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Algorithms for Plant Pathology: Automation of Plant Leaf Colour Chart using Image Processing

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Abstract: Traditional way of making use of leaf colour chart does matching of the leaf colour with the colour images available on the colour chart through naked observations. But this approach has few drawbacks such as different people perceive different colour of the same object based on ability to differentiate colour as well colour differentiation may vary in different lighting conditions and person to person also. Hence this can be automated by taking the help of digital image processing, where the image capture camera is given as the input to the expert system developed and system itself directly correlate the colour features of the input with the store features in the database image and outputs Requirement of particular nutrient or excess of it.
The mapping of captured image to the database image has few challenges such as scaling effect and different illumination conditions affecting colour contents of the captured image. By making the use of scale invariant image processing techniques and taking one reference colour image while capturing the image of leaf helps to Mathematically model the transformation, due to different illumination conditions and Exact inverse transformation can be Applied on to the capture image before making the comparison between the query image and the database images Which will nullify the effect of variation in surrounding light in intensity while capturing the images.
This paper suggest Image processing based algorithm for automation of identification of leaf color chart to handle different challenges of scale and lighting condition at the time of image acquisition
Keywords: LCC, RGB, HSI, PDI, SVM, Color spaces, Pattern Recognition, Algorithms,, Color Spaces, Classifiers, Wavelet transform

I. INTRODUCTION

Plant pathology (also phytopathology) is the scientific study of plant diseases caused by pathogens (infectious diseases) and environmental conditions (physiological factors). Organisms that cause infectious disease include fungi, oomycetes, bacteria, viruses, viroid, virus-like organisms, phytoplasmas, protozoa, nematodes and parasitic plants. It does not include ectoparasites like insects, mites, vertebrate or other pests that affect plant health by consumption of plant tissues. Plant pathology also involves the study of pathogen identification, disease etiology, disease cycles, economic impact, plant disease epidemiology, plant disease resistance, how plant diseases affect humans and animals, pathosystem genetics, and management of plant diseases. Plant pathology plays important role in the scientific and social development of the world. Hence in short plant pathology can be considered as a branch of science that basically deals with the diseases or troubles or sufferings of Crop plants. A plant pathologist is a professional who specialises in plant health much like a physician specialises in human health of a veterinarian in animal health.

LCC is a modest, quick, and convenient field instrument to gauge green color power of leaf, which is identified with the plant's nitrogen content. Yellowish green speaks to the least nitrogen fixation and dull green as the most astounding.[1]

Nitrogen (N) fertilizer is essential in rice Production. Apply N fertilizer a few times amid the developing season to guarantee that the harvest's nitrogen require is provided, especially at basic development stages. What's more, the test is Nitrogen is the most restricting nutrient in every one of the soils. Blanket fertilizer suggestions over expansive territories are not effective as it doesn't consider inconstancy of soil N supply and changes in the trim request. It is more gainful if N data sources could be changed in accordance with genuine harvest conditions and nutrient necessities.

The Leaf Color Chart (LCC) is utilized to decide the N fertilizer needs of rice crops.[2] LCC has four green strips, with color extending from yellow-green to dim green. It decides the greenness of the rice leaf, which shows its N content. All plants requires nutrient components for their foundation and survival. Among those nutrient components, nitrogen (N) is the most critical nutrient which is basic for photosynthesis and in this way builds the yield. Not at all like different harvests, N can be overseen viably at ongoing every one of the phases of product development by utilizing Leaf Color Chart (LCC). LCC is the chart which gives the idea that of leaves and having the color from dim green to yellowish green colors. Yellowing of leaves in paddy demonstrates the

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inadequacy of nitrogen, however it is hard to choose the amount of nitrogen to be connected in view of the degree of yellowing. The fixation green or yellowish green colors of LCC mirror the N focus (inadequate or adequate) of paddy clears out. Dim green color of a leaf speaks to the bottomless nitrogen status of that leaf and increments in yellow color demonstrates the viciousness in insufficiency of that leaf.

The leaf color chart comprises of 4 or 6 green strips, first strip with light green color and the last strip (fourth or sixth) with dim green color and in the middle of strips (second to fifth) is with changing force of green color. The leaf color chart (LCC) is a creative financially savvy device for ongoing or product require based N administration in Rice, Maize and Wheat. LCC is a visual and subjective marker of plant nitrogen inadequacy and is a modest, simple to utilize and basic contrasting option to chlorophyll meter/SPAD meter (soil plant examination advancement) .It gauges leaf color power that is identified with leaf N status. LCC is a perfect device to advance N use in Rice/Maize/Wheat at high return levels, regardless of the wellspring of N connected, viz.,organic excrement, naturally settled N, or concoction fertilizers. In this way, it is an eco-accommodating apparatus in the hands of ranchers.

