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URBAN FARMING: SOLAR NUTRIENT FILM TECHNIQUE SYSTEM

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Abstract:

Farming in urban areas is recognized as a sustainable approach towards the provision of food, and it has increased in Malaysia over recent years. Urban farming has emerged as one approach to contribute to local food security by increasing the availability and accessibility of fresh and healthy produce. Solar Nutrient Film Technique System is a product that can overcome challenges for agriculture sector at urban area. This product objective are to reduce the cost of living, to improvement of food self-sufficiency, to minimize water usage, to create environmentally friendly product and to provide space for agriculture activities for urban area. The novelty and uniqueness of NFT are it can be grown outdoors, indoors even in small space. Furthermore, the NFT is the cultivation of plants without using soil. Vegetables are planted in inert growing media and supplied with nutrient-rich solutions, oxygen, and water by using the electric pump. The application of solar pump also can reduce the cost of electricity and save the environment. Due to challenges of life in an urban environment where the time and space for gardening are limited, the innovation idea of hydroponics system will help the people to plant their fresh produce even though in the city. It creates commercialization potential to individual or company to start on agriculture production. Hydroponic agriculture using the Solar NFT System could be an option for meeting the world's growing food demand. One of the aspects to consider is the nutritional needs of the hydroponic plant. The NFT hydroponic nutrient controlling system is designed to help farmers manage the proper amount of nourishment for their plants. To manage the amount of nutrients, this system use the linear regression method. The precision gained from the controlling system experiment is 87.84%.

Keywords:

Nutrient Film Technique, Urban Farming, Environmental Friendly, Hydroponics.

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Introduction

Farming in urban areas is recognized as a sustainable approach towards the provision of food, and it has increased in Malaysia over recent years. Urban agriculture is discovered as growing food in the city area, which is including the plant either on allotment land, own house area or unoccupied property within the metropolitan region or near the urban centres. Also, urban farming has emerged as one approach to contribute to local food security by increasing the availability and accessibility of fresh and healthy produce (Mohammed, 2018).

NFT can be grown outdoors, indoors even in small space. Hydroponic allow for the crop to grow in the area where Growing traditionally has been a problem and the place where the soil is poor in terms of fertility and where water is minimum. Furthermore, the NFT (Nutrient Film Technique) is the cultivation of plants without using soil. Vegetables are planted in inert growing media and supplied with nutrient-rich solutions, oxygen, and water by using the electric pump. Thus, the bare roots of the plants come in contact with the water and can absorb the nutrients faster.

Also, by applying this method, the crops can be planted even though the condition of the soil is unsuitable. When a plant is grown in soil, its roots are perpetually searching for the necessary nutrition to support the plant. If a plant’s root system is exposed directly to water and nutrition, the plant does not have to exert any energy in sustaining itself. The power the roots would have expended acquiring food and water can be redirected into the plant’s maturation. As a result, leaf growth flourishes as does the blooming of fruits and flowers.

Apart from that, the introduction of “Solar NFT System” can help the urban people to grow their crops for food consumptions even though the space is limited and the system that works automatically will not be a burden to the user. The application of solar pump also can reduce the cost of electricity and save the environment.

The NFT system is the primary focus of this research. The plant roots in this arrangement are suspended in channels called gullies through which a thin film of nutritional solution travels, keeping the roots damp but not logged. The nutrients are mixed appropriately in a primary reservoir, from which it runs through the system at a rate of 1 litre per minute, continually nourishing the plants. Automation can be used to modify the system for aeration (Sheikh, 2006).

The primary premise of the NFT is the recirculation of nitrogen solutions for crop production. The technique is easily adaptable to a wide range of crop production (Burrage, 2006) and is appropriate for short-term crops such as lettuce, leafy crops, and herbs. Larger NFT systems are better suited for long-term crop production like cucumbers and tomatoes (Sheikh, 2006; Burrage, 2006). This makes hydroponics economically appealing, and with such excellent benefits, it is ideal for protecting natural resources, making the cultivation efficient to governments.

