Sustainable Farming in Soilless Culture Non-Circulating Kratky Method Using Fuzzy Logic Control and Measure Greenness

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Abstract- ***Organic horticulture and organic commodities have to face severe rivalry in today's economic environment. Even though there are several forms of home gardening, there is a need for a more organized and structured need has arisen. In horticultural, plants are planted on the water as a substitute for soil, it is feasible to achieve great efficiency although might be more suitable. Feeding the seedlings with the appropriate nutrients and hormones, as well as oxygen, is critical to the plant's vitality. The plant requires these chemicals and supplying them to the roots of plants would guarantee that the plant obtains the nutrients and oxygen it requires on a constant schedule. The system's strength is to give the plant the necessary oxygenation through the Air Roots of the seedlings being planted. The plant needs oxygen as well as nutrients from these root fibers as it grows over time, the amount of fiber required to extract oxygen will rise. The intensity of chlorophyll on the leaves can be determined by evaluating the quality of the plant and its nature. A more robust process is required considering urban expansion and human involvement is limited. To overcome these situations systems used to employ the latest IoT and microcontroller technologies. This study to control ecosystems introduce fuzzy logic controls and use a computer vision-based approach to computing plant greenness.***

Indexed Terms- ***Arduino, DHT11, Kratky, Hydroponics, Sensors, Actuator, ph, Electric Conductivity***

I. INTRODUCTION

With the complexity of today's society their everyday life, things exist all around them, and the substances they consume are diverse and complicated, as can be seen in the present world whole over the world. In 's era, which is centered on goods and services, there are even more complicated arrangements., In terms of consumption and service requirements. As a result, all fields are divided into distinct sectors, as are their service and service consumers. Existing in the contemporary world, economic liberalization dynamics and market rivalry are the fundamental characteristics of product and service diversity. The impact of this diversification on a country's GDP will ultimately have a direct influence on them [1]. Recently used strategies and technologies, as a result of the effect of information systems, several lonely areas have been given a new impetus. The Global Trade Economy together with modern technologies will be able to achieve significant progress ahead [2].

A. Impacting on agriculture

In today's civilization, the extent of agriculture also differs greatly. Agriculture has a significant economic influence on a country's economy. Defects in traditional agriculture caused by modern innovations It has paved the way for a new adventure in agriculture. New technology will greatly contribute to the advancement of agriculture. The diversification of agricultural technology in agricultural planting and related activities is occurring regularly. The interest in home gardening or horticulture is a lot to see in modern society. The issue of space as a result of urbanization must be correctly anticipated to predict future surges. The horticulture system improves the family unit by allowing them to grow more nourishing and healthful vegetables around their gardens. It elevates mental contentment and occurs in an urbanized environment. It helps to alleviate some of the anxious tendencies. In addition to a country's local economy and life, the index is a vital contributor to advancement. Elevated concentrations of refinement can be obtained by integrating the concepts of home

gardening with current technologies remotely yet in less human intervention.

B. Environment impact

Not only that, but in the case of large-scale processing of plants that grow on the soil but the required cultivated lands area impacted, soil erosion can occur due to the rapid growth of land areas toxic chemicals also add to the water consumed, potentially causing the soil to have become infertile, and the toxic chemicals that contribute to the clean water consumed by humans have a serious impact on health [3]. Long-term exposure of these deleterious chemicals to the soil renders the soil infertile and reduces the efficacy of plant metabolism owing to the loss of soil-friendly microorganisms and bacteria.

As a result of the aforementioned, the fundamental goal of this research is to create a more productive system. To attain those goals, the applicability of new technologies is being evaluated. These observations are being made with an Arduino device. by a microcontroller device used to the plant it significant towards this investigation, and it regulates the changes that take place throughout the ecosystem. The ph levels and the electric conductivity of the dissolved by the Kratky system regularly adjust this microcontroller. Eventually, the information captured by the microcontroller system will be monitored towards the study. This system continually monitors the plant's environment, which aids in the regulation of the plant's photosynthesis system. The electric conductivity meter, pH meter, temperature meter, and humidity sensors are used in this investigation. Fuzzy logic is used to compute data acquired in conjunction with these sensors. The degree of actuator start time is defined by the calculation of data provided via fuzzy logic. Through the microcontroller unit, fuzzy logic evaluates and delivers fuzzified inputs and outputs. The resultant outcome is frequently comparable to the pH value. Divide the pH value from 1 to 14 to get acidity ph 1-6, neutral ph 6-7.5, and alkaline ph 7.5-14 [4]. If the quantity of acid in the solution is significant increases, the system is it be prepared using a pH increasing solution added to the container. The device also applies a pH balancing substance when the amount of liquid alkaline is raised. As the value of electric conductivity increases, we can see that the quantity of ions present in the solution is imbalanced. As mentioned above, the Kratky method specialty here is short-term, less costly, and more effective under limited conditions can be grown. The above-mentioned stability is mostly owing to the plant's continual influx of plant oxygen as well as other roots to that there will be a high level of equilibrium.