II. LITERATURE SURVEY

Access to nitrogen fertilizers can mean the difference between success and failure of an entire year's investment for an Asian rice farmer. But overuse of fertilizer can degrade the long-term quality of the soil and water resources on which they depend and can eat away at precious little profits. But researchers have discovered that rice leaves themselves can give clues about how much nitrogen is needed for optimal yield.

A new 4-panel leaf color chart (LCC) that corresponds to actual colors of rice leaves has been developed for rice cultivation in sia—the chart was created by the Irrigated Rice Research Consortium (IRRC) in collaboration with the University of California Cooperative Extension (UCCE). The LCC consists of plastic panels, each with distinctly different shades of green ranging from yellowish green to dark green. LCCs can be used by farmers in the field to gauge how much nitrogen fertilizer is needed for efficient use, and to maximize rice yields.[3]

The LCC is used at critical growth stages by simply holding a rice leaf against the panels. A farmer can tell whether the crop has received too much nitrogen or is nitrogen deficient, by comparing leaf color too LCC panels. This provides real-time guidance for when to apply, and when not to apply fertilizer. Any color outside the range of the four panels would signal extreme nitrogen deficiency or excess.

"The challenge for poor smallholder farmers is how to plan for the application [of nitrogen] in an environment that is very versatile," says Dr. Christian Witt, IRRC researcher in the development of LCC. "Small changes in soil fertility gradient from field to field will have a great impact on the nitrogen demand of the crop. Also, you have seasonal variation. In the dry season the yield potential is higher, so the plant requires more nitrogen. In the wet season, soil fertility is usually sufficient to cover a significant portion of the nitrogen demand. And not every wet season or dry season is the same. So it is extremely difficult to plan for your nitrogen requirement before the season." The new LCC can be used for all high-yielding rice varieties in Asia. Guidelines on the use of the chart have to be adjusted for local conditions. The critical leaf color—signalling optimal growth—depends on region, rice variety, season, and cropping method. A prescribed amount of nitrogen is applied when the color of rice leaves falls below the critical LCC value.

This effective, low-cost tool helps farmers improve their nitrogen fertilizer management, improving their prospects for success. "Smallholder farmers benefitted from the low cost [about US$1 a unit] and the learning that was associated with it," says Witt. "It wasn't just the chart, but also learning when the plant really needs the nitrogen and observing leaf color. Once farmers used the LCC for two or three seasons,{they} adjusted their nitrogen management, and they developed an eye for the optimal green leaf color. Managing soil fertility and having adequate tools to be able to communicate soil fertility to farmers is essential to sustainable agriculture and food security."[4]

The chart and guidelines for using the LLC are being promoted in many Asian countries through the IRRC. More than 250,000 units of the 4-panel LCC are due to be distributed to rice farmers in Bangladesh[5], China, India, Indonesia, Myanmar, the Philippines, Thailand, and Vietnam. Further research is being conducted to establish whether the LCC could also be used for nitrogen management in maize. The nitrogen (N) requirement of hybrid rice is generally greater than in conventional rice varieties. Recommendations for N monitoring at regular intervals of 7–10 days through leaf greenness are available, but farmers are accustomed to apply fertilizer N at selected growth stages only. An inexpensive leaf color chart (LCC) and non-destructive chlorophyll meters were evaluated for site-specific N management strategy in world's first aromatic rice hybrid PRH-10 at the Indian Agricultural Research Institute, New Delhi.

Leaf colour charts are an effective, low cost tool to assist farmers in improving their nitrogen fertilizer management. These standardised guidelines developed by IRRI for efficient fertilizer use are based on the colour of the plant's leaves. Using LCCs for rice in Asia has helped Asian farmers estimate plant nitrogen demand, to produce high rice yields. The general idea is that a critical leaf colour has to be maintained for optimal growth, and the LCC provides guidance when to apply nitrogen fertilizer to avoid nitrogen deficiency. The critical leaf colour depends on the varietal group (inbred, hybrid, new plant type) and crop establishment method. The LCC is used at critical growth stages to decide whether the recommended standard nitrogen rate needs to be adjusted up or down based on the leaf colour.

The LCCs must be specific to the crops in the region: LCCs developed at the University of California, using Californian rice varieties, produced a spectrum of colours that did not match the rice leaves found in Asia. The Asian LCC can be used for all modern, high yielding rice varieties in Asia, but guidelines on the use of the chart have to be adjusted to local conditions. Local guidelines on the LCC use have now been developed for the major irrigated rice domains in Asia.

