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Soil Analysis and Prediction of Suitable Crop for Agriculture using Machine Learning

S. Panchamurthi. M. E[1], M. D. Perarulalan[2], A. Syed Hameeduddin[3], P. Yuvaraj[4]
[1]*Assistant professor, Department of EIE Panimalar Engineering College, Chennai.*
[2, 3, 4]*Student of Panimalar Engineerimg College, Department of EIE*

Abstract: To provide assistance to the farmers by predicting the suitable crop for their agricultural purposes by using sensors which provide great accuracy and also suggesting the fertilizers required for the growth of the crops

I. INTRODUCTION

In India, agriculture is one of the important sectors as 50% workforce is involved in agricultural activities. Contribution of Agriculture sector in Indian economy is much higher than world's average (6.1%). But Traditional farms in India still have some of lowest per capita productivity and farmer incomes due to lack of development of technology in agricultural sector. Soil analysis is important methodology as it gives nutrients present in soil such as pH value, EC value, moisture, Temperature and NPK values. In automated soil testing human efforts will be reduced by monitoring the quality of soil using soil sensor. Depending on the values we get from our device suitable list of crops is predicted. Crop prediction is also important parameter in order to increase the yield production. So on the basis of pH value, EC value, moisture, Temperature and NPK values we predict the appropriate crop along with the required fertilizers such as gypsum for alkali soils and lime for acid soils. More economical use of fertilisers and better soil management practices for increasing agricultural production. so that farmers will overcome the exiting method drawback.

Soil testing mechanism used in India is a very tedious job and it takes time as different samples of soil is collected from farming land and sent to the laboratories, then test are done and reported back to the farmers. This procedure generally takes almost 7 to 10 days and may be more if the laboratory is far away from the land. What these lab do is, it collects soil samples from different location in the area, performs tests and makes are report for that farming area. Will the report accurate if one sample is collected from the land where rice is grown and the other where some vegetable is grown in the same area?

If yes then there is great possibility that report may differ from the report generated from the samples from only the rice cultivated land. Generating two reports for the same area is not possible as laboratories are limited and their testing load is very high.

II. LITERATURE SURVEY

Mostly the agriculture is ineffective in India because of the lack of knowledge about agriculture and usage of fertilizers. At present soil ingredients are being tested only at soil testing laboratory , where they use primitive method. In the existing system the soil can be tested just to check out the fertility and the moisture level. It has to be given to the lab for testing the soil. It will take some days to fetch result. Farmers are suffering much to get the farm lands survey reports quickly. Farmers get scared of rain every year for their demand yield. In primitive method, various soil nutrients can be suggested with the help of pH value. Asper the availability of nutrients, recommendation of cultivating particular crop will be given with the help of pH electrode.

A. Preparation Of Soil Samples For Analysis In Existing System

1) *Handling in The Laboratory:* As soon as the samples are received at the soil testing laboratory, they should be checked with the accompanying information list. If the soil testing laboratory staff have collected the samples themselves. Then the adequate field notes might have been kept. All unidentified samples should be discarded.
2) *Drying Of Samples:* Samples received in the laboratory may be moist. These should be taken to maintain the identity of each sample at all stages of preparation. During drying, the trays can be numbered or plastic tag could be attached the soils are allowed to dry in the air. Alternatively, the trays may be placed in racks in a hot air cabinet whose temperature should not exceed 450 c and relative humidity should be between 30-60%.
3) *Post Drying Care:* After drying the samples are taken to the preparation room which is separate from the main laboratory. Air dried samples are ground with wooden pestle and mortar so that soil aggregate are crushed but the soil particles do not break down. Samples of heavy clay soils may have to ground with an end runner lining to the mortar. Pebbles, concretions and stones should not be broken during grinding, the soil is screened through a 2mm sieve. The practice of passing only a portion of ground sample through the sieve and discarding the remainder is erroneous. This introduces positive bias in the sample as the rejected part may include soil elements with differential fertility.

