *Manual Mode:* First and basic is the manual control, where the users can turn ON/OFF light and fans by clicking on the manual option on the app and then toggling the switch section for each of the home appliances. This will stop all the automatic sensors from working and then the users can operate the appliances as they like.

b) *Automatic Mode:* The installed system also gives an option to the users to control their appliances automatically through the system itself Once users go with the auto this option in the app they immediately initialize the sensors for the automatic mode and then taking upon the sensor's value the microcontroller reacts upon them. Here the users get an opinion to relax and forget about all the controlling problems, all the problems are taken by the system. The proposed system is installed with various sensors which play a vital role in automatic options. There are various sensors like the DHT-22 which is a humidity and temperature sensor, which tells the controller whether to slow down or speed up the heating and cooling system, the other sensor used is the PIR sensor which turns the light only when it detects a personal presence and the last which the LDR sensor which is the photo light sensors which tells the controller to turn the light when there is not enough light inside the house.

c) *Voice-Control Mode:* The installed system can also be operated by giving voice commands by the users to the system. The voice command can turn on the automatic mode or through the manual mode the voice command can be given via Google Assistant to the application.

V. SYSTEM OUTPUT

Fig. 4 shows the real execution of the proposed framework where we can see an Arduino which is associated with different sensors that help in programmed mode, likewise, Arduino is associated with transfers with then associated with a home machine which are light and fans.

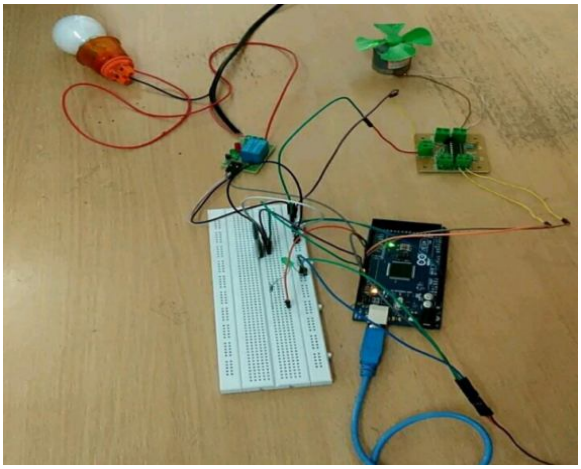

Fig 4: System Implementation

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The user experience of our application is as displayed in Fig. 5 where the client can toggle the buttons if needed to turn on/off an appliance. After which the android application sends value to the Firebase and provides the client a toast message of its interaction.

Fig 5: User Experience in android application

VI. EXPERIMENTAL RESULT

The proposed framework was created as presented in Table 1 and was sent away for testing and was tried with every one of the points and afterward determined how much the framework is productive in various cases and then the framework's general effectiveness was determined.

Test Cases

Test Case #	Test Scenario	Expected Data	Actual Result	Pass/Fail
1	Check whether bulb starts through Arduino	The LED bulb should respond when the Arduino is connected to battery	As expected	PASS
2	Check whether NodeMCU is working correctly	The NodeMCU should connect with the Wi-Fi	As expected	PASS
3	Check whether the android app is sending the value to Google Firebase.	When the android app is toggled with value that value should reflected in Google Firebase	As expected	PASS
4	Check whether the NodeMCU is taking the value from Google Firebase	When the Firebase reflected with a new value, NodeMCU should take the new value	As expected	PASS
5	Check whether the serial communication between the NodeMCU and Arduino is working correctly	The value taken from the firebase, NodeMCU should send to Arduino and the value should be reflected in Arduino console	As expected	PASS
6	Check whether the voice command is working properly	To see whether the voice command can change the value in Firebase	As expected	PASS
7	Whole Project As in One	Changing the value from the app should be reflected in starting / turning off the led	As expected	PASS

Table 1: Experimental Results

In the first place, we tried the android part of the framework that whether the android application is sending the information to firebase, it had finished the assessment by sending the information in 0.1sec, after that we tried the firebase whether changes the worth, the firebase likewise breezed through the assessment by changing the worth extremely quick, the third test we did whether the Arduino is working simply by flickering the drove light through Arduino and the Arduino has additionally the breezed through the assessment strikingly, and afterward we tried the entire framework out and out by first diverting light from android application, and the framework was surprisingly breezed through the test by turning light in 0.36sec.

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VII. CONCLUSION AND FUTURE SCOPE

The IoT market is growing at a rapidly growing technology market and has many different concepts. Where home automation makes this concept more wide and rich. Home automation makes life easy especially in scenarios where there is scarcity of manpower. The proposed system is very different from many other automation projects as it not only has buttons and switches but also has a voice command option that makes the user's experience more pleasant and restful. It also has an automatic option so the users also need not worry about the appliances, the system would itself control the appliances in your presence. It also helps the management of geriatric care especially those living alone also catering to the needs of physically challenged people as they need not go to switchboards to start the appliances. This allows them the independence and thus a semblance of dignity.