The results of research show that for many farmers in Asia, sub-optimal nitrogen management is a key constraint to increasing yield. Consequently, improving nitrogen management can help produce greater yields. It was also found that yield responses to phosphorus and potassium fertilizers often occurred only after nitrogen management was improved.

Improved nitrogen and fertilizer management are key components of the site-specific nutrient management[6] (SSNM) approach developed by the International Rice Research Institute (IRRI). Field studies using the LCC method in major irrigated rice areas have shown significant yield and profit increases with SSNM over farmers' typical use of fertilizers.

Since 2003, more than 250,000 LCCs have been distributed to Asian rice farmers in Bangladesh, China, India, Indonesia, Burma, the Philippines, Thailand and Vietnam. Efforts are now underway to promote the technology at wider scale among Asian rice farmers. Field experiment was conducted at the wetlands, Tamil Nadu Agricultural University, Coimbatore in Noyyal series deep clay soil (Vertic ustochrept), to standardise the Leaf Colour Chart critical value (LCC cv.) and the rate of nitrogen application in CO 47 rice variety. The study was conducted in factorial randomized block design with three replications. The treatments included three levels of LCC cv. (LCC cv. 3, 4 and 5) with different rates of N application (20, 25, 30 and 35 kg ha-1 at a time) along with three checks (control, blanket N (150 kg N ha-1 in four equal splits) and manage N practices (150 kg N ha-1 in four unequal splits)). LCC readings were measured every week from 21 Days After Sowing (DAS) to 84 DAS and nitrogen fertilizer was applied as per treatment schedule. The performance of blanket N and manage N were almost comparable among themselves in all aspects. Grain yield and straw yield increased with increasing LCC levels.

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A field experiment was conducted in a farmer"s field in the district of Nadia, West Bengal, India to study the management of N through leaf color chart (LCC)[7] and soil plant analysis development (SPAD) or chlorophyll meter in rice (cv. IET-4094) during the Kharif (wet season) of 2001-2002 and 2002-2003 by taking the treatment combinations based on different levels of N at fixed schedule and through LCC and SPAD. The experimental soil (0-15 cm) had pH 7.33; organic C 0.43%; available N 408.70 kg ha(-1); available P 6.92 kg ha(-1); and available K 66.31 kg ha(-1). The results of LCC and SPAD or chlorophyll meter for the N management in rice show that values of both LCC and SPAD significantly increased with an increasing level of N. The mean values of LCC and SPAD varied from 3.19-5.31 and 27.36-39.26, respectively, in rice. The results show that the amount of N can be saved as 20-42.5 and 27.5-47.5 kg N ha(-1) through the use of LCC and SPAD in rice over the fixed-timing N treatment T7 where 150 kg

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N ha(-1) was applied in three (3) splits without reduction in the yield. The SPAD- and LCC-treated N plot showed higher N-use efficiency over fixed-scheduling N treatment in rice. The results further show that SPAD value of 37 and LCC value of 5 have been proved to be superior treatments over SPAD (35) and LCC (4) for the best management of N in rice in an Inceptisol.

III.TRADITIONAL WAY OF MAKING USE OF LCC

The leaf Colour chart is conventionally used by following steps

A. Step1 Select plant for testing

Randomly select at least 10 disease-free rice plants or hills in a field, where plant population is uniform.

B. Step2 Match the leaf to the chart

Select the topmost, youngest, fully expanded leaf from each hill or plant. This part best reflects the N status of the plants.
Place the middle part of the leaf on the LCC and compare its color with the color panels. Do not detach or destroy the leaf.

C. Step3: Measure the leaf colour :

Measure the leaf color under the shade of your body. Direct sunlight affects leaf color readings.
If possible, the same person should read the LCC at the same time of the day, every time.
If the color of a rice leaf is in between two shades, take the average of the two values as the reading. For example, if the color is in between 3 and 4, the reading should be 3.5.

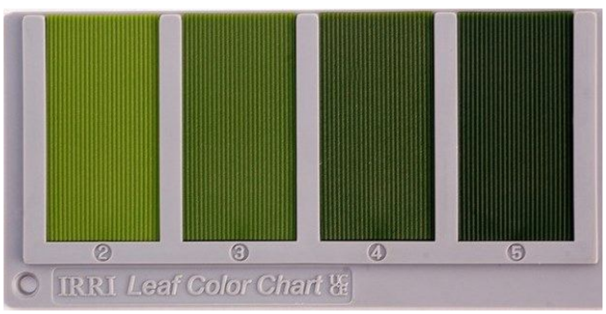

Fig. 1 IRRI Leaf Colour Chart(LCC)

