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Smart Bins for Garbage Collection using IoT

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***Abstract:** Up to the Industrial revolution, people all over the world lived mainly in the countryside. But today, about half the world's population lives in urban areas. Cities can become smarter by integrating data and technology into their assets. With the increase in population, there is an increase in the garbage especially in cities. Though the Municipal Corporations are trying their best to maintain the city clean by collecting the garbage timely from all the bins, they are mostly found overloaded and make the place unhygienic. This project proposes a smart bin that operates automatically to solve the above mentioned problem. The smart bin sends alerts to the garbage collector whenever it is about to be fully filled, the message is sent in a local language so that it is easily understandable. The alarm is also sent to the garbage collector. The level of garbage in the bin is found using an ultrasonic sensor. The data obtained from the sensor is stored in the database. An application is being developed which uses this data from the sensors to display the status of the garbage level in the bins, also shows the location of the bin which in turn is reflected in a Google map.*
***Keywords:** Ultrasonic sensor, Arduino, bread board, Wi-Fi module*

I. INTRODUCTION

The world produces large amount of garbage on day to day basis is a known fact. In order to lead a healthy life, proper waste management is needed. The first step in waste management is collecting the waste on-time before it overflows from the bins and get decomposed which leads to pollution and spreading of various diseases. As a result people has to spend a lot of money in order to compensate the loss. The cost incurred will be very less if the garbage is being collected on time before it overflows. In most of the public places, the dustbin gets filled and overflows and the corresponding garbage collector is unaware of it. There is also a possibility that when the garbage collector arrives the bin can be unfilled. To resolve this problem smart dustbin using IoT (Internet of Things) is being proposed so that the operational costs are reduced and human resource can be utilized effectively [8,14]. The significant focus of this project is to provide real-time information [12]. It deals with the hardware configuration of smart dustbin, its working and its integration with software. The smart dustbin consists of ultrasonic sensors connected to an arduino board. A sensor is a physical device which senses any particular property and shows some response. Example: IR sensor, ultrasonic sensor, smoke sensor etc. Here in this system ultrasonic sensors are used. These sensors calculate the level of garbage filled in a dustbin by sending ultrasonic waves and calculating the time taken for them to reflect. The data collected from the sensors is stored in the database. ThingSpeak cloud is used for this purpose. An application is developed to show the data that is recorded on the cloud. The level of garbage in the bins are shown in the app. Apart from this the location of the bin is also shown to the user using Google maps. And when the bin is filled up to 80%, it will send alerts to the corresponding garbage collector. Once the bin is actually filled we send another notifying alarm to the person who collects the garbage from bin. Thus garbage collector can come and collect the garbage. This can also be applied for household garbage collection [13].

II. HARDWARE COMPONENTS USED

The following are the hardware components that are used in this proposal

A. Arduino UNO

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that sense and control both physical and digitally.

Fig.1 Arduino Board

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All of its products are licensed under GNU Lesser General Public License or GNU General Public License, permitting the manufacture of Arduino board and software distribution.Arduino UNO is a microcontroller which is a board based on the ATmega328P [2] that is depicted in Fig.1. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. “UNO” means one in Italian and which is a base for the release of Arduino software (IDE) [1]

B. Wi-Fi module

ESP8266-01 is a low-cost Wi-Fi module enabling Wi-Fi network connection is depicted in Fig.2. It has a self-contained SOC (system on a chip), which means that it can also function independently without a controller. However, it is possible to connect it to Arduino via serial communication, which introduces the potential for more GPIO’s (General Purpose Input Output) in addition to other benefits.ESP82266 is an all-purpose Wi-Fi module so you can add it to virtually any new or existing project, alongside any board or component, to make IoT project [3]. Wi-fi module is usually used when there is a necessity to connect to the internet [4].