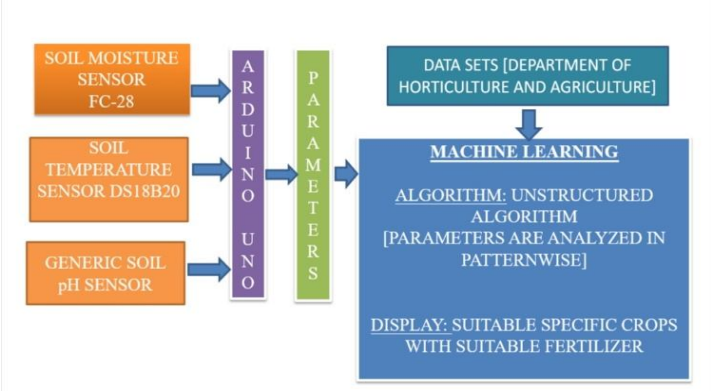
B. Limitation of Existing System

1) Time period to get the result will take 15-20 days.
2) Single soil sample from the land cannot predict the overall efficiency throughout the land.
3) Farmer doesn't have enough knowledge to know which fertilizer to use.
4) Chemical methods use in the laboratory are more dangerous care must be taken.
5) Carrying multiple soil samples to the lab is not feasible for the farmers.

III. PROPOSED SYSTEM

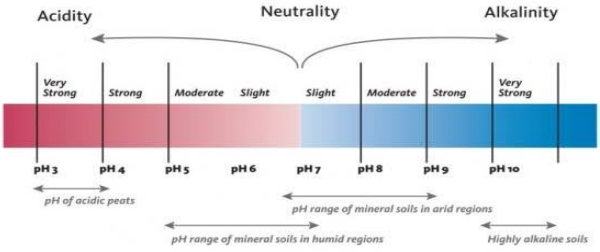
Our system will overcome the drawbacks of the primitive methods used till date. Here the soil parameters and nutrients present in the soil like NPK are analyzed to determine the fertility level of that soil. Along with soil analysis our system will also predict the crops using machine learning. It compares the present data and existing data collected from the Department of Horticulture and agriculture according to the different parameters like pH, EC, moisture, temperature values. Farmers can test the soil multiple number of times during cultivation process and take necessary precaution to get good yield. At the end reports will be generated so farmers can keep record of their fertility.

A. Block Diagram



B. Sensors

1) pH Sensor



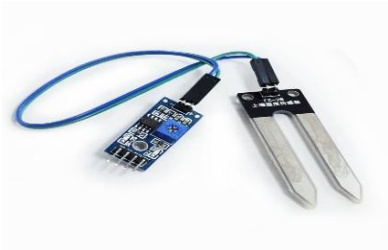
a) From the soil sample ,the pH is measured using Generic soil pH sensor.
b) This pH provides a great extent for the detection of the specific crops.
c) The pH value gives that the acid nature and basic nature of the soil which is important for the soil analysis.

2) Soil Moisture Sensor

This sensor is used to measure the moisture content of the soil sample. It measure the texture of the soil such as

a) Sandy loams
b) Silt loams
c) Clay loams
d) Silt clay

Nitrogen content of the sample is indirectly measured by the soil moisture sensor



C. Soil Temperature Sensor

Factors that influence soil temperature are

1) Surface soil temperature: Radiation from the sun, slope of the land, water content, vegetative cover and albedo(light reflected by the earth).

2) Subsurface soil temperature: Heat flux from the surface, water content, bulk density and heat capacity of the soil. It measures the Temperature of the soil sample through which we can partially predict the crop to be cultivated with respect to different seasons

It also plays a major role in the irrigation of the land

D. Machine Learning

Machine learning is an application of artificial intelligence(AI) that provides system the ability to automatically learn and improve from experience without being explicitly without being explicitly programmed. Machine learning focus on the development of computer programs that can access data and use it learn for themselves.

1) Algorithm Used In This Project: Supervised learning algorithm

The supervised learning algorithm is used by maximum machine learning users. There is a basic fundamental on why it is called supervised learning

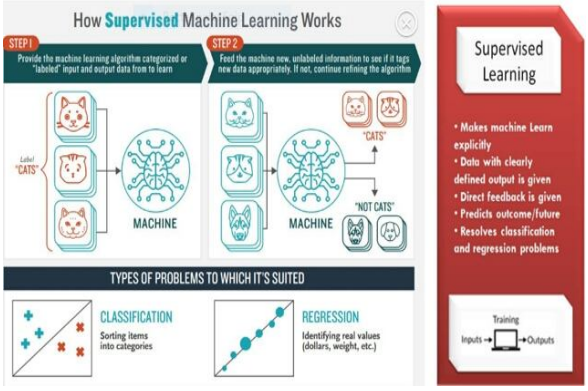
It is called as supervised learning because the way an algorithm's Learning process is done, it is a training Dataset

While using Training dataset, the process can be thought of as a teacher supervising the learning process

The correct answer is known and stored in the system already

The algorithm helps in making predictions about the data that is in training process and gets the correction done by the teacher itself

There is an end to the learning only when the algorithm has achieved an acceptable degree or level of performance



2) Types Of Problem To Which It Is Suited

a) Classification Problems: Classification problem can be defined as the problem categories, such as the "red" or "blue" or it could be "disease" and "no disease".

b) Regression: A Regression problem is when the output variable is a real value, such as "dollars" or it could be "weight".

