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Smart App Assisted Colorimetric Determination of Iron: A Case Study in UDUPI Taluk

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Abstract: ***Water is an important source for several uses. Water from surface and groundwater is used extensively to get the various industrial and domestic demands. Increased industrialization and urbanization discharges wastewater in the environment without treatment. By the infiltration and runoff, The water reaches subsurface and water above the ground and pollutes fresh water. Groundwater treatment is costlier and requires proper assessment.***
The area selected for study is Udupi taluk, Karnataka state. The study says that in Udupi region the soil is sensitive and here the soil is lateritic, there is a chance that the soil induces iron content in water which may increases concentration of iron in water. According to BIS 10500:2012 the limit of iron concentration in water is 0.3mg/lt. If iron content in water exceeds from 0.3mg/lt, it causes various health effects and waterborne diseases.
Therefore, the study of iron plays an important role in the region such as Udupi. The quality of groundwater, that is concentration of iron chooses randomly from open wells. The collected samples are tested in laboratory to determine the concentration of iron in each sample. The app is generated, which provides amount of iron in specific location within the region of Udupi taluk. Generation of map helps as a decision support system because it provides an amount of iron in required place. The app helps to take preventive measure to decreases the amount of iron.
Water is filtrated using low-cost filter media which work as slow sand filter, contains sand, rice husk ash, coconut coir coconut coir and charcoal. It absorbs iron content from water and reduces amount of iron from water. The filtration media has greater efficiency of around 70% which is within the BIS limit.
As water is basic necessity the project is relevant to society. Generation of maps and low-cost filter media will be beneficial to society. The type of low-cost filter media can be used every household and the project also comes under lab to land theme.
Keywords: Sample collection; Iron analysis; Map generation, App; Low cost filter media;

I. INTRODUCTION

Water is very important natural resource, which is required for various domestic uses. The water from subsurface is used much in Udupi region. The study says that the soil in region like Udupi is very sensitive, in this region the soil is lateritic which induces iron content in water. Iron concentration in water causes stains in cloths and increases corrosive action of water, which leads to growth of iron bacteria. According to BIS 10500:2012 the acceptable limit of iron in water is 0.3mg/lt. Iron content in water may increased due to several reasons such as use of landfill leakage, municipal sewers, irrigation water infiltration contains fertilizers and pesticides, septic tank, pollution from volatile organic compounds, intrusion of saltwater etc. These all causes major effect to health and various waterborne diseases. Therefore, the study plays a important role in the region such as Udupi. The app generation provides amount of iron in the required location, provides variation in iron content and also the areas which have high iron concentration which acts as a decision support system.
The water samples are collected from various regions within the region of Udupi taluk and each sample is tested in lab to determine the iron content in each sample. The samples which contains iron more than 0.3mg/lt are filtered using low-cost filter media.

II. STUDY AREA

Udupi district lies along the west coast of peninsular India and gigantic western ghats. The district is situated from 13º04 - 13º59 N latitude and 74º35 -75º12 E longitude enfolding an area of 3575km^2. The area is about 88km long and around 80km wide, adjoined in the north by Uttara Kannada district; in the east by Shivamogga and chikamagalur districts; in the south by the Dakshina Kannada district and the west by Arabian Sea. Udupi district has seven taluks, namely, brahmavara, Byndoor, Hebri, Karkala, Kaup, Kundapura and Udupi.

Figure 1 Study Area – Udupi Taluk

In Udupi district 4000mm of highest annual rainfall occurs. The main occupation here is agriculture. More than 80% of the peoples depends on agriculture for their livelihood and only the 40% of land is available for cultivation. 3 types of soils could be seen within the district, namely, sandy soil, yellow loamy soil and red lateritic soil. As this is costal region there are few beaches, which are tourist attractions. Namely Kaup beach, Malpe beach, are tow of the beaches in Udupi.

III. METHODOLOGY

A. Ground Water

Groundwater is fresh water in sub surface pore space of soil and rocks. It is water that is flowing within aquifers below the water table. It is sometimes useful to make a distinction between groundwater, it is present beneath Earths surface. About 30% of water available in the world is groundwater. Groundwater is used for agricultural, municipal and industrial use.