Unlike other projects, this system is not limited to specific distances for operation, the user can operate the system from any remote location with a stable internet connection as the only requirement. In the future, we can add a user authentication module to improve the security of the application. The key advantage of the system is if the control circuit fails then the manual switching option of the traditional method is available. The voice option helps the nonusers of technology to use the system and also encourages them to learn about technology.

It performs with the help of connected smart devices and appliances that use communication technology like WiFi, Bluetooth, and Ethernet, to share data and facilitate the efficient management of power consumption. It has advantages like:

1) *Cost-effective:* Home automation appliances have a longer life cycle than regular devices. Hence this saves money.
2) *Self-sufficient:* The home automation technologies come with the option of running on sustainable sources of energy like wind or solar power and even water harvesting.
3) *Eco-friendly:* Smart home appliances consume a minimum amount of power. This is because they use stored user data to modify the output. This means a fair amount of energy is saved.

In the future,

a) We will try to embed the system with other voice assistants like Apple's Siri, Amazon's Alexa and Microsoft's Cortana so that users having iOS phone or some other software can also operate the system with voice assistants.
b) We will also try to add more sensors so that more appliances can be operated automatically.
c) We have also decided to add security like biometric sensors and pin code as the security authentication so that only the authenticated people can only operate the appliances.

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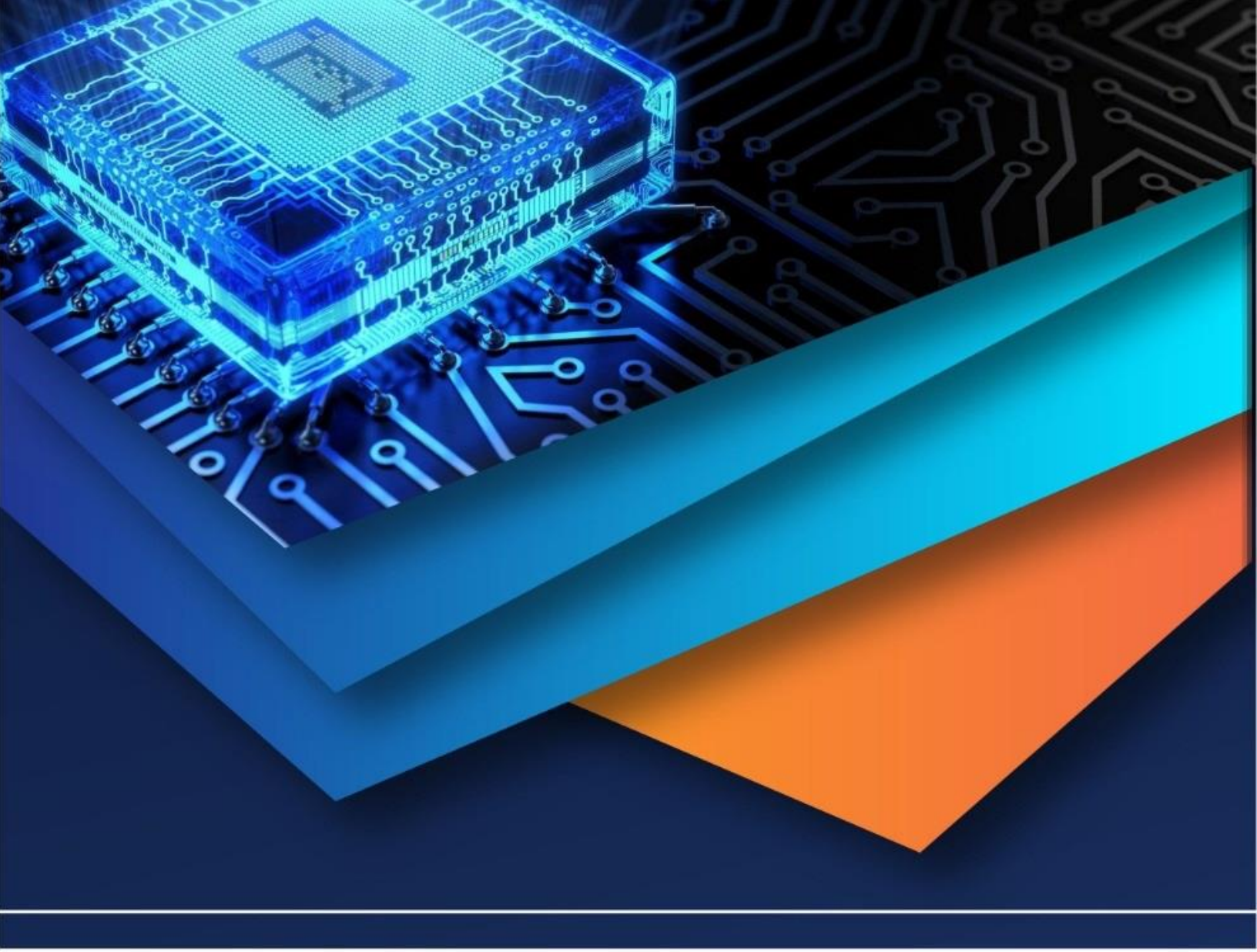

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