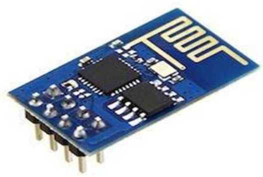

Fig.2 Wi-Fi Module

C. Ultrasonic Sensor

Ultrasonic sensors measure distance by using ultrasonic waves [6] is depicted in Fig.3. The sensor head emits an ultrasonic wave and receives the wave reflected back from target. Ultrasonic sensors identifies the target by measuring the time between the emission and reception [5].

Fig.3 Ultrasonic sensor

D. Bread Board

Bread board is a construction base for prototyping electronics. Most electronic components can be interconnected by inserting leads or terminals into holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board is depicted in Fig.4. [7].

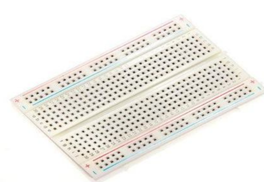

Fig.4 Bread Board

E. Jumper Wires

Jumper wires are used for making connections between items on the breadboard and the Arduino’s header pins is depicted in Fig.5. They are used to wire up all the circuit [9].

Fig.5 Jumper wires

III. PROPOSED METHOD

Ultrasonic sensor detects the filled level in a bin. The sensor emits a sound wave that travels in air. When the wave hits an obstacle during its travel, it is reflected back to the same sensor. Once it is returned the echo pin will go high for a particular period of time which is equal to the time taken by the wave to return back is depicted in Fig.6.

Using this data, the distance is measured by the following formula.

Distance = Speed * Time

Here, the speed of ultrasonic wave is used which is equal to 340 m/s. The following figure shows the working of ultrasonic sensor. The Wi-Fi module is used to connect to the local network. Connecting to the local network is important because, it is necessary to send the data collected by the sensor to the cloud for storage purpose[10].

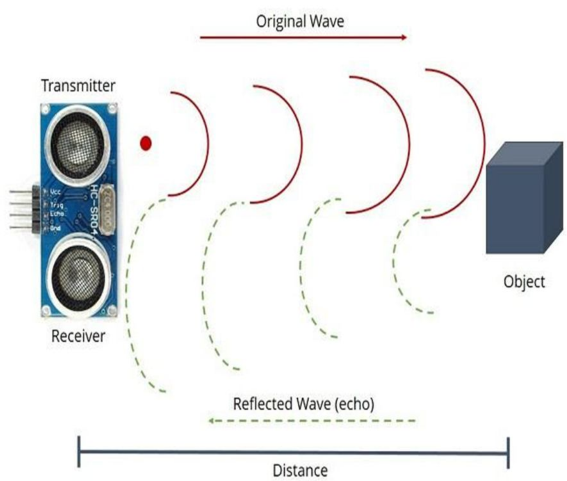

Fig.6 Working of Ultrasonic sensor

The data collected from the sensor is thus uploaded into the cloud continuously with the help of Wi-Fi module.

The cloud that is being used in our system is Thing Speak. This cloud has been chosen because Thing Speak is a free IoT analytics platform service that allows us to aggregate, visualize and analyze live data stream in the cloud. It provides visualizations of data posted by the devices instantaneously. An android mobile application is developed that shows the recent status of the bin. The entire flow of the system is depicted in the Fig.7. Below.