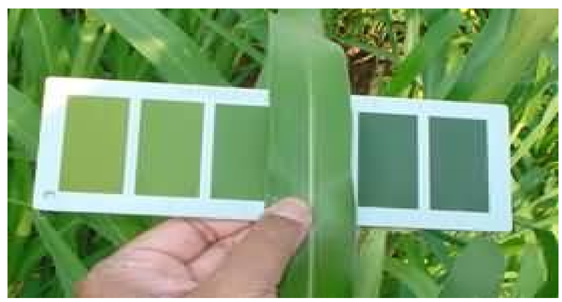

Fig. 2 LCC Matching with Rice Leaf

D. Step4: Determine the average LCC

Take the reading of the 10 leaves, and determine the average. If the color is more or less than 3, N fertilizer top dressing is needed.

TABLE I
LLC CRITICAL VALUR FOR N AND UREA REQUIREMENT IN KG

Sl. No.	Season & variety		LCC critical value	N requirement (kg)	Urea requirement (kg)
1.	Wet season (Kharif)	Non-basmati	4	28	61
		Basmati	3	23	50
2.	Direct seeded*		3	23	50
3.	Boro rice*		4	35	76

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IV. PROPOSED ALGORITHM

A. The Algorithm Suggest Following Steps to Be Followed

1) Create database of colour based feature vector for images in leaf colour chart.
2) Capture the query leaf image along with reference colour image present in it.
3) By modelling the transformation in capture image due to variance in illumination apply exact inverse transformation and create similar feature vector for the query image
4) Minimum distance classifier with different distance measurement techniques[8] can be used to find out the similarity between the features of the query image and features store of the database images. Different colour models can be used to create feature vectors and based on its performance to differentiate between the class a colour model can be suggested for leaf colour chart of a particular plant

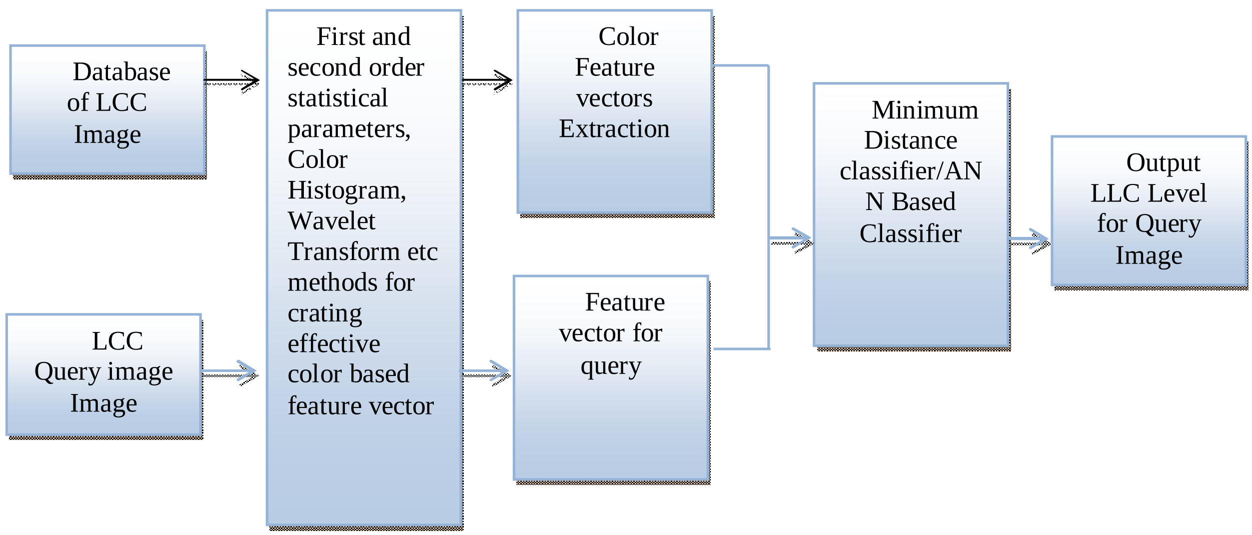

Fig. 2 Block Diagram of LCC based on Image Processing

V. CONCLUSIONS

Image Processing based Leaf color chart (LCC) can be cost effective, fast, reliable, quite simple, and useful tool to assist farmers in decision making regarding top-dress N application to crops. The proposed alternative for Leaf color charts (LCC) can offer generous open doors for agriculturists to evaluate plant nitrogen (N) request progressively for proficient fertilizer utilize and high rice yields. LCC was made for rice yield and still regularly utilized on rice edit. Side effect of nitrogen inadequacy is vanishing of green leaf color inside the plant is like all field crops, so LCC can be utilized all tight leaf trim plants counting rice, wheat, sugarcane, millet, and onion, and so forth.. Be that as it may, LCC can likewise be utilized on lower more extensive leaf trim. The significant advantages to the farmers is they can measure nitrogen deficiency within the crop at field step.

