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Indoor Farming Hydroponic Plant Grow Chamber 3 Layer: A Research

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Abstract: The future of agriculture is indoor farming and gardening, which eliminates the need for large agricultural fields. Using intelligent grow chambers, which monitor and provide the plants with all the nutrients they need for healthy growth, gardening and farming are simple to accomplish and even better. So, utilizing a programmed hydroponic system, we have designed a three-layer indoor farming and gardening system. Without using soil, gardening is known as hydroponics. For an ideal grow environment, our system uses a sophisticated water supply and drainage system together with air flow and artificial sunshine. Our method would enable indoor organic food production in all weather conditions as and when necessary. By providing optimum plant conditions, the system offers a fully automated way to monitor and support plant development.
Keywords: Indoor Farming, component, Hydroponic, Mechanism, working, design.

I. INTRODUCTION

The Greek terms hydro, which means water, and ponos, which means labour (i.e., working water), were combined to form the English word hydroponics. The term initially appeared in a scientific journal article (Science, 178:1) written by W. F. Gericke in February 1937. Dr. W. A. Setchell of the University of California had proposed the term, which Gericke had adopted. In the late 1920s, Dr. Gericke started experimenting with hydroponic growing methods, and in 1940, he published one of the first publications on soilless cultivation. Later on, he made the claim that agricultural production would no longer be "chained to the earth, but that some commercial crops might be produced in greater quantities without soil in basins containing solutions of plant food.Ease of Use.'' Dr. Gericke missed the fact that hydroponic farming would largely be restricted to enclosed conditions for growing high cash value crops and would not make its way into the production of a wide variety of commercially cultivated crops in an open environment.[1]

According to the Food and Agriculture Organization of the United Nations (2012), almost 870 million people worldwide lack access to enough food, which is partly caused by population growth, unfavourable meteorological conditions including drought, low land productivity, and poverty. To effectively feed the world, conventional agriculture has struggled to get over these barriers. Residential demands outpace agricultural needs as populations rise. Unpredictable, unfavourable weather conditions expose conventional farmers and put their finances at risk. Farmers labour too hard as a result of low land production.

To close these gaps, fulfil the demands of coming generations, and enhance output like never before, new agricultural methods are being created. One such farming method is hydroponics, which uses a water-based, nutrient-rich solution that can be adjusted to best fit each crop to grow plants without soil. In contrast to traditional, soil- based agriculture Hydroponics is a more environmentally and economically viable alternative to soil-based agriculture.[16] By using less space and cultivating plants more densely, it raises land production acre for acre. It has the extra benefit of being able to produce year-round and is shielded from unfavourable weather because it is often stationed in greenhouses with controlled environments (Spray & Spray, 2019). It doesn't depend on the properties of the soil and doesn't speed up soil erosion, runoff, or contamination from fertiliser (Christie, 2014).[6] Due to its closed-loop water recycling technology, which prevents water from escaping through soil infiltration or evapotranspiration, it is also up to 90% more water efficient (Christie, 2014).Finally, since there is no longer a possibility of plant diseases transmitted through the soil, pesticides are not necessary (Viviano, 2017). These factors make hydroponics a potential agricultural technique for addressing future output demands without compromising environmental sustainability.[3]

I looked up the definition of hydroponics in three dictionaries and three encyclopedias. Hydroponics is described as "the science of growing or the production of plants in nutrient-rich solutions or moist inert material, instead of soil" (Webster's New World College Dictionary, fourth edition, 1999); "the cultivation of plants by placing the roots in liquid nutrient solutions rather than in soils; soilless growth of plants" (Random House Webster's College Dictionary, 1999); and "the process of growing plants" (Oxford English Dictionary, second edition, 1989).[1][2]

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Fig. 1 Farming done with hydroponics techniques.