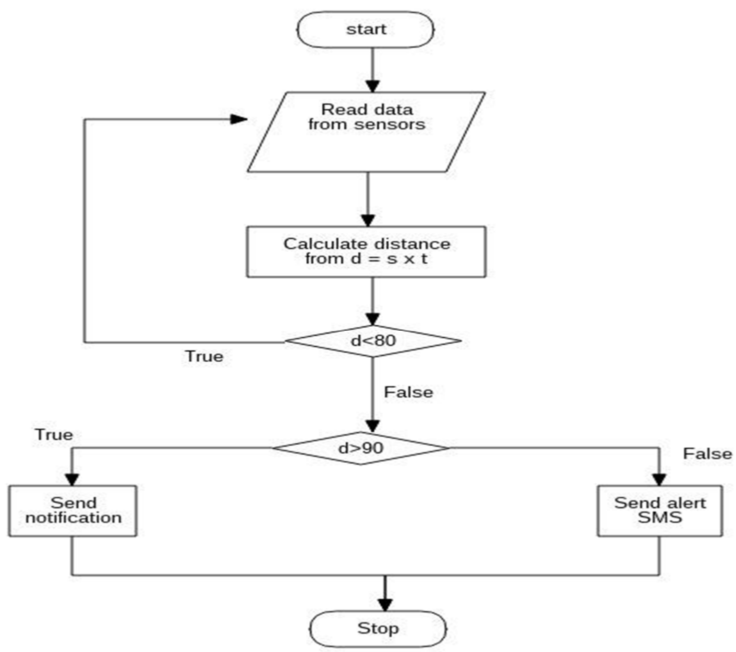

Fig.7 Flow of process

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A. Background for Mobile Application :

Thing Speak has many APIs for collecting data produced by the sensors and also APIs for reading that data from applications. We can assume the IoT project as having two parts. One of the parts is where we need to program a thing to send data and the other part is where we want to see the data.

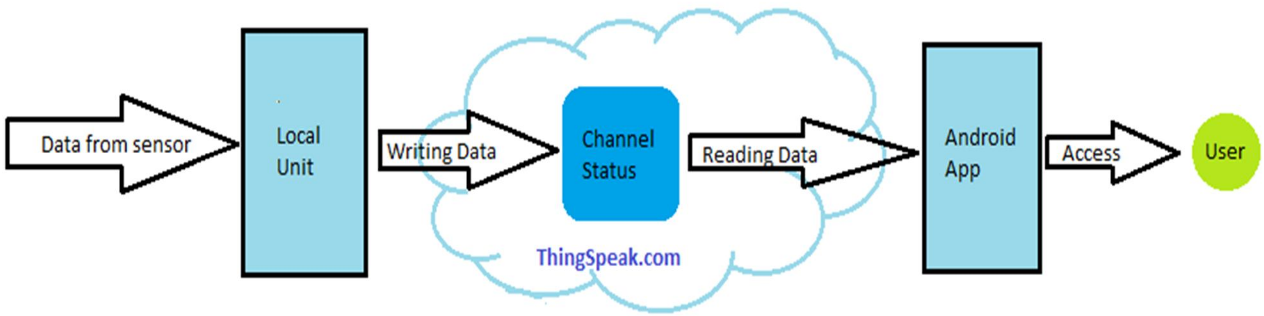

Fig.8 Background for mobile application

In our case we need to send data from the smart bin and want to see the recent data in a mobile application. ThingSpeak actually sits in the middle and makes it handy to do both. It collects data from sensors and then displays the sensor readings on a custom Android application that runs on a mobile phone. The figure depicts the given scenario as in Fig.8.

B. Working of Mobile Application

The mobile application in this project uses APIs provided by the ThingSpeak to retrieve data from the cloud. Details of the APIs can be found in the documentation section of ThingSpeak. The mobile application also shows the location of the bin in the Google maps. Another important feature of this project is alerting the garbage collector. We are sending a message to the garbage collector whenever the bin is more than 80 % filled. The garbage collector then sees the message and will collect the garbage. For this message service in our project, we are using IFTTT. It is a free service with the help of which we can connect all our "services" together, so that tasks are completed automatically.