C. Proposed solution using Kratky method

The purpose is to produce short-term crops in the soil as well as an alternative growing medium is considered [5]. The distinctiveness of hydroponics systems in terms of the nutritional requirements of transplanted plants Directly from the plant, root hairs can be obtained. Kratky's approach may be emphasized as the most successful in this regard and as a means of producing higher yields in a shorter time frame[6]. The specialty of the Kratky method is that not only the nutritional demands of seedlings but also the necessary oxygen, are set to be assimilated by the roots of plants. An air root system is created by the system. After the solution reaches equilibrium volume, the number of Air Roots in this system rises with time. This unique air root system gives the plant the nutrients it requires more efficiently than any other plant, along with oxygenation. Photosynthesis, which influences the greenish color of seedlings, therefore receives more oxygen and nutrients via this root system, which is very conducive to activities in the plant's metabolism. However, in the conventional agriculture technique, a plant that grows throughout the soil medium is provided a lot of moisture along with nourishment, which is not always accessible on a plant via the root system. This deficiency is visible using both the novel technique and the conventional method.

In this study, four samples will be utilized for observation, and each sample is distinct from the others, and external influences will be presented differently. However, the findings for this study's-controlled experiment come from a plant grown on the soil surface under normal conditions. These strategies can be used to assess the benefits and drawbacks of incorporating new technologies for usage in the future world. The first specimen investigation utilized was a self-controlled microcontrollers system for horticulture. This provides the plants with the right atmosphere it requires to operate during their life span. Second, the observation samples are only collected

once every 48 hours. This indicates that the second sample used does not receive continual attention, regardless of how relevant it is. The plant received for the third sample has no external factors that it regulates. It emphasizes the importance of the study representing the first instance in the Kratky method in this case.

The distinctiveness of the three systems listed above differs from one another. The observation gained in those four systems shows that the most deviant findings are taken. These findings may be derived from the characteristics of the plants in specimens. Calculate the chlorophyll level of the plant regularly by checking its greenness level in each sample. The root system of the plant can monitor the health of the plant. The size and number of leaves on the plant can also be used to track the plant's growth.

II. LITERATURE REVIEW

The research was done to adjust the values of Electric Conductivity and pH levels in hydroponics plantations [7]. The recommended approach was tested also with cultivation in the test hydroponics nursery. The link between EC and pH with the hydroponic growing medium is being studied. The connection mathematical Practice problems indeed provided for variable modification utilizing linear approach model with the EC and pH values. Had discovered the aqua fortis (HNO3) employed in the pH regulate method affects the EC value. The plant nutrient management system is made up of the following parts. PH increases for one, then decrease for the next, and the third one is the same done for EC. The system built throughout this research employs pH and EC sensors that link to a computing device and can show statistics on the loT method. The fuzzy inference system application is used to operate and manage a method by using particular situations. To investigate seedling absorption of nutrients. To implement fuzzy rules, identify the parameters engaged to be described. There is an equal portion to model in this scenario. pH and EC are process variables. in 4 testing samples are the system that will give. It uses a process model to complete in the ambiguous set supplied by the inclusion exponential reason. The goal of fuzzified is to obtain an insert. Determine the similarity score for each of the reasons for the two inputs. The translational number of PH acids is divided into two parts lower and higher. Set the value of every rule fuzzy in the result field. To test the tree style of modification. Directly perform Test 1 To only seeding do you need to make an EC modification. Test 2 Only change the PH directly for seeding. Study 3 involves adjusting the EC and the pH at the same time. Again, for based on the fuzzy reasoning described in this paper, this technique employs that both the EC formula and the pH formula. The research employed hydroponic conservatories seeded using DRFT Technique, which was devised to fit the Thailand environment by enhancing oxygen movement and seedlings nutrition supply. The system's version of the fuzzy inference system method can modify pH and EC. These studies revealed that such a fuzzy set theory using 12 principles may manage a variable to its finest by selecting whether to switch alternatives. The effectiveness of such a fuzzy inference approach for nutrition modification is conducted to evaluate the production of two usual procedures used as benchmark datasets. Every product's effectiveness is determined by the number of fertilizers added to the mixer, which changes both PH and EC readings. Management of the approach by an untrained producer with no fundamental understanding of agriculture. Supervision of products by a professional that knows chemical and agricultural concepts. The test results reveal that by altering the nutrition in the same environment, the PH and EC values change over time. Depending upon that test, putting alkali toward a holding tank containing 120 liters may raise its acidity to 0.5, and introducing 5 ml a pH lowering fluid could lower the pH to 0.1, although putting 50 ml of a solution may raise the EC. This operation supply acidic or alkali is needed, and indeed the EC parameter is also needed. All classic controllers take roughly it given time regulate the liquid in the appropriate pH value. Its fuzzy controller likewise produces great results for the appropriate EC spectrum. It may be stated using a fuzzy controller can minimize skills and labor for fertilizing. The fuzzy set theory could be modified the quickest. A much less moment phase reduces the quantity of material utilized, which can cut the number of nutritional solutions by nearly two-fold. This study presents the notion of horticultural management through the use of an intelligent system. Its fuzzy control is employed inside the pH and EC judgment processes, which works well enough for