II. LITERATURE REVIEW

Farmers may produce a wide variety of crops using the growing agricultural technique known as hydroponics. Wick systems, deep flow method, nutrient film technique, ebb-and-flow, and shallow-aggregate ebb-and-flood are a few examples of hydroponic system types. The particular hydroponic system used is a key factor in designing a successful hydroponic greenhouse.

Wick systems—possibly the simplest system—use capillary action to draw water up to the aggregate that supports a plant's roots from a reservoir (Sanders, 2016).Although fairly easy to construct, this system needs ongoing upkeep to make sure the wicks are clean and able to supply adequate water to the plant's roots. For both fragile plants like strawberries and bigger plants like tomatoes, it is not advised.

According to Maximum Yield (2017), the Deep Flow Technique (DFT) suspends plant roots in a bed of nutritional solution that is 2-3 inches thick and may flow around the roots. This supports smaller plants with short growth cycles and shallow roots, such as lettuce and other leafy greens, but not bigger plants or those with longer growth cycles.[7] Aeration is necessary in this system to make sure that the water has the right amount of dissolved oxygen for the plants.

One of the most well-liked methods for commercial cultivation is the nutrient film technique (NFT). It consists of canals in which the roots are suspended and through which nutritious solution continuously flows. A "film" of nutrients is provided to the roots by this recirculating system in the form of a shallow flow. This method is frequently applied to strawberries, herbs, and leafy greens. In order to prevent too much resistance to the solution running through the channels, plants with roots that develop quickly should not be used (Espiritu, 2018).[15]

Ebb-and-flow systems, also known as flood-and-drain systems, are a hydroponic technique that uses watering cycles spaced out throughout the day. Depending on the plant, the roots are placed in a growth medium, such as clay pebbles, and occasionally soaked with the nutrient solution. This system uses timers to enable autonomy, and after flooding the plants, the water flows back into the reservoir. Although extremely flexible and more water and energy efficient than other systems, this system does utilise more growth media (No Soil Solutions, 2018). In contrast to ebb-and-flow, drip systems allow water to enter the plant from above and exit through a syphon. Due to the durability of planting in a growth medium with cyclical watering, both approaches are frequently utilised with bigger plants.

Joseph (JC) Chadic created the shallow-aggregate ebb-and-flood (SAEF) hydroponic system, which incorporates components from NFT, ebb-and-flow, and DFT systems. The irrigation trays have a thin layer of aggregate that is only saturated by 2-3 mm, making them the least energy- and water-intensive of all the methods previously used. This method is particularly effective for lettuce and other leafy greens.[4]

III. PROBLEM DEFINATION

Need a considerable amount of land. In standard traditional farming, the land needed for farming is employed in a horizontal method, requiring greater land area than vertical farming to raise the same quantity of food.

Consumes 70% of the available water. The old traditional methods of farming require more water because there is more land to irrigate, and the most common irrigation method is canal irrigation, which has its own drawbacks because more water is supplied than is needed, which results in waste and lowers the fertility of the soil or even causes soil erosion by flooding fields.[9]

Insecticides are present. In order to prevent rats, snakes, and other pests from eating the crops that have been planted, pesticides are used. However, the use of pesticides for this reason degrades the quality of the crops, which may be harmful to ingestion. disorders with a long latency such as cancer, neurological, reproductive consequences, etc.

Environmental and health risks. The current farming methods in India produce food at a good pace, but they won't be able to meet the rising food demand in the future. Due to the usage of pesticides and fertilisers to improve the health and yield of crops, food quality is also steadily declining.[13] The negative side effects of conventional agricultural practises include soil degradation, excessive water usage, chronic illnesses like cancer, etc.

Small farmers are disadvantaged by this. Small farmers are individuals who depend on these crops for their living but only have a small amount of land available for farming. Droughts or soil degradation decrease crop quality and yield, which has an impact on farmers' livelihoods and increases the cost of repaying loans they took out to cultivate crops—for things like pesticides, fertiliser, seeds, water supply, transportation, and many other things.