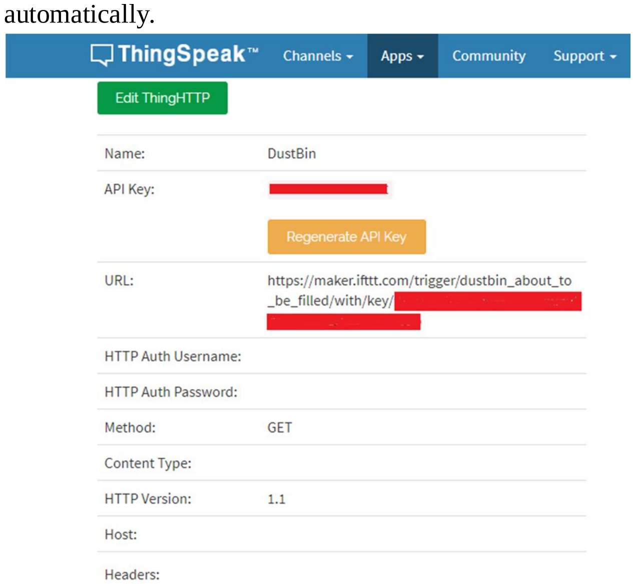

Fig.9 Snapshot of creating a ThingHTTP

There are numerous ways we can connect all our services and the resulting services are called "Applets" [11]. This project uses the SMS (Short Message Service) service from the IFTTT. This service is triggered as a reaction to the data in the ThingSpeak channel. The ThingHTTP app lets us trigger the predefined HTTP requests with the API key and a GET request from the device. The snapshot of this creation is depicted in Fig.9.

The React App provided by the ThingSpeak is used to evaluate the channel data and trigger this SMS (message) event. Thus, we are creating an instance of the React app that triggers when the bin is filled for 80% or above is depicted in Fig.10.

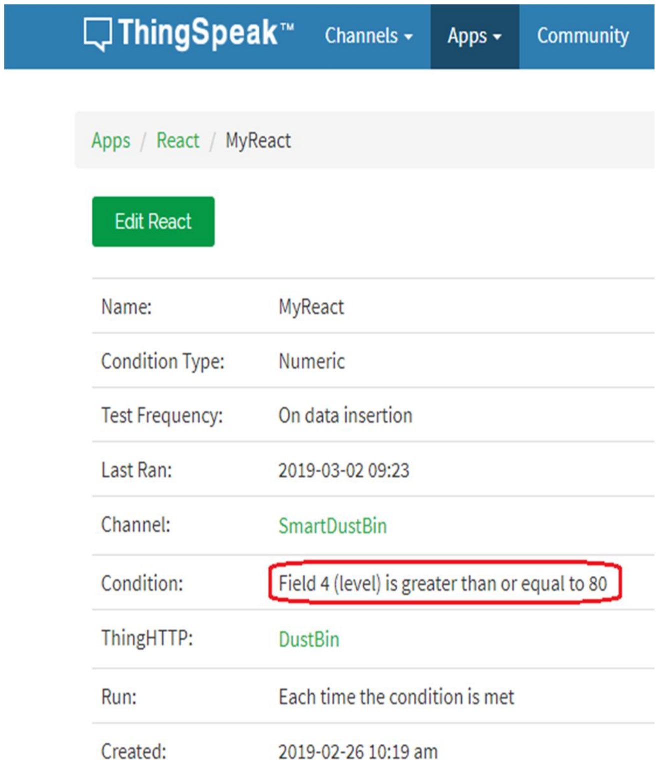

Fig.10 Snapshot of creating React

IV. EXPERIMENT RESULTS

In this experiment, Arduino has been programmed based on the following considerations.

A. Height of the Dustbin – 50 cm
B. Level 1 (<23 cm) – Below 50%
C. Level 2 (<36 cm) – Below 80%
D. Level 3 (= 45 cm) – Fully filled

The graph below shows the status of dustbin on various days. It has the level of bin on Y – axis and date on the X – axis depicted in Fig.11.

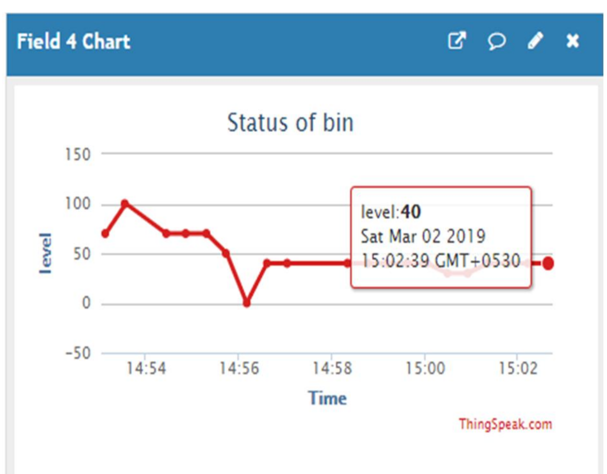

Fig.11 Chart showing status of bin

A snapshot of android mobile app is developed that shows the current status of the bin with the color coded pictures of the dustbins is depicted in Fig.12.Below.