people. These findings indicate that using a fuzzy controller could improve the overall regulation of fertilizer addition to seedlings. Decreases the quantity of liquid fertilizer used and the quantity of labor required. As a result, the device may be utilized for full horticultural management. That is the investigation of the said scope of managing the quantity of water that is suited one per plant that will be the focus of study. Furthermore, research into using the method to manage the population increase and the effect of an operation is continuing.

III. METHODOLOGY

This study's purpose is to how beneficial it is by combining the Kratky technique with IoT technology. As a result, because four specimens were utilized in this investigation, the fourth specimen was designated as the controlling sample. The study based on the research question is the Kratky method in hydroponics using IOT technology, rather than a plant that is normally planted in soil. This research is centered on the ability to plant more fruitful plants despite today's restricted land due to rapid urbanization. The findings made as a consequence of these investigations are utilized to simulate a variety of ways. To get the conclusions, basic primary data is combined with secondary data. Primary data as PH, electric conductivity, and average greenness measurements are obtained.

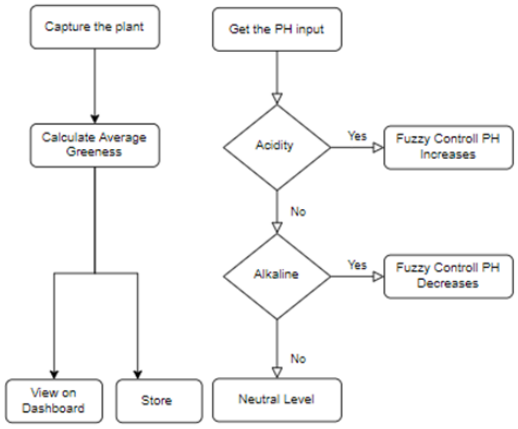

Fig.1. Flow of the Fuzzy and Greenness.

A. *Measure plant greenness*

As secondary data amount of the leaves, the weight of the roots, and the intensity of greenness of each plant are utilized to determine the plant's quality. The method used to derive the plant's green color performs multiple computations on the image it produces. It separates the RGB values and then splits the green color obtained above by the pixel in the frame to get the mean value of greens. Simultaneously, the fuzzy expert system estimates the pH of the motor about the operation time.

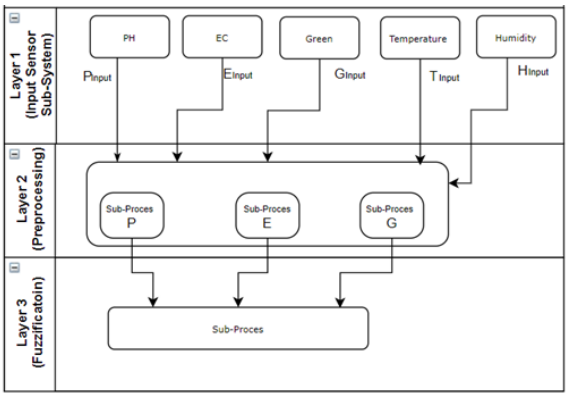

Fig.2. Layers of the system.

