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Identification of Urban Waterlogged Areas along with its Prediction

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Abstract*: *Waterlogging is a natural phenomenon where water gets accumulated in an area which results to damage and destruction of material things which causes setback in our day to day lives. We are proposing a system that uses a set of hardware and Google Cloud Platform in such a way that it identifies water logging problem in a particular area. The Web Application displays different areas with various severity colour codes. It also does the analysis based on previous year reports and does predictions of waterlogging severity. The prediction of waterlogging is done using machine learning algorithm where a target variable helps us to determine the score of waterlogging in a particular area. In order to simplify the work of BMC officials we have developed a notification module along with Facebook chatbot which will simplify the identification of waterlogged areas for them.

Keywords: Waterlogging, Decision tree, Google Cloud Platform, IoT, prediction.

I. INTRODUCTION

Now as we are aware of what is waterlogging which that mainly occurs by rainwater gets accumulated in a particular area and what are the problems associated with it we will deal with how to cope up with this problem and steps to mitigate it[1]. One of the major cause of waterlogging is the improper maintenance of drainage system which results to sanitary and heavy traffic problems. Some of the other causes of waterlogging includes the high tides ,which mainly cunts if the area is closer the coastline, area's height etc. The studied region for this paper is chembur. Currently the system in action to get rid of it quiet simple and based on the severity in the region and phone calls from native peoples. Until now the disposal of this surplus water was purely based on its own passage through manholes which is very unreliable as they can get choked anytime, so have come with a solution to deal with this problem, to identify the waterlogged area we will be placing ultrasonic sensors[2] and esp8266 (microcontroller with wifi modules)[3] on the street lamps as they are at a safe height. Also they will have continuous source of electricity.

These sensors will collect the change in height levels data, continuously within time intervals of 15 minutes(variable) and send the data to server. Here the data is stored in database and analyzed for severity and various reports generation.

The responsible authority is informed about the water-logging condition through push notification. He/She can then remotely give command to start the pumps or inform the drainage cleaning groups to clear out the sewers of that area. Furthermore this data of the previous years are collected and is analyzed for predictions in long terms, medium term and short term. The accuracy of predictions is cross-checked by comparing it with actual value and predicted value.

II. NEED OF THE PROJECT

In the last couple of years there has been a need of a system that not only identifies waterlogging but also predicts it. It has been observed that waterlogging during the rainy season has caused more number of live damages, also material damages to our society. So it is a high time to build such a system that helps the BMC officials to act fast in cases of waterlogging, so that no human live or material damages are caused.

Thereby, we propose a system where we actually track each and every area for changes in the water level and based on that we classify them as low, medium and high. This helps in notifying the BMC officials about the current level and the quick action they need to perform based on that severity.

Also when the water logging occurs, there are multiple people trying to report, hence creating a chaos therefore the area goes unreported many a times, so we have developed Facebook chatbot where a user can report waterlogged area anytime, anywhere without any delay.

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III. DATA USED

For the prediction Module, data is collected from various sources like local Authorities , Online Websites , Weather APIs [4] and Tide APIs [5]. The Data mainly contains the Rainfall Data of the particular area , Tides Schedule for the nearest coastline area and rain rate of the area. The Data collected is used to put input inside the prediction Module, where Decision Tree Algorithm is used to predict the Label for Input Data. For the future prediction of the value the data will be collected from Online APIs, which will provide the forecasted data for coming 10 - 15 days.

IV. METHODOLOGY

The main methodology of the system is to collect the data from the different sensors which are installed at various locations will provide the current water level at respective location. Based upon the current water level at the location the marking is shown on the website. The system uses different APIs in order to get current rainfall and tides schedule.
System is divided into multiples modules:

A. Identification Module

In order to identify different regions based on the waterlogging level, each region comprises of ultrasonic sensors to determine the height at any given time. Based on the height level measurement regions can be classified into low, medium and high categories.

B. Prediction Module

For the prediction module we have used the Decision tree for the classification of the area into predefined categories .There are three predefined categories {0 , 1 , 2} where 0 represents the low level severity , 1 represents the medium level severity and 2 represents the High level severity.