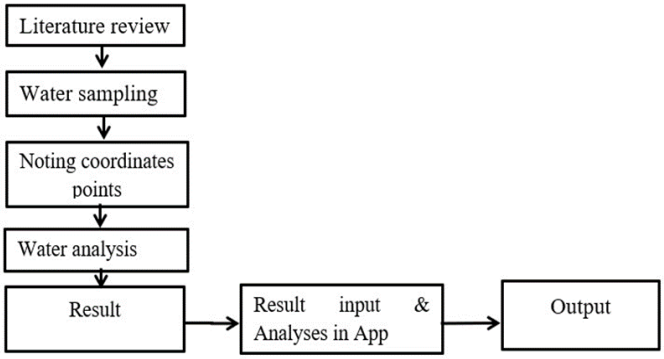

Figure 2 Methodology Flowchart

1) Groundwater Sampling

The groundwater from the wells are collected and tested in laboratory according to American Public Health Association (APHA 2005). The method adopted for sampling was “grab sampling”. Water from 50 wells located within the region of Udupi taluk were collected during the pre - monsoon period of year 2024. Water is collected using bottles were carefully cleaned first and after that the groundwater samples were collected. The collected groundwater samples were preserved prudently and tested in chemical lab for to check the iron concentration in each sample. The results obtained were compared with standard permissible values recommended by BIS10500:2012. The water quality parameters of iron evaluated in the lab using standard techniques, according to the APHA 2005 guidelines.

2) Analysis of Iron Concentration in the Laboratory

Aim: To determine the amount of iron present in the sample, by colorimetric method using spectrophotometer.

a) Apparatus Used

- Spectrophotometer
- Glass cuvette
- Silica dish
- 1000,500,250,100 ml standard borosil round
- Heating mental
- Pipette
- Funnel

b) Reagents Required

- Standard iron solution 0.01 mg iron per ml
- Concentrated HCL
- Hydroxyl amine solution
- Ammonium acetate buffer
- Phenanthroline solution
- Sodium acetate buffer

c) Test Procedure

- Take 1ml, 2ml…. of standard iron solution in the 100ml flasks.
- Add 1ml of sodium acetate buffer and 1ml of hydroxylamine to each flask.
- Dilute the solution in flasks to 75ml with distilled water.
- Then add 5ml of phenanthroline monohydrate solution to each flask and make up to 100ml with distilled water.
- Take 25 or 50 ml of water sample in 250 ml beaker.
- Add 1ml of hydroxylamine solution and 2ml of concentrated HCL and boil for 10 minutes, cool and transfer this solution to a 100ml standard flask.
- Add 5ml phenanthroline monohydrate and 10ml ammonium acetate, make up to the mark by using distilled water.
- Wait for 10 minutes and match the colour obtained for sample with the standard colours prepared.
- Find the amount of iron in standard flask and match the colour obtained.
- Prepare a standard graph by taking absorbance value in Y axis and content of iron in mg/lt on X axis.

B. Filtration

It is the process of removal of particles from water. Removal of particles takes place by number of mechanisms such as flocculation, straining, sedimentation and surface capture. Filtration is the one of the simple technique used for water treatment. It helps to remove the impurities from the water and the process is very simple.

1) Filter Media Used

a) The filter media used to filter the samples is made with glass chambers.
b) The materials used for filtration is charcoal, sand, coconut coir and rice husk ash.
c) The total height of the glass used in filter media is 40cm, Length* Breadth =40cm*20cm.
d) A tap is situated at the bottom of the unit which acts as outlet, collects the filtered water.
e) 4cm is the thickness of each filter media.

2) Filter Media Materials

a) Rice Husk Ash

Rice husk ash is a industrial absorbent. The thickness of layer used in filter media is 4cm. It consists of large surface area, absorbs heavy metals such as magnesium, calcium, iron.

b) Coconut Coir

Coconut coir is environment friendly material. It work as a durable and effective filtration medium. It consists of sufficient number of macropores and micropores.

c) Charcoal

Charcoal is a ideal water filter material. It removes toxins from water. Increases effectiveness of filter media and adsorbs organic compounds.

d)

e) Sand

Sand removes suspended matter and other impurities from water. The particle size used in filtration process is 0.3mm. The other materials used such as rice husk ash, coconut coir and charcoal required the chemicals to work effectively. Sand does not required any flocculant chemical for filtration.