B. *Controlling ph and electric conductivity*

The Kratky approach applied in this research is what makes it so effective. The grown successfully quicker than the plant because it consumes the nutrients it requires by roots and frequently oxygenation by special Air Roots. It is also simple to combine the cutting-edge Internet of things (IoT with microcontrollers). A plant is grown as a controller sample on the soil surface under ordinary environmental circumstances to calculate the system's validity and reliability. As an independent variable, pH and electric conductivity are both considered. To perform the final analysis, the method incorporates primary data obtained from samples collected from all four experiments. The plant obtains the nourishment it would need mostly through the roots under the hydroponics technique. As a result, the study has taken initiatives to minimize difficulties absorption into the root hairs of the system used in the study. Because the four specimens utilized in the investigation were positioned at small distances, it was hypothesized that the external factors in the environment would not vary. It was also considered that the four plants created their micro-ecosystem.

Every twelve hours, the first sample's measurement is obtained. Every two days, the second sample is gathered. The third sample assumed that the system remained unchanged.

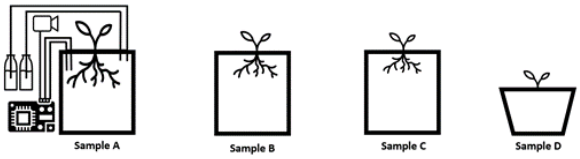

Fig.3. System samples.

A microcontroller system was used to carry out the research. A PH sensor, an electric conductivity sensor, a temperature and humidity sensor, and a camera module were utilized to collect data. To control the first sample study, two submersible water pumps, a servo motor, a relay switch, and DC power are used. The first system uses fuzzy logic implemented to control throughout. Furthermore, since this study was performed on a premise, initiatives have been introduced to provide a consistent supply of light level to the plants.

Fig.4. Implemented physical system.

As it is retrieved, the data necessary to analyze it is saved in storage. The data obtained in the research was subsequently processed in several ways. It was discovered that the data gathered had been destroyed for a variety of reasons. As the quantity of data destroyed lowers, the value was determined by other statistics. Also, the magnitude of the values provided by the fuzzy logic system is approximated to the nearest degree of the truth as a motor operating time. All across the particular research, Excel is utilized to evaluate data. The study did not use methods such as the NFT, Drip irrigation, Aquaponics that uses hydroponics technology Kratky method [8]. The Kratky approach is used to make things easier and convenient in a short amount of time. The influence of hydroponics Kratky method on reducing the complexity of food cultivation with people's busyness soon. This study's plants should be suited for short-term cropping. The seeds of the green cabbage plant were selected for this experiment because they can be tested quickly.

IV. RESULTS AND DISCUSSION

The investigation was carried out in a certain time frame, which was followed by observations made seven weeks later. This system will capture plants' average greenness and provide a basic idea about plant health. Only minor variations in pH and electric conductivity values were recorded throughout the study.

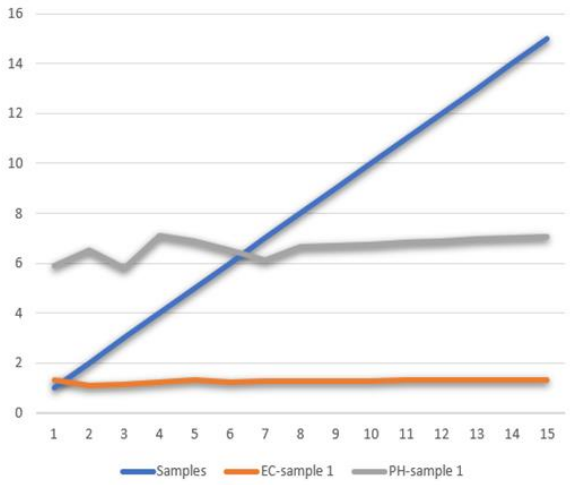

Fig.5. Sample A, PH, and Electric Conductivity.

According to the results of a study, the first sample demonstrated a high grade of the planted plant. The chlorophyll component, which intensity the plant's green color, was likewise significantly high in the initial specimen. According to an initial research question based on the research, it is hypothesized that these Kratky methods will result in a high-producing plant.