C. Analysis Module

In Analysis Module data obtained from the sensors is put into use, where the actual severity score of each region is calculated. This also helps in notifying the BMC officials.

D. Notification Module

In Notification module authorities will be notified based upon the current water logging data and severity of waterlogging. There are three types of notifications sms notifications, email notifications and push notifications.
Using the twilio service as cloud communication platform, authorities will be notified about the different regions and their water logging le

E. Evaluation and reports Module

In this module based upon error rate(from prediction module),severity, current and previous rainfall data Graphs and Reports will be generated. Graphs will be of three types

1) Year vs efficiency
2) Top 10 water prone areas
3) Weekly region wise reports.

V. IMPLEMENTATION

For the Implementation of the above methodology in which we have used Ultrasonic Sensor [2](HC-SR04 Distance Measuring Transducer module) to measure the current water level at the particular level. At the server end we have used Google Cloud Platform to host the server , maintain the hardware devices , Database in Big Query[6].

A. Identification Module

In Identification module we have Ultrasonic sensors programmed using mongoose OS. Sensor measure the water level and sends the Data to Google pubsub[7] via the ESP8266 [3] attached with it. Each Sensor has its unique device Id which will be used to recognise the area from which the data belongs to. After Google pubsub data is sent to the Google BigQuery via Data Flow Created on the server. Dataflow is a pipeline which sends data from Pubsub to Bigquery (Data repository).Since there will be continuous data from various sensors we will have to store it identify the area hence we will have to store it in the Database
Server code is written in Nodejs (ExpressJs). Frontend access the server via AJAX API calls (routes in Express Js).

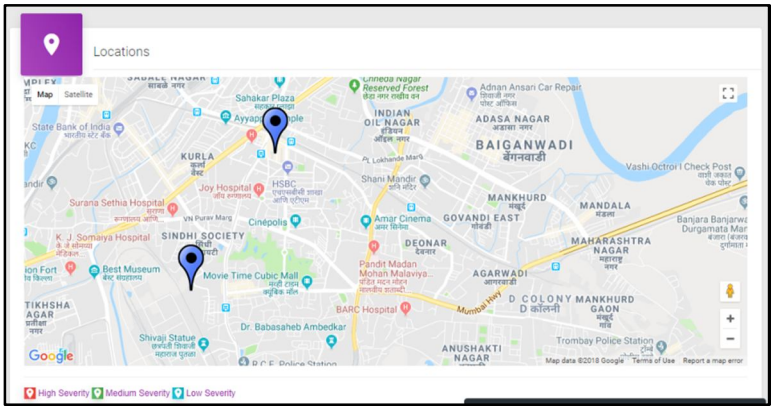

Fig. 1 Identification module

B. Analysis

In Analysis we determine the Severity of the respective area. Data is fetched via API call and based upon the water level severity of the respective area is determined done on client side. Based upon the Analysis level of the severity is determined .There are three types of severity

Level 1 : Water level between 0 to 5 inches

Level 2 : Water level between 5 to 10 inches

Level 3 : Water level more than 15 inches

C. Prediction

In prediction Module severity of the coming days is determined in order to make Officials ready for the coming difficulties. Here IBM Watson machine learning platform is used to Deploy the ML model. In the Model we have Implemented Decision trees to predict the class label. The we used the AJAX API calls to accesses ML model to the server. After Predicting the Level for different areas ,On the web page it has been shown top severity areas for the coming days.