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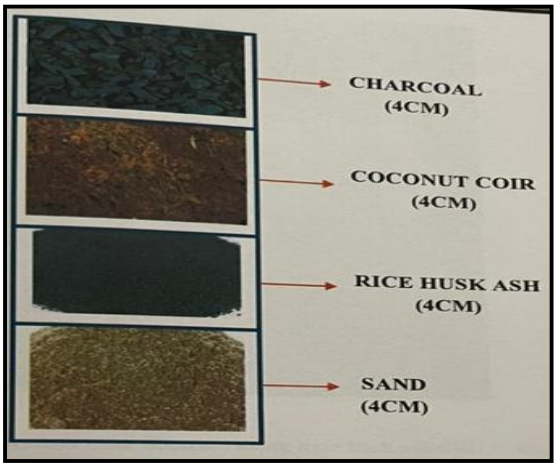


Figure 3 Mixed Layers of Filter Media figure

3) Filtration Process

Initially before the filtration the water samples gethared are analysed in the laboratory to determine concentration of iron in the samples. According to Bureau of Indian Standards the acceptable limit of iron concentration in water is within 0.3mg/lt, if it exceeds the limit causes major effects to health and causes various waterborne diseases.

The study plays a major role, after testing of water the samples which consists high iron content are filtered using low-cost filter media consists of sand, coconut coir, rise husk ash and charcoal. Which filters the sample. As iron is heavy metal the filter media materials absorb the iron and may provides iron concentration within the limit. The tap is fixed at the bottom of filter media used to collect the filtered water. The filtered water is again tested in laboratory to analyse the iron content.

IV. RESULTS AND DISCUSSIONS

A. Determination Of Iron Concentration

Water is a natural solvent and pure water does not contains any taste. Increase in iron content in drinking water causes unpleasant metallic taste. The results shows that the iron content varies between 0 to 0.99mg/lt as acceptable limit is 0.3mg/lt the water is not fit for drinking.

Flask no.	Volume of std. solution (ml)	Conc. of std. Iron (100ml)	Conc. of std. Iron (1000mg/lt)	Absorbance value
1	1	0.01	0.1	0.017
2	2	0.02	0.2	0.030
3	3	0.03	0.3	0.034
4	4	0.04	0.4	0.048
5	5	0.05	0.5	0.061
6	6	0.06	0.6	0.071

Table 4.1 Standard Absorbance Values of Iron

B. Details about the Iron Content in UDUPI

Total of 50 samples were collected in Udupi Taluk and the test is taken as mentioned in chapter 3.1.1. The values are shown n table 4.2. The graph is plotted for concentration of iron (mg/lt) v/s absorbance value as shown in fig 4.1. From the graph, the observation made is that the Iron in 7 locations exceed 0.3 mg/lt and 43 samples are within the limit. The 7 locations which exceed 0.3mg/lt are Eshwarnagar (0.33 mg/lt), Kasturabhanagar (0.85 mg/lt), Kalsanka (0.38 mg/lt), Tenkpete (0.96 mg/lt), Mission compound (0.99 mg/lt) and Gudiangadi cross (0.48mg/lt) Hence the water must be treated well before drinking filtration.