3) Supervised Learning: In supervised learning, we start with importing dataset containing training attributes and the target attributes. The Supervised Learning algorithm will learn the relation between training examples and their associated target variables and apply that learned relationship to classify entirely new inputs (without targets).

4) *Support Vector Machine Algorithm:* In the learning step, the classification model builds the classifier by analysing the training set. In the classification step, the class labels for given data are predicted. The dataset tuples and their associated class labels under analysis are split into a training set and test set. The individual tuples that make up the training set are randomly sampled from the dataset under analysis. The remaining tuples form the test set and are independent of the training tuples, meaning that they will not be used to build the classifier. The test set is used to estimate the predictive accuracy of a classifier. The accuracy of a classifier is the percentage of test tuples that are correctly classified by the classifier. To achieve higher accuracy, the best way is to test out different algorithms and trying different parameters within each algorithm as well. The best one can be selected by cross-validation. To choose a good algorithm for a problem, parameters such as accuracy, training time, linearity, number of parameters and special cases must be taken into consideration for different algorithms.

E. Dataset

The Data measured using the sensors and Dataset collected from the DEPARTMENT OF HORTICULTURE AND AGRICULTURE both are incorpated into the machine learning-python. The Algorithm here we used will compare both values, there will be a definite match. The data matched will appear in the screen through that we can predict the suitable crop for that particular soil and based on the nutrition status we can suggest the required fertilizer for the land which play a vital role in farmers development

Dataset for Tiruvallur district collected from DEPARTMENT OF HORTICULTURE AND AGRICULTURE

State: Tamil Nadu
District: Thiruvallur

Sr.No.	Sample No.	pH	EC	OC	N	P	K
1	Poonamallee						
1	TN6096069/2017-18/74412254	7.40 MAl	0.10 N	0.57 M	205.00 L	63.00 H	125.00 L
2	TN6096069/2017-18/74413029	7.30 MAl	0.10 N	0.51 M	190.00 L	88.00 H	164.00 M
3	TN6096069/2017-18/74415135	7.20 MAl	0.20 N	0.47 L	183.00 L	63.00 H	99.00 L
4	TN6096069/2017-18/74415881	7.10 MAl	0.10 N	0.45 L	178.00 L	88.00 H	154.00 M
5	TN6096069/2017-18/74415881	7.10 MAl	0.10 N	0.45 L	178.00 L	88.00 H	154.00 M
6	TN6096069/2017-18/74417634	7.00 N	0.10 N	0.54 M	200.00 L	100.00 VH	123.00 L
7	TN6096069/2017-18/74418125	6.20 MAc	0.20 N	0.32 L	156.00 L	50.00 M	173.00 M
8	TN6096069/2017-18/74418913	7.20 MAl	0.20 N	0.57 M	205.00 L	25.00 M	125.00 L
9	TN6096069/2017-18/74419335	7.10 MAl	0.10 N	0.60 M	213.00 L	63.00 H	135.00 L
10	TN6096069/2017-18/74419707	7.10 MAl	0.10 N	0.47 L	183.00 L	63.00 H	183.00 M
11	TN6096070/2016-17/74544303	6.70 SlAc	0.46 N	0.51 M	188.00 L	50.00 M	136.00 L
12	TN6096070/2017-18/74432303	7.20 MAl	0.47 N	0.48 L	194.00 L	50.00 M	135.00 L
13	TN6096070/2017-18/74433567	6.80 SlAc	0.18 N	0.47 L	183.00 L	38.00 M	240.00 M
14	TN6096070/2017-18/74436296	7.10 MAl	0.36 N	0.47 L	166.00 L	38.00 M	193.00 M
15	TN6096070/2017-18/74437317	7.10 MAl	0.20 N	0.37 L	156.00 L	63.00 H	173.00 M
16	TN6096070/2017-18/74437490	6.20 MAc	0.20 N	0.32 L	156.00 L	50.00 M	173.00 M
17	TN6096070/2017-18/74496127	6.90 SlAc	0.33 N	0.38 L	166.00 L	13.00 L	108.00 L
18	TN6096070/2017-18/74496593	7.10 MAl	0.30 N	0.50 L	183.00 L	50.00 M	154.00 M
19	TN6096070/2017-18/74497017	7.20 MAl	0.30 N	0.51 M	194.00 L	25.00 M	125.00 L
20	TN6096070/2017-18/74497577	7.20 MAl	0.44 N	0.38 L	169.00 L	50.00 M	135.00 L
21	TN6096070/2017-18/74498334	6.70 SlAc	0.24 N	0.41 L	170.00 L	50.00 M	284.00 M
22	TN6096070/2017-18/74499198	6.60 SlAc	0.31 N	0.51 M	194.00 L	63.00 H	201.00 M
23	TN6096070/2017-18/74499650	6.70 SlAc	0.20 N	0.37 L	158.00 L	63.00 H	173.00 M
24	TN6096070/2017-18/74500337	6.50 MAc	0.25 N	0.48 L	188.00 L	38.00 M	261.00 M
25	TN6096070/2017-18/74500983	6.60 SlAc	0.32 N	0.36 L	166.00 L	25.00 M	250.00 M