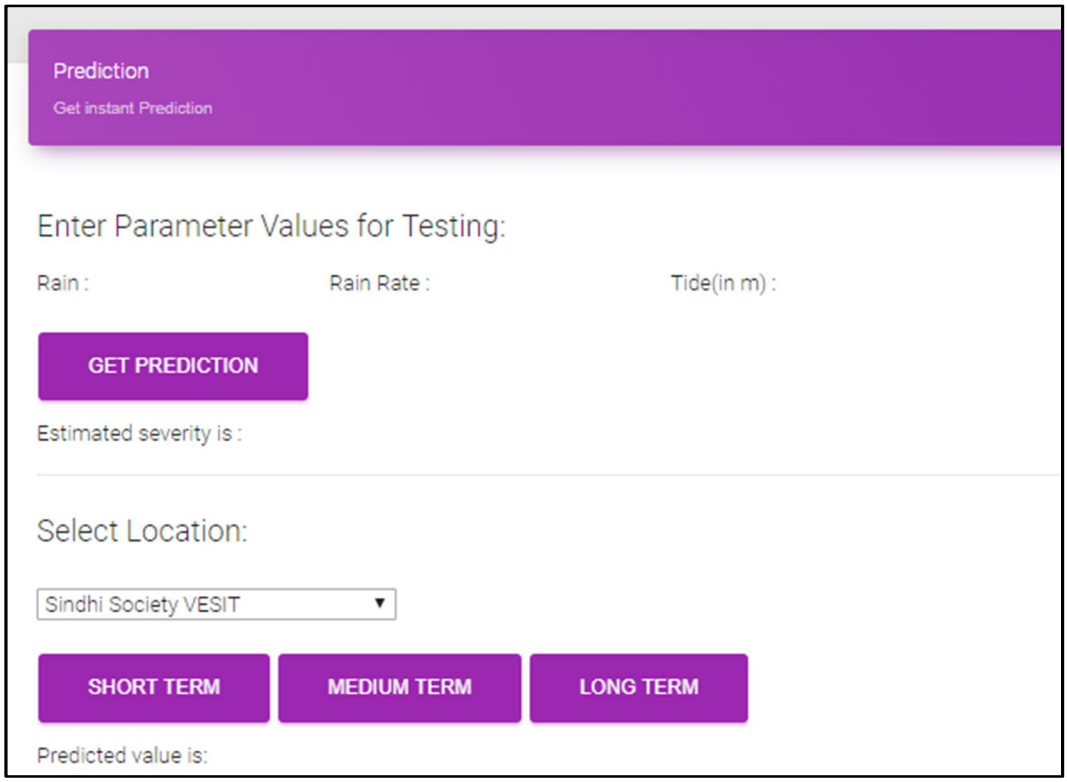

Fig. 2 Prediction module

D. Notification

Since the main highlight for the System is to make officials get the knowledge about current situations at various places so we have used the Twilio API to automatically notify the user.It will send the current water level and time to the Official or the user of the respected user. Express framework is used to code the notification module.

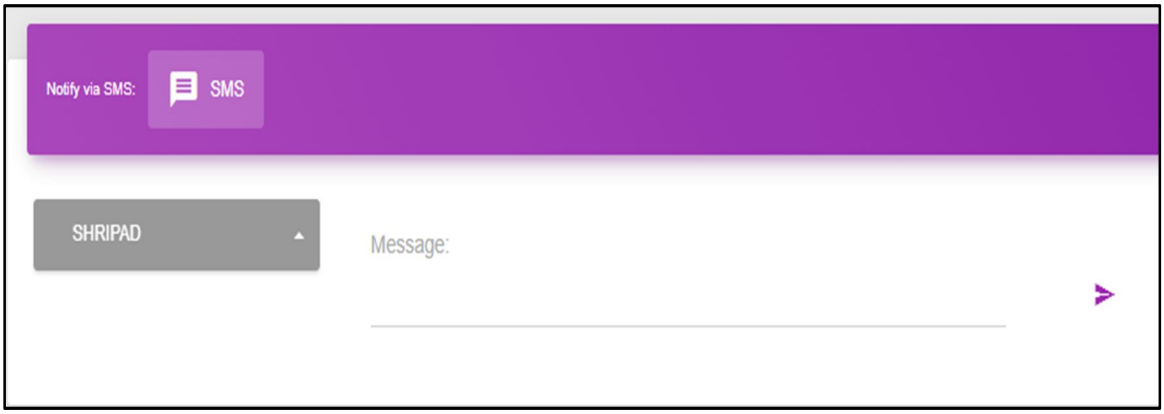

Fig. 3 Notification module

E. FAQ Chatbot

For the new User to the system there is facility of the FAQ chatbot. It will give the answers to the basic queries and brief overview of the system. Google Dialog flow is used to design Chatbot to answer FAQin main website. Here the user will get the knowledge about the basic entities and directions to use the system.