C. Graph Of Concentration Of Iron In The Region Of UDUPI Taluk

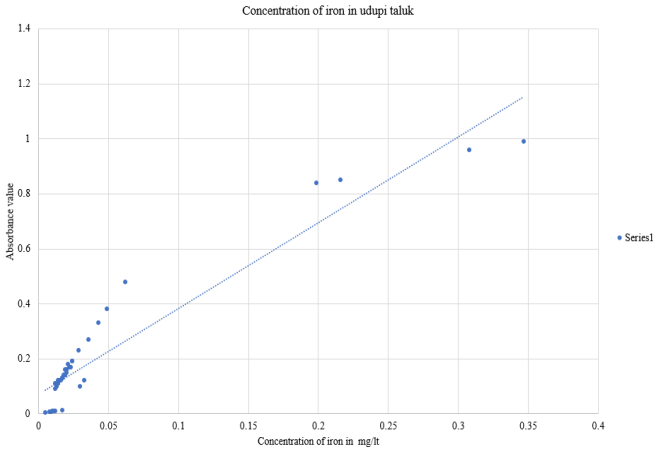


Figure 4.1Result of iron concentration in Udupi Taluk

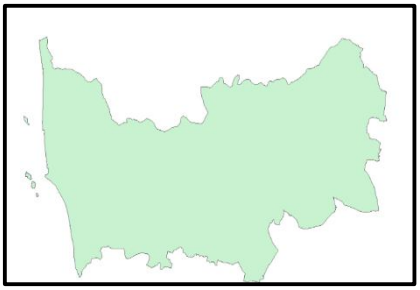


Figure 4.2 Shape file of Udupi Taluk

SL.NO	PLACE	LATITUDE	LONGITUDE	ABSORBANCE VALUE	CONC OF IRON (mg/l)
1	PARKALA	13.362931	74.811241	0.019	0.14
2	ATHRADY	13.350616	74.829129	0.013	0.1
3	ESHWARNAGAR	13.356556	74.797668	0.043	0.33
4	ANANDNAGAR	13.339809	74.781511	0.023	0.17
5	V.P NAGAR	13.346373	74.776212	0.036	0.27
6	KASTURBANAGAR	13.333696	74.762837	0.216	0.85
7	INDRALI	13.340655	74.766563	0.021	0.18
8	KUKKIKATTE	13.328811	74.762668	0.012	0.09
9	SANTEKATTE	13.384912	74.737371	0.017	0.13
10	NEJAR	13.389039	74.729444	0.016	0.12
11	KEMMANU	13.3993	74.7088	0.019	0.14
12	KALSANKA	13.361476	74.749976	0.049	0.38

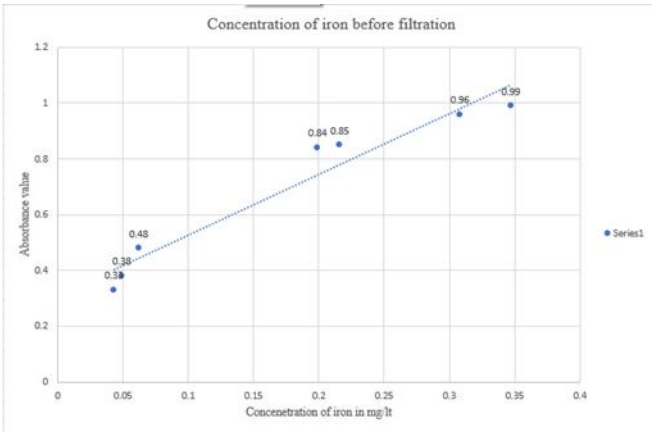
13	NITHUR	13.353026	74.744959	0.009	0.007
14	AMBAGILU	13.367711	74.747476	0.011	0.009
15	SANTOSHNAGAR	13.368305	74.758771	0.011	0.009
16	PERAMPALI	13.368079	74.770073	0.009	0.007
17	PUTTUR	13.3681	74.7452	0.013	0.1
18	INDUSTRIAL AREA	13.324672	74.790017	0.199	0.84
19	MANCHIKERE	13.323774	74.789493	0.01	0.009
20	ALEVOOR	13.314316	74.775314	0.015	0.12
21	RAMPURA	13.312423	74.774736	0.017	0.013
22	MANIPURA	13.292879	74.77969	0.022	0.17
23	KURKAL	13.2855	74.7737	0.02	0.16
24	CHITPADI	13.328144	74.756621	0.014	0.11
25	BEEDINAGUDDE	13.335239	74.755947	0.014	0.11
26	MARUTHIVEETHIKA	13.337926	74.753496	0.02	0.16
27	KOLAMBE	13.328517	74.753394	0.015	0.12
28	MISSIONCOMPOUND	13.328904	74.747185	0.347	0.99
29	VALAKADU	13.333412	744.7505	0.012	0.11
30	TENKPETE	13.338009	74.753207	0.308	0.96
31	DODDANGUDDE	13.354516	74.761941	0.015	0.12
32	KADIYALI	13.346674	74.756067	0.015	0.12
33	KUNJIBETTU	13.345935	74.7641641	0.005	0.004
34	PANIYADI	13.342419	74.762423	0.02	0.15
35	ADIUDUPI	13.348071	74.728183	0.033	0.12
36	KALMADI	13.346594	74.716838	0.014	0.11
37	MALPE	13.347242	74.707415	0.017	0.13
38	KIDIVOOR	13.338192	74.720553	0.017	0.13
39	KUTHPADI	13.333803	74.725474	0.017	0.13
40	AMBALPADI	13.33623	74.730599	0.008	0.006
41	KORANGRAPADI	13.311595	74.734179	0.015	0.12
42	KANNARPADI	13.324557	74.730836	0.012	0.009
43	KINNIMULKI	13.324724	74.736836	0.014	0.12
44	GUDDEANGADICROSS	13.311744	74.73415	0.062	0.48
45	GUNDIBAIL MAINROAD	13.363161	74.769695	0.018	0.14
46	SHANTI NAGAR MANIPAL	13.330197	74.795754	0.024	0.19
47	ANJAR	13.35561	74.8505081	0.024	0.19
48	AGUMBE ROAD	13.384437	74.90377	0.019	0.16
49	MUTHURU	13.3237993	74.852152	0.03	0.1
50	BUKKIGUDDE	133.3209118	74.8965282	0.029	0.23