We have collected more than 300 of the data, this is an part of the complete set.
The collected data are highly relatable to the Tiruvallur district of Tamil Nadu.
It is the basic key for the structured algorithm through which analysis can be done.

F. Different Crops Cultivated in Tiruvallur Area

1) Production Of Cereal Crops

a) Paddy
b) Bajra
c) Sorgham
d) Ragi

2) Production Of Pulse Crops

a) Red gram
b) Greengram
c) Blackgram

3) Production Of Spices And Codiments

a) Chillies
b) Tamarind

4) Production Of Vegetable Crops

a) Brinjal
b) Tomato
c) Sweet potato

5) Production of fruit crops

a) Banana
b) Mango
c) Lemon
d) Jack
e) Guava

6) Production Of Oil Seed Crops

a) Groundnut
b) Sun flower
c) Coconut
d) Gingelly

IV. FERTILIZER RECOMMENDATIONS

Fertilizers recommendations are based on the results of the soil test analysis and on the nutrient requirement of the crop to be grown. Recommendations on time and method of fertilizer application are also included.

There are two ways for making fertilizer recommendation:

1) Recommendation which indicate the nutrient requirements and yield potentials for optimum economic production based one or more moisture conditions of the field.

2) "Target Yield Recommendation" which indicate the nutrient requirements for a range of various lower and higher yield potentials under the same moisture conditions. With this information the producers have the flexibility of selecting a fertilizer application rate or target yield that best suits their individual situation.

A. Fertilizer Types

Soil amendments are made by adding fertilizer to the soil but there are different types of fertilizers. There is bulky organic fertilizer such as cow manure, bat guano, bone meal, and organic compost and green manure crops. And then there is a also chemical fertilizer which is also referred to as inorganic fertilizer and is made up with varieties of specified uses chemical fertilizer usually comes in either granular or powder form in bags and boxes, or in liquid formulations in bottles

The different types of chemical fertilizers are usually classified according to the three principal elements, namely Nitrogen (N), Phosphorous (P) and Potassium (K), and may, therefore, be included in more than one group.

B. Organic And Inorganic Chemical Nitrogenous Fertilizers Types

This type of fertilizer is divided into different groups according to the manner in which the nitrogen combines with other elements. These groups are;

Sodium Nitrates, Ammonium sulphate and Ammonium Salts, chemical compounds that contains Nitrogen in amide form, and animal and plant by products.

C. Organic And Inorganic Chemical Phosphate Fertilizer Types

The phosphate fertilizers are categorized as natural phosphates, either treated or processed, and also by products of phosphates and chemical phosphates

1) Rock Phosphate
2) Super Phosphate
3) Slag
4) Bone-meal

D. Organic and Inorganic Chemical potassium Fertilizer Types

Chemical potassium fertilizer should only be added when there is absolute certainty than there is a potassium, deficiency in your garden soil. Potassium fertilizers also work well in sandy garden soil that responds to their application. Crops such as chilies, potato and fruit trees all benefit from this type of fertilizer since it improves the quality and appearance of the produce. There are basically two different types of potassium fertilizers:

Murate of potash (potassium chloride) and sulphate of potash (potassium sulphate)

V. ADVANTAGES

A. The Crop is predicted within half an hour. Time consumption is reduced
B. We can take multiple test throughout the land. The accuracy of prediction is increased
C. The chemical process is neglected which is more risky
D. Soil test process is provided to the farmers at their door step
E. Farmers get huge awareness on suitable crop cultivation and fertilizers to be suggested

VI. CONCLUSION

Soil analysis and prediction of suitable crop provides the crop and fertilizer recommendation based on the processing of different parameters of soil.The farmers can get the soil testing services at the doorstep. This project replaces the primitive method of soil testing in a effective way and so, the farmers get to know about their soil quickly. The result provided by this project helps the farmer to take up decision and prevent them to use unbalanced fertilizers. This project is greatly useful to the second level farmers.