Still more research is needed on the optimum panel colors and thresholds for other crops. Because LCCs are low cost and easy to use, their application to horticulture and turf management would allow small-scale operations to benefit from N management. Still more research is required on the ideal board colors and edges for different products. Since LCCs are ease and simple to utilize, their application to agriculture and turf administration would enable little scale tasks to profit by N administration.

VI. ACKNOWLEDGMENT

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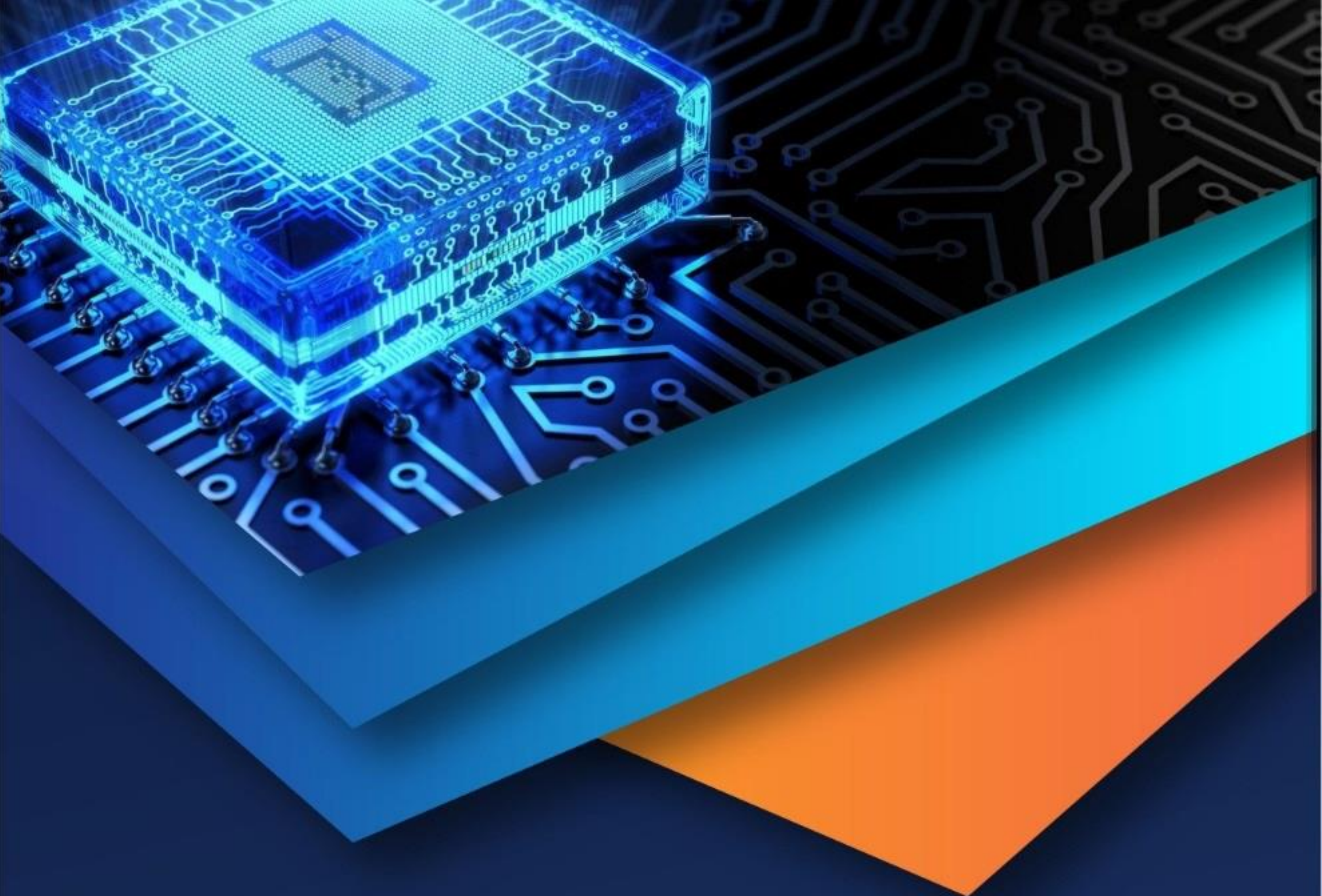

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