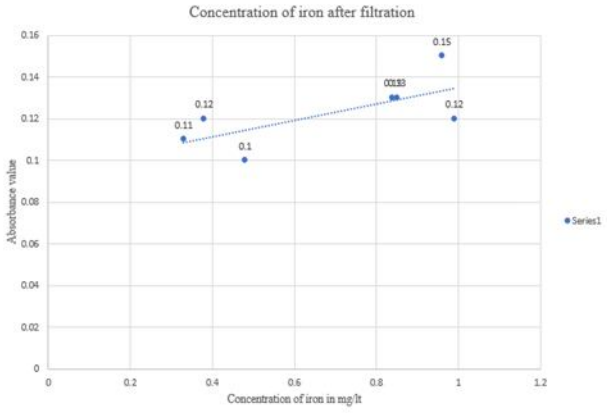
Table 4.2 Iron Values in Udupi Taluk

D. Filtration

The water samples which exceeds the limit of 0.3mg/lt are filtered in the filtration media. Seven samples taken for filtration, which are from Eshwarnagar, Kasturabhanagar, Kalsanka, Industrial area, Tenkpete, Mission compound and Guddeangadi cross.
Filtration is the easy and economical technique for removal of iron. The study says that rice husk ash gives good results in filtering the water. It reduces the concentration of iron and provides visibly clear water.

Figure 4.6 Filtration Media and its process





E. Smart App – Ironate

Advantages of Smart app

a) Users can easily access the app on their smartphones which makes it convenient to know concentration of iron anytime , anywhere.
b) The app provides accurate amount of iron content in specific location.
c) Using of app is more cost effective compared to traditional laboratory methods and also saves both resources and time.
d) A well designed app offers a user friendly interface, making it easy for users to input data and know the results without specialized knowledge.
e) The app can store historical data.

V. CONCLUSION

1) The Iron analysis conducted in lab shows few samples above 0.3 mg/lt. It is above the BIS 10500:2012 permissible limit. The study area classified in three categories namely safe, better, danger.
2) An app is generated which shows the concentration of iron in the specific location within the region of Udupi taluk helps as a decision support system.
3) Water quality management can be done for groundwater, as study helps as a decision support system.
4) Filtration is the simplest and cheapest technique for iron removal. Hence mixed media layer is economical and is used for iron removal. Totally this is environmental friendly project.
5) The project is relevant to society as water is basic necessity, this kind of maps and low-cost treatment will be having societal benefits. As the low cost filter media can be used in every household, the project also comes under lab to land theme.