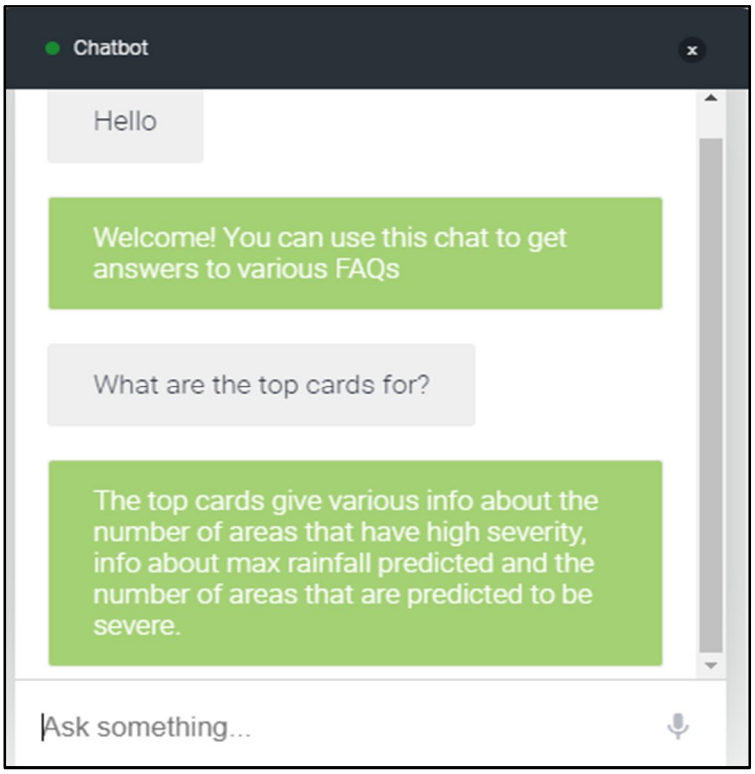

Fig. 4 Chatbot on webpage

F. FB Chatbot

As it becomes harder for the officials to manage the phone calls during worst situations of the water logging so we have Introduces the FaceBook Chatbot form where anyone can report the waterlogging to the officials. Dialog flow and Google cloud functions is used to implement this bot. The reported messages will be shown on the Online Reporting Module in th web page.

Client uses FB messenger to report logging near his location. FB messenger transfers this data to Diaglow flow. Dialog flow sends this data to a webhook (which is an API to enter data in Bigquery)Client fetches the reported logging via AJAX API calls to Bigquery to display the data.

Fig. 5 FB chatbot

G. Reports

At the Reports Module the Region Wise Water logging reported in the different years has been shown. Google data studio is used to trousers charts and reports and the iframe is then inserted into the html web page.