The soil might be harmed by it. By lowering the quality of the soil, the use of pesticides, fertilisers, and excessive irrigation promotes soil erosion and reduces fertility. Crop rotation and soil deterioration both contribute to the annual decline in crop growth.[5]

Technical expertise is needed for commercial hydroponic crop production, but it is either difficult to get or more expensive.

IV. BENEFITS OF HYDROPONICS

Design considerations allow for precise management of greenhouse settings, including temperature, humidity, light, and ventilation (Rimol Greenhouse Systems, 2018). This degree of control enables the establishment of perfect growing conditions for crops and may even contribute to increased productivity. Additionally, it removes a constraint that conventional agriculture has on growing crops by allowing them to be produced in their opposing season. Reverse seasonality, as the name "reverse seasonality" suggests, is a phenomenon that only greenhouse-grown plants may exhibit. The hydroponic farmers may enter the market without having to compete with conventional producers by providing crops with artificial surroundings that imitate their optimal growth conditions. Although there are certain hazards associated with hydroponics because of its reliance on both human and equipment reliability, the advantages far exceed them.[14]

V. METHODS OF DESIGN

Select a greenhouse, making sure that it has the required attributes. o Important elements include adequate doors and aisle room, the ability to install a head house, and a construction that can be altered to meet the needs of the customer.

Determine the most crucial characteristics so that the customer may use them as a guide when selecting a greenhouse and planning the inside architecture. o These characteristics include taking into account instructional programmes, allowing space for a growing station, offering a range of hydroponic systems to display, and incorporating both homemade and commercially available hydroponic systems.

Create the inside layout of the selected greenhouse while aiming to satisfy the customer. o This plan will need to include entrances that are easily positioned for tours and tending to hydroponic systems, at least three distinct hydroponic systems, comfortable walking area, and room for a growth station.

Pick plants that will be lucrative to cultivate and sell in the greenhouse. The ability of the local market to buy the plants, the crop's propensity for success in hydroponic agricultural systems, and a practical coupling with another crop to grow in reverse seasons will be the most crucial criteria in picking crops.

When developing hydroponics systems, take into account various materials. o I needed to be aware of the properties of the materials (such PVC) before developing the systems and figuring out the diameters of the pipes and pumps. These features include the supplier, form (such as closed or open channel), friction factors, and roughness coefficient.

The optimal hydroponic system combination for the crops you have chosen should be used. The systems had to function with paired sets of crops so that the client could use reverse seasonality, fit into the greenhouse well enough to prevent blocking light from other systems while also not wasting interior space, and be made with enough room for each crop to not crowd in the system.

Make the necessary calculations for the hydroponics systems that were created. o Calculations are required to size the pipes and pumps for each system, compare various design possibilities, such dividing reservoirs into sub-systems, and adhere to design constraints, like low flow rate.

Calculations and designs should be iterated to ensure that the best option is selected. o These iterations will utilise varying numbers of hydroponics systems in an effort to maximise space efficiency while still satisfying the cyclical demands of the market.

Finally, provide the customer your recommended designs. Successful crops, suitable systems, and the inside design of the greenhouse particularly for chosen crops in chosen systems will all be included in the final suggestions.[8]

VI. MODEL DESIGN

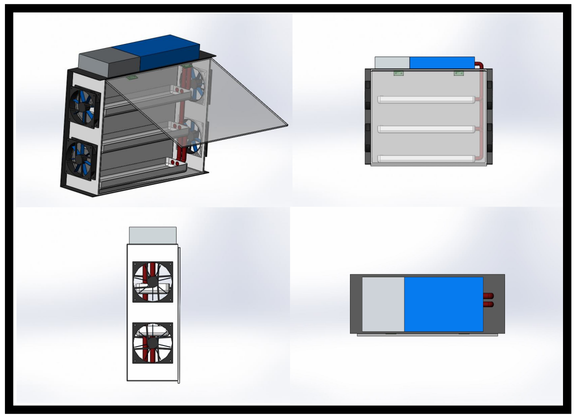

Fig. 2 Solidwork Model Design.