VI. SCOPE FOR FUTURE WORK

Instead of iron other parameters of water can also be tested namely pH, turbidity, chlorine analysis, fluorine analysis, nitrogen analysis, etc.
Other treatment methods using Low-cost filter media can be done.

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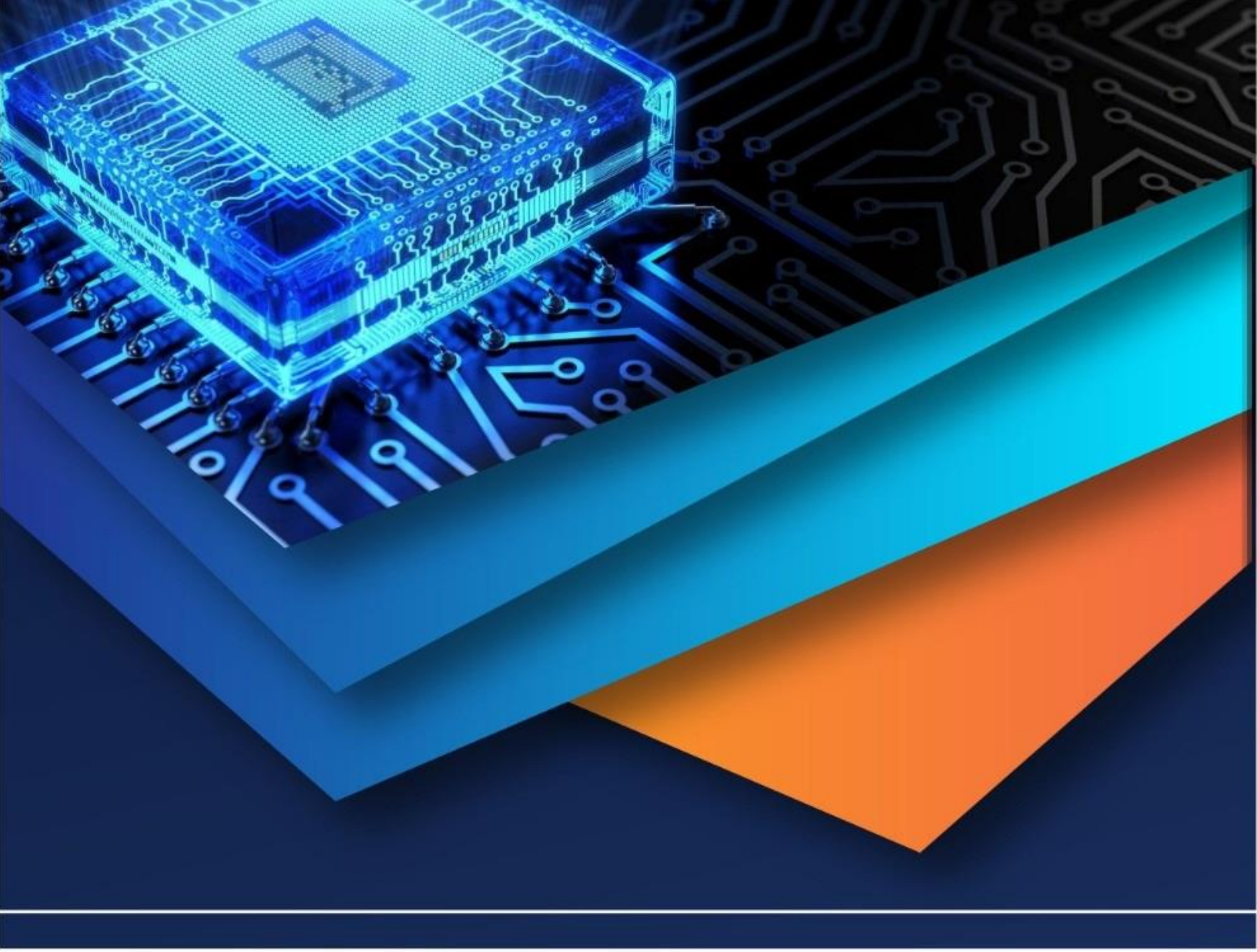

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