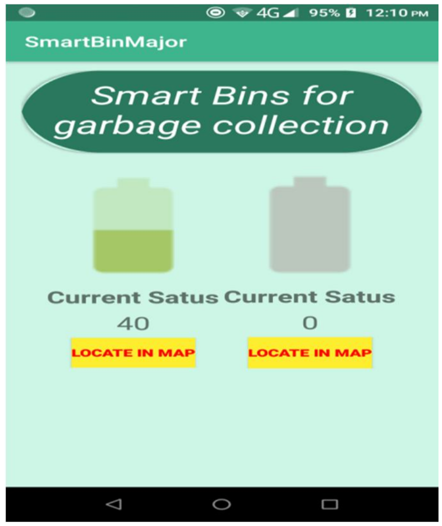

Fig.12 Snapshot of mobile app

A message is delivered to the garbage collector when the bin is filled to 80% or above. The figure below displays the sms that is received by the garbage collector in a local language (Telugu) depicted in Fig.13.

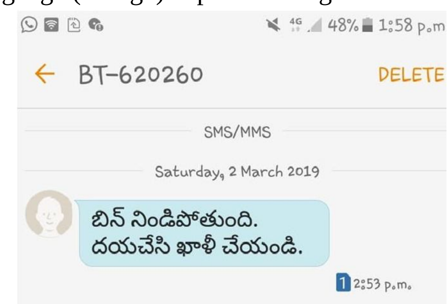

Fig.13 Snapshot of SMS

The following figure shows the route to the destination bin from the current location of the garbage collector. The route is open in the Google maps application when the user clicks “Locate in Map” button in our mobile application depicted in Fig.14.

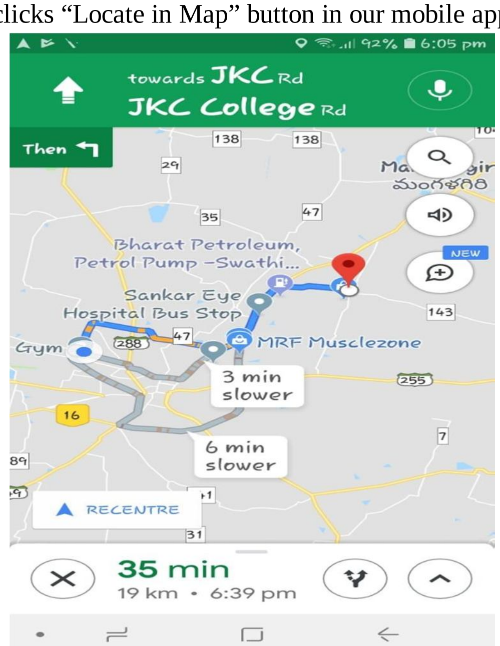

Fig.14 Snapshot of route displayed from Google maps

V. CONCLUSION AND FUTURE SCOPE

The functioning of a smart dustbin is discussed and proposed an approach for an effective waste management using Internet of things (IoT). The main objective of this project is to have a real time access of information about the dustbin and to make the proper use of the valuable human resource .The data is read from the dustbins and alerts were sent at appropriate time to the garbage collectors. An application has been developed which contains location of the dustbin so that the garbage collector can navigate to the desired destination. There is a large scope for this project in future. Advanced analytics can be applied on the data that has been collected from the sensors. Based on those results, municipalities can decide which areas need more bins and which places do not need many bins. It can be implemented on a large platform thereby contributing a lot to the effective waste management and cleanliness and another enhancement that can be done is route optimization. In the near future, integration of the public and household garbage collection can also be incorporated.