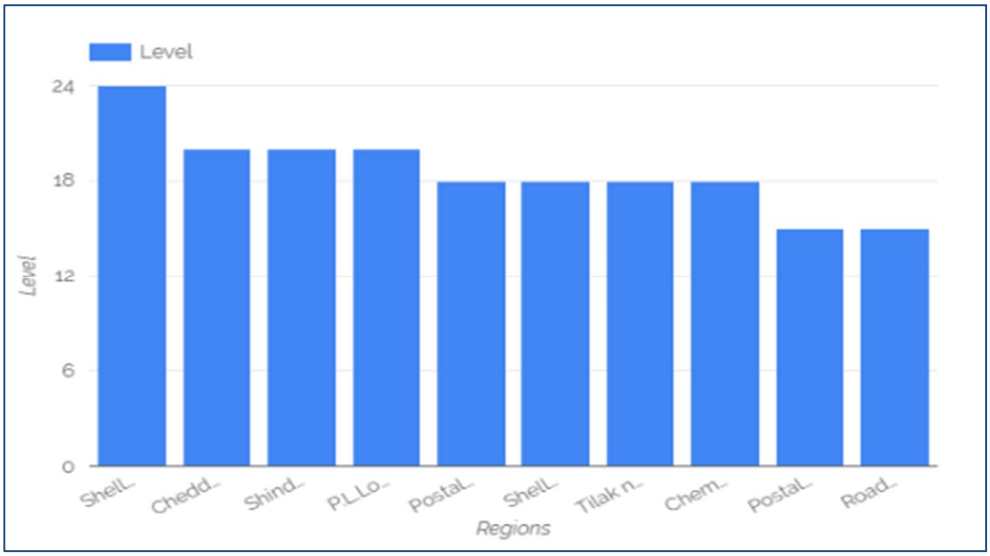

Fig. 6: Max Rainfall in 2017

H. Maps

To Identify the particular area easily Google maps has been used. To show it User is required to enter info like (Name of officer, latitude, longitude. Phone number) in the Add Sector module .Client uses the latitude, longitude of the installed sensors to report Waterlogging on map using Google maps API.

Colour codes are used to indicate severity (Blue - low level, Green - medium level , Red - high level) on maps.

V. RESULTS

For testing purpose we have installed two hardware modules at different places , based upon the water level it is updating the indicator in the webpage as follows:

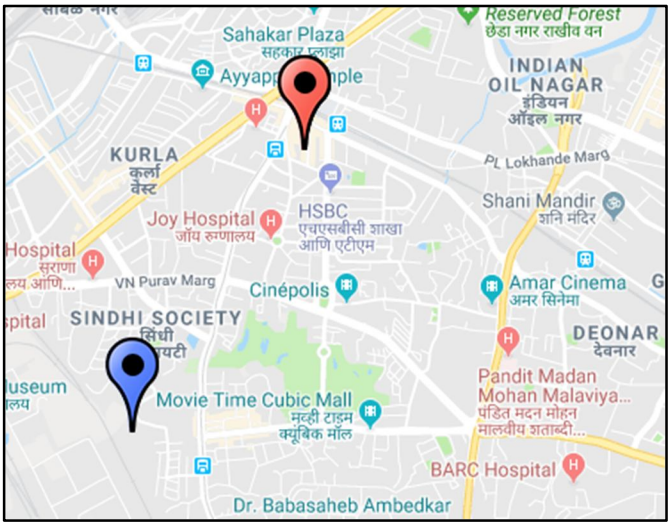

Fig. 7 Severity Identification in two different areas

As we can see that the indicator in collectors colony region is blue which means that the waterlogging severity in that region is low but the severity on the other region which is near the chembur station is colored red which means that the waterlogging severity in that particular region is high. For the Machine Learning we have used the Decision tree model the tree structure of the model is as follows.

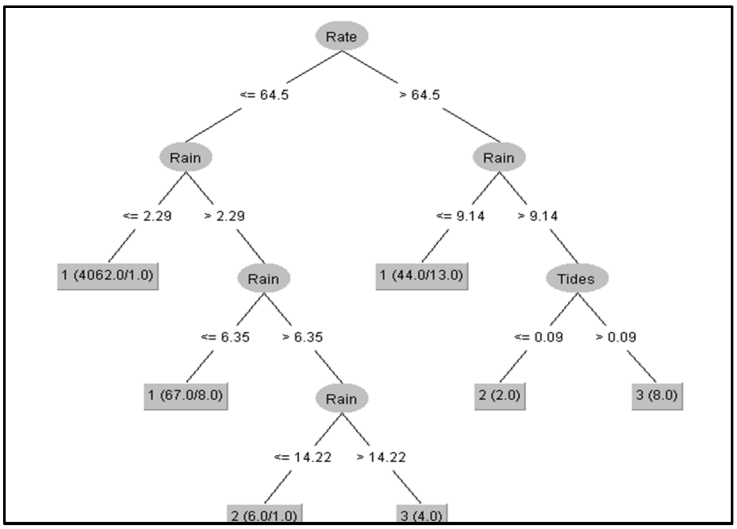

Fig. 8 Decision tree

The above decision tree is generated using the tool weka, as it is clear that the root node is Rain rate based upon which the tree gets splitted into two parts. Since it is an multi level classification so we have some parameter repeated more than one time

VII. CONCLUSION

The waterlogging is a natural cause mainly occurs due to high rainfall but there are certain other factors like High tides(if an area is near to the coastline) , area's height does matter upto an extent. The proposed system Identifies the waterlogging in particular area using the sensors data. For the prediction of waterlogging in future it uses previous available data and creates an decision tree model. For the communication with the server we can use other technologies like Zigbee but those are not efficient as the proposed one. Based upon the parameters it can make short term, medium term and long term prediction for coming days. Since the backend of the system is handled by google cloud platform non-functional requirements like load on server, backend security are taken care of indirectly.