A. Circuit Design

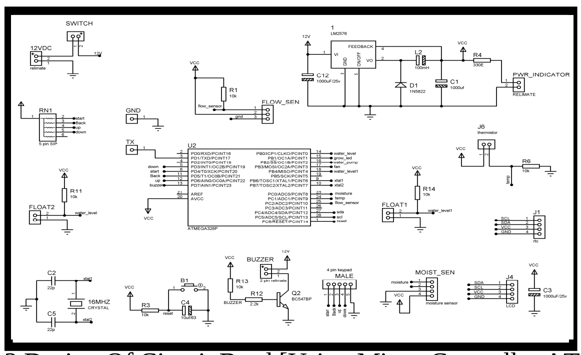

Fig. 3 Design Of Circuit Bord [Using Micro-Controller ATMEGA328P].

B. PLC Design

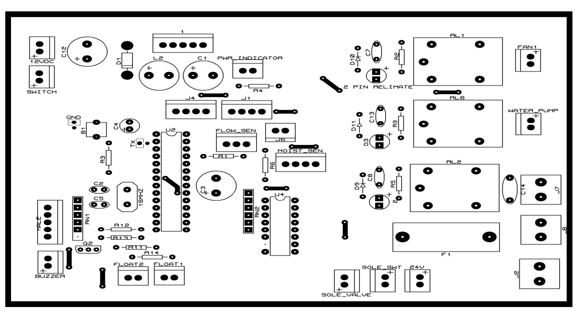

Fig.4 Main Controller PCB With ATMEGA328P

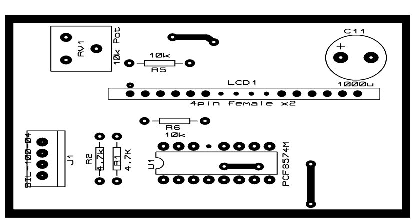

Fig5. PCB for LCD 16X4 with PCF8574

VII. FABRICATION PROCESS

1) Supporting Frame: A wooden outer casing will be used. It will support mounting for all the components.
2) Transparent Casing: Made of sheets of acrylic.
3) Tray: Plants will be planted in a ready-made plastic tray.
4) Water Tank: At the top of the chamber, a plastic tank will be utilized to hold water.
5) Piping: Pu pipes will be used to transport water from the water tank to the plants.
6) Fans: To maintain the temperature inside the chamber, four 12V DC fans will be employed. On either side of the room, it will be mounted.
7) Growing Light: On the upper side of the plants, it will be mounted. Electric light that promotes plant growth is known as a grow light. Grow lights either aim to offer a spectrum of light that is comparable to that of the sun or one that is better suited to the requirements of the plants being grown.
8) Sensor for temperature: It is utilized to measure the chambers inside temperature.
9) Moisture Sensor: This device measures the amount of moisture inside a chamber.
10) Water Level Sensor: This device measures the level of water in the tray.
11) Pump: The flow inside the trays is regulated by a 12V DC pump.
12) Circuitry Contro
13) Connectors
14) Fasteners
15) Hinges

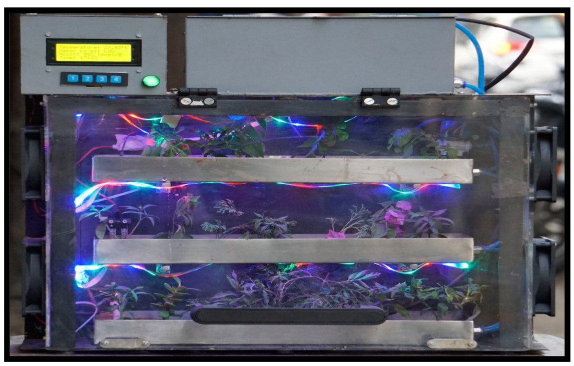

FIG.6 Indoor Farming Hydroponic Plant Grow Chamber 3 Layer

VIII. WORKING PRINCIPLE

The technology uses sensors to keep tabs on the grow chamber's temperature, moisture content, and water level. The user may programmed in the system the necessary moisture content and temperature range. The system keeps track of these variables and runs the fans to keep the chamber at the right temperature and moisture level.