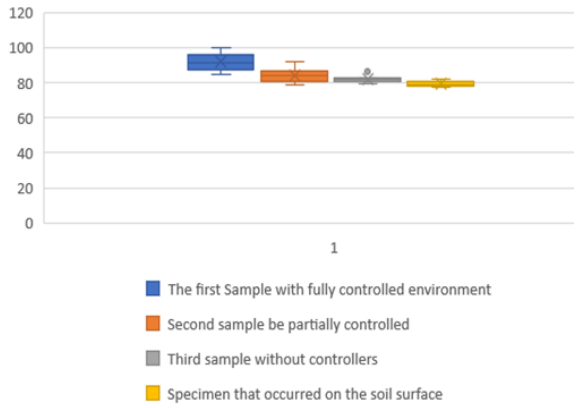

Fig.6. Greenness division across the system.

The plant's green intensity is getting maximum by the system managing the system via continual computations.

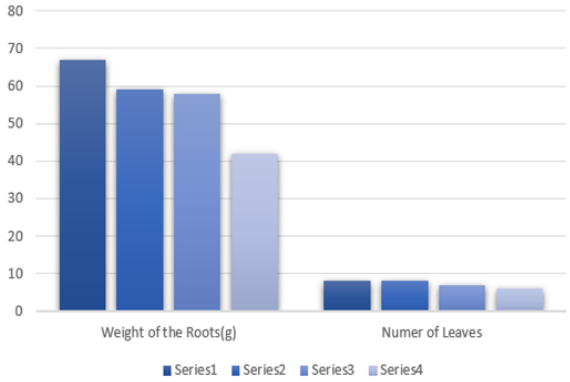

Fig.7. Weight and Number of leaves.

A significant alteration in the roots and leaves of the plant developing in that environment may be noticed with the continual application of the conditions given to the first sample.

CONCLUSION

This study aimed to identify effective Hydroponics strategies with IoT and Fuzzy controlling. Based on a quantitative and qualitative analysis of results is indicated that the system is capable to gain great effectiveness. This is because the plant's nutrients and enzymes are continually delivered to it regularly and properly. Future research might explore based on more data science approaches and using machine learning forecasts to plant growth to better understand the ramifications of these findings. The viability of plants grown with the hydroponics Kratky technique upon combining with the most modern IoT technology with fuzzy logic control and automate regular measuring plant. Future work on this subject will include giving and monitoring the plant's air roots as well as providing environmental factors using logistic regression forecasts.

REFERENCES

[1] P. Smith *et al.*, “Agriculture, forestry and other land use (AFOLU),” 2014.

[2] I. M. F. Staff, “Global Trade Liberalization and the Developing Countries,” *International Monetary Fund. Washington DC: IMF*, 2001.

[3] J. M. Hungerford, “Committee on natural toxins and food allergens: Marine and freshwater toxins,” *Journal of AOAC International*, vol. 89, no. 1, pp. 248–269, 2006.

[4] A. A. Alexopoulos, E. Marandos, A. Assimakopoulou, N. Vidalis, S. A. Petropoulos, and I. C. Karapanos, “Effect of Nutrient Solution pH on the Growth, Yield and Quality of Taraxacum officinale and Reichardia picroides in a Floating Hydroponic System,” *Agronomy*, vol. 11, no. 6, p. 1118, 2021.

[5] S. Ghahremani *et al.*, “Short-term impact of monocultured and mixed cover crops on soil properties, weed suppression, and lettuce yield,” *Communications in Soil Science and Plant Analysis*, vol. 52, no. 4, pp. 406–415, 2021.

[6] B. A. Kratky, “Three non-circulating hydroponic methods for growing lettuce,” in *International Symposium on Soilless Culture and Hydroponics 843*, 2008, pp. 65–72.

[7] M. Fuangthong and P. Pramokchon, “Automatic control of electrical conductivity and PH using fuzzy logic for hydroponics system,” in *2018 International Conference on Digital Arts, Media and Technology (ICDAMT)*, 2018, pp. 65–70.

[8] M. N. Halgamuge, A. Bojovschi, P. M. Fisher, T. C. Le, S. Adeloju, and S. Murphy, “Internet of Things and autonomous control for vertical cultivation walls towards smart food growing: A review,” *Urban Forestry & Urban Greening*, p. 127094, 2021.