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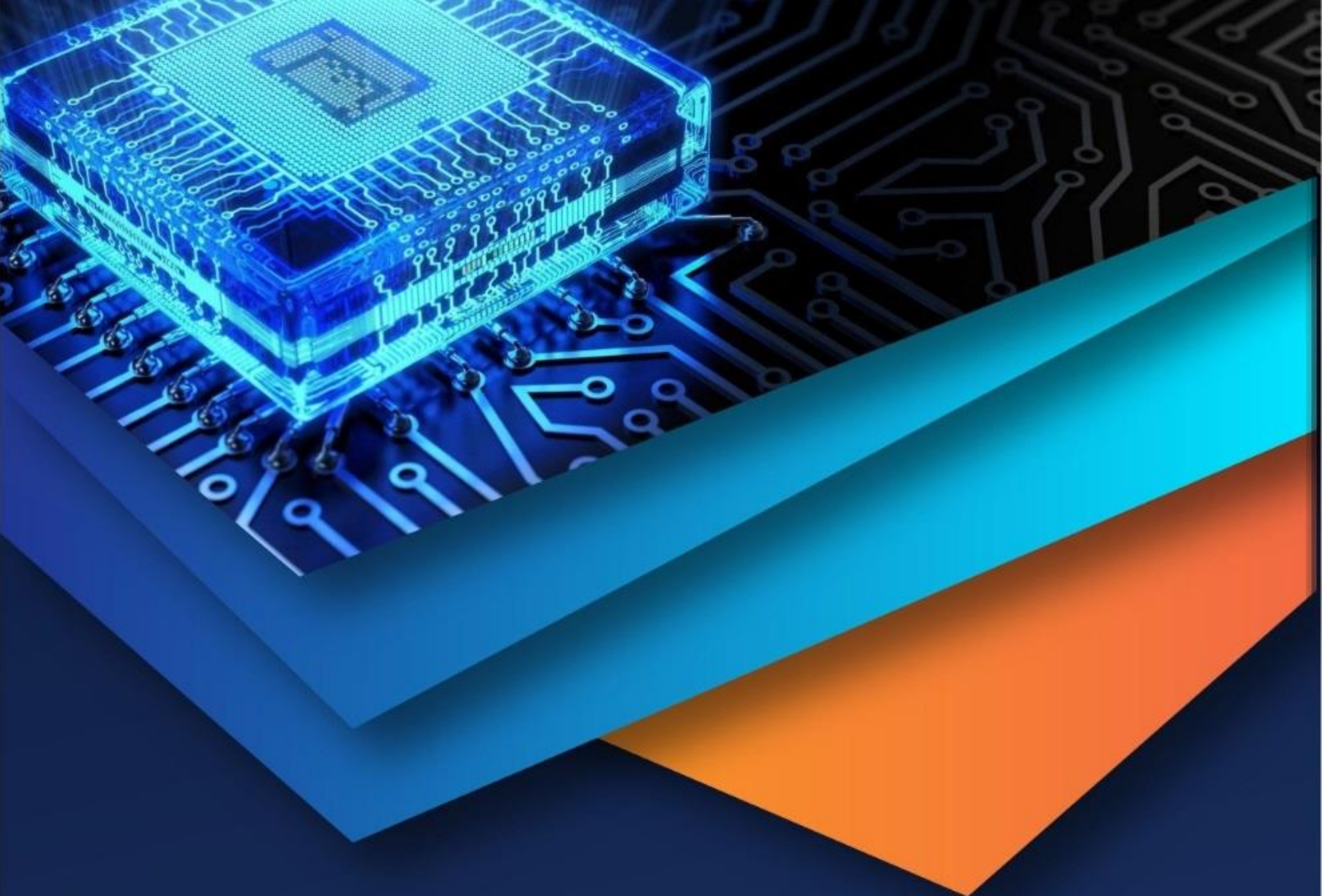

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