A. Future Scope

The hardware and the azure notebooks has to be combined. Further alternations are made to improve the accuracy level of prediction of the crops and fertilizer for our monsoon climate and to reduce the size of the sensors so that it become compact. Improvements are made to improve the size of the dataset. Additional benefits include; improved crop maturity and quality, higher tolerance to disease and pest damage, and increased growth. Soil testing done before a crop is to be grown, makes it the best indicator of fertilizer requirements for that crop season.

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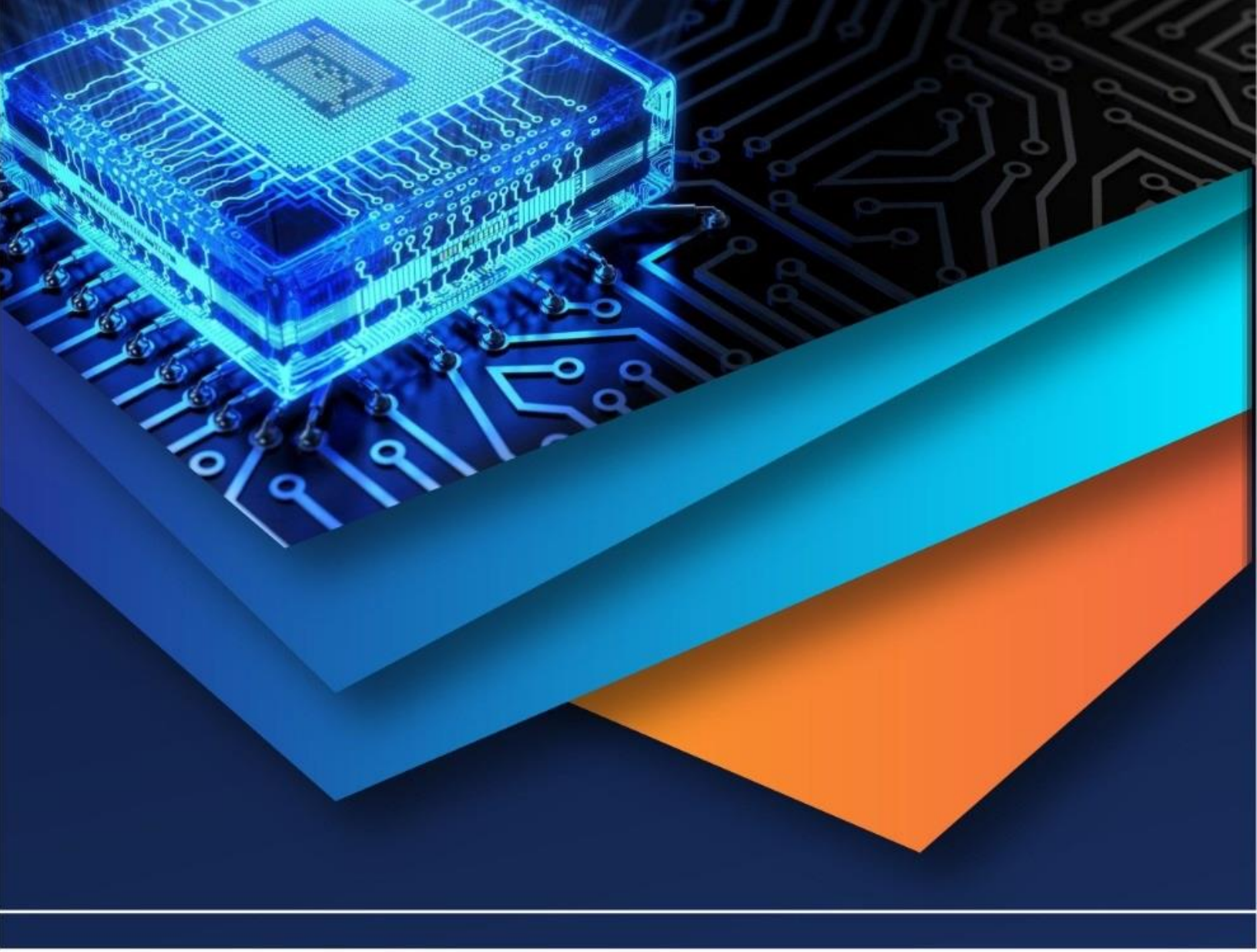

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