The system then uses the water sensors to monitor the water level in the system, the pump motors to add water to the system as needed, or to remove extra water as needed.[12] As directed by the user, artificial sunlight is automatically turned on and off to maintain the optimum temperature and provide the right amount of light for plant development. When the system runs out of water, a buzzer is activated from the onboard water tank, which is utilized to sustain the water supply. The complete arrangement is operated according to user programming using an inbuilt controller circuit.

IX. OVER VIEW OF AUTOMATION

Nowadays, practically all production processes are being atomized in an effort to provide products more quickly. For the reasons listed below, the manufacturing process is becoming atomized.

1) To achieve mass production;
2) To decrease labor costs;
3) To increase plant productivity;
4) To decrease workloads;
5) To decrease labor costs;

6) To decrease production times;
7) To decrease material handling;
8) To achieve high levels of worker productivity;
9) To achieve mass production; Lower Maintenance.

X. FUTURE SCOPE

The fastest growing industry in agriculture is hydroponics, despite the fact that it may not have a substantial market share. It is anticipated that it will control future food production globally. As more and more farmland is destroyed by inadequate management and abuse, leading people to resort to more cutting-edge techniques of agriculture production, hydroponics is expected to flourish.

Due of the shortage of arable land and growing land costs as an island nation, certain nations like Japan have already adopted a proactive approach to these technologies.[14] The majority of Japan's hydroponics is carried out using NFT or sand/gravel methods. The Japanese have developed better and more productive plants for hydroponic rice cultivation using bio-technological techniques, such as those provided by hydroponics. Instead of the customary one harvest each year, four harvests may be carried out thanks to environmental management. Cities like Indianapolis are investing more in regional food production systems as the world's population moves towards cities, which provides chances for economic growth and lowers a city's carbon footprint by using 90% less water than conventional agricultural techniques

Significant agricultural innovation has also been applied to desert regions, such as those in Israel. The nation has been employing hydroponics to produce berries and bananas in shipping containers due to its desert environment and overall lack of water. Although these fruits cannot be cultivated in that environment, they can nonetheless produce 1,000 times more than they can in a normal climate. Even some very large companies have seen the benefits of hydroponic systems. In the spring of 2017, hydroponic gardens were erected at a few sites of the global retail chain Target as part of a series of experiments. With little water use, these gardens can supply exceptionally fresh veggies and herbs to clients.[10]

XI. CONCLUSION

With the use of a hydroponic system, it is evident from the aforementioned study that it is feasible to grow plants entirely without soil, which results in higher-quality, better, and more nutrient-rich plant development. Furthermore, by giving artificial light, it complements the excessive amounts of sunshine that plants can get to reach their full height. As there are no pesticides used, the technique can also help protect the environment. It follows that hydroponic farming is the way of the future.

Hydroponics is emerging as a significant method to address these issues in a sustainable and ecologically responsible manner in a society where fresh water and food resources are becoming increasingly scarce. The hydroponics sector is predicted to develop enormously in the future, especially as the circumstances for soil-based cultivation become more challenging. Soilless culture will eventually replace traditional agriculture in a country like India where urban expansion is outpacing all predictions, increasing the amount and quality of the product and ensuring the country's long-term food security. However, greater attention through governmental action and the emphasis of research organizations might speed up the development of hydroponics.[16]