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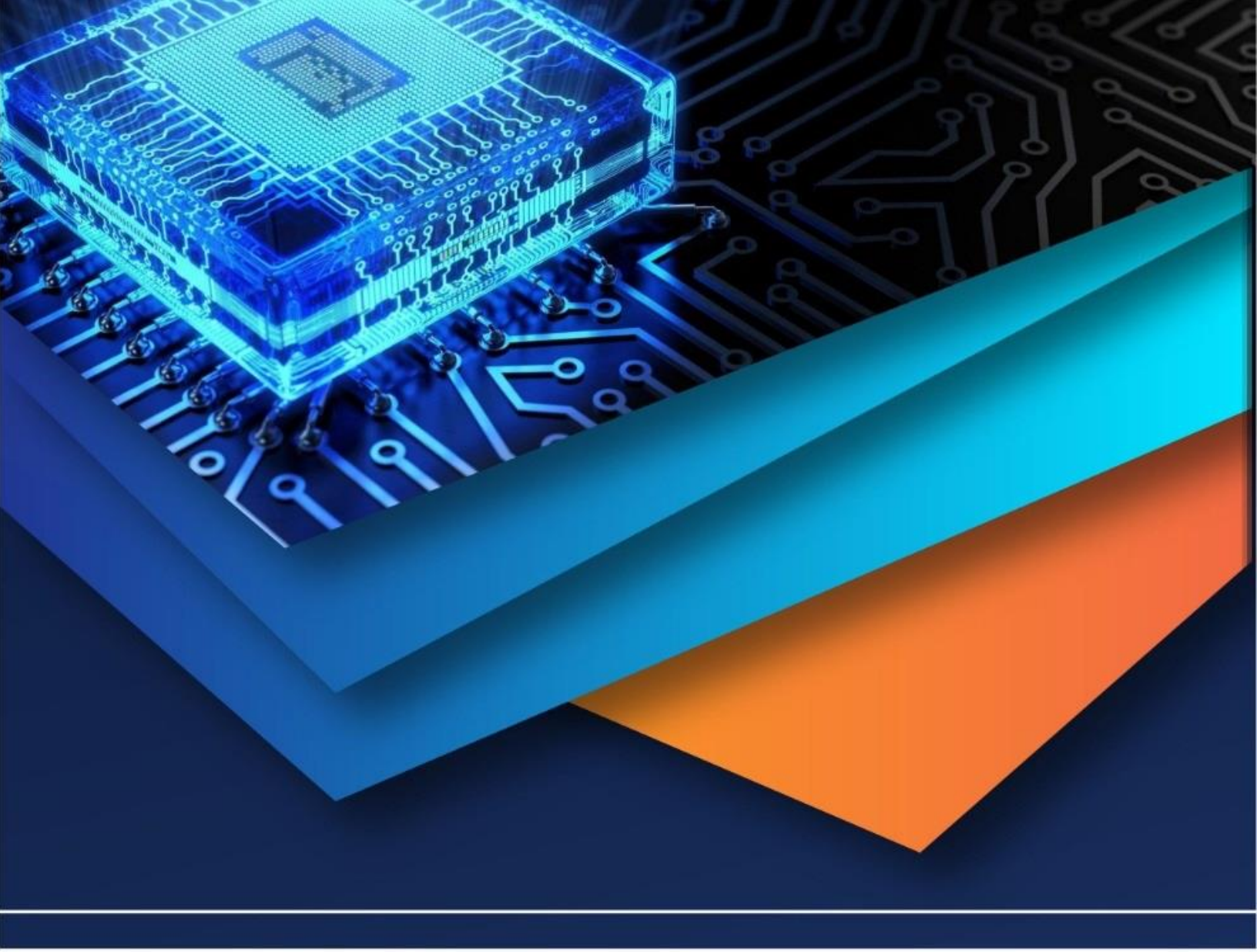

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