XII. ACKNOWLEDGEMENT

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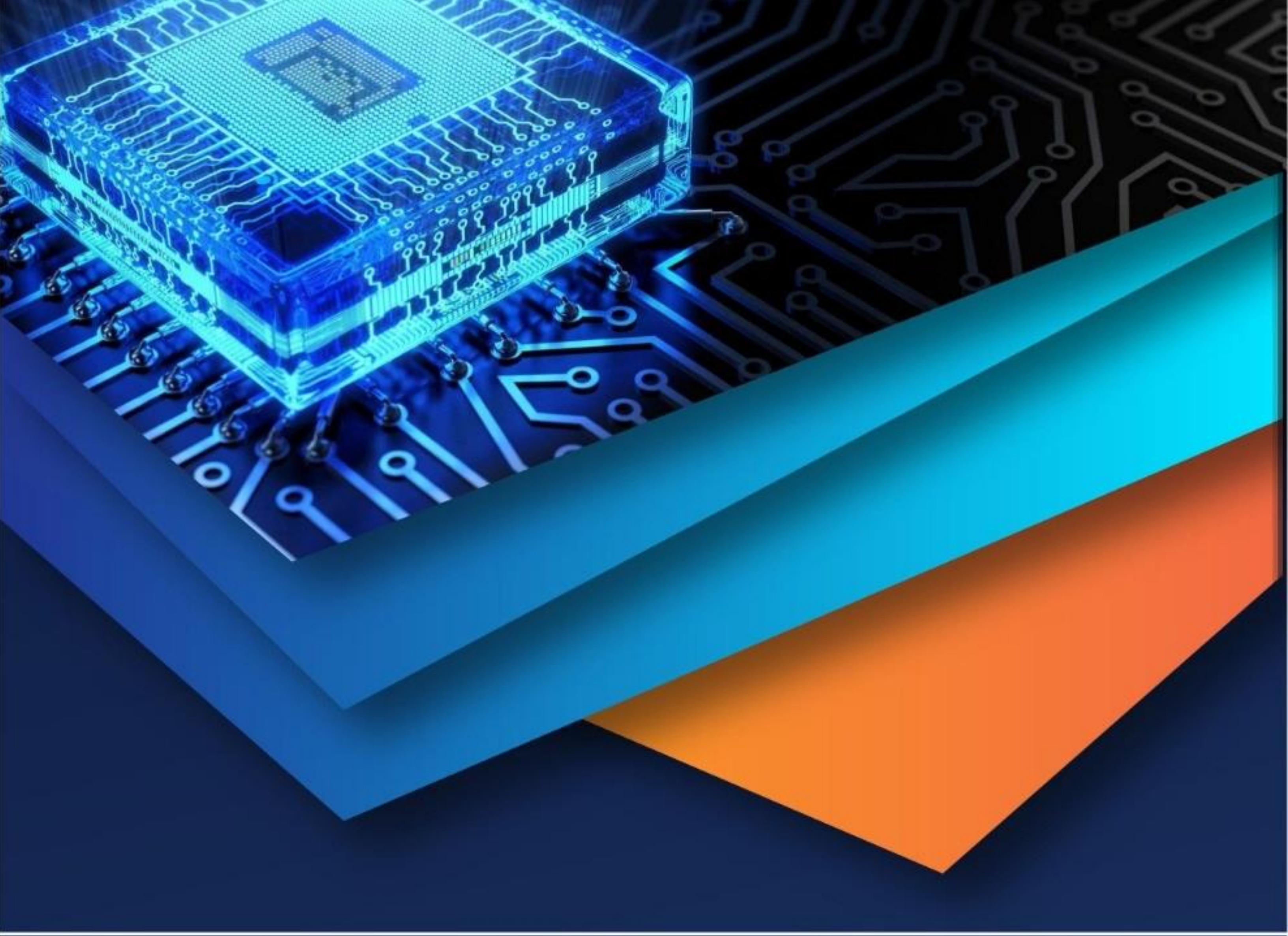

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