Hydroponics has been adopted on the Chinese mainland to maintain a good production environment (Jiang, 2006). It has also grown in popularity in the United States, Canada, Western Europe, and Japan, where people are extremely conservative and protective of their environment (Jensen, 1997).

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Furthermore, increasing food production while maintaining ecosystem stability and environmental rehabilitation has been a significant problem in Pakistan. As a result, hydroponics was introduced as the best solution to the problem (Sheikh, 2006).

In general, there is an increasing understanding of the environment and ecology in the agricultural economy. Hydroponics has been practised in Malaysia as well, a place with a more tropical environment. In this study, we look into a conceptual design for a low-cost, basic system for testing agricultural productivity.

Literature Review

Most residents have chosen to live in metropolitan areas in recent years, largely due to the abundance of the work opening and social services. As a result, much of the land was used for farming before were transformed into residential units, factories and highways. It also has contributed to low production of agricultural products.

Higher fruit and vegetable prices due to the import bills as the country now depends heavily on food imports, especially vegetables and fruits, which could not fulfil the demand of the market. In 2012, sustainable agriculture or sustainable farming activities were eventually adopted on the basis. After 2015, NGO's even interested in it through government departments. Also, the Ministry of Agriculture and Food Industries has created a division of urban agriculture to encourage urban farming to urban people (K.V.Bhaskar Rao, 2016).

Besides, urban farming is important; this is because if the importing countries involved a conflict or suffer any other food-related disasters where the disaster country could not supply their produce to Malaysia. To overcome that problem, as a preparation, urban agriculture can serve a better option for raising or supplementing food output for own consumptions, particularly cash crops like vegetable bakchoy, lettuce, capsicum, spinach, kale which develop within a short duration can be conveniently cultivated by urban dwellers (Han, 2017).

Due to challenges of life in an urban environment where the time and space for gardening are limited, the innovation idea of hydroponics system will help the people to plant their fresh produce even though in the city.

Figure 1: Rooftop Gardening

Sources: (https://urbanizehub.com/urban-farming-social-innovation/)

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Rooftop and vertical gardening, as well as hydroponics innovation it is also an agriculture without soil and are already being implemented in the most environmentally friendly communities. However, a lot of space that is currently used for driving and parking may be freed up. Last year, the mayor of Oslo announced that automobiles would be prohibited in the city centre beginning in 2019, while Helsinki has ambitious plans to make its "mobility on demand" service so good that no one would want to drive a car in the centre by 2025.

Policies that prohibit or limit the use of private vehicles are becoming more prevalent and successful when accompanied by reliable and clean public transport, as well as bike lanes and pedestrian spaces. Road improvements could result in significant gains in cultivable land and green space. One of the most transformational motorway removal initiatives exposed not only a polluted highway but also a missing stream (UrbanizeHub, 2016).

Figure 2: A Farm On The Top Of A Building In Switzerland
Sources: (https://oldmooresalmanac.com/urban-farming-for-your-life)

This is not a novel concept. People have been farming in cities for a long time in places like Cuba, where it arose out of necessity rather than leisure. This occurred in Cuba owing to fuel shortages. Due to the lack of transportation, farmers were unable to get their produce to market, and people went hungry while food deteriorated. Even today, 90% of Havana's fresh vegetables comes from local urban farms and gardens. Even once the fuel crisis was over, many never returned to their dangerous old ways, and they remained urban farmers. Cuba is far from Europe or the United States. However, the concept is applicable anywhere, urban gardening available to everyone, no matter where they live (Roman, 2017).

Abbreviations and Acronyms

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NFT (Nutrient Film Technique) and EC (Electrical Conductivity).
Estimation of Electrical Conductivity and pH in a Hydroponic Nutrient Mixing System Using a Linear Regression Algorithm (Kaewwiset, 2017) presents the relationship between A&B solution and EC, the amount of nitric acid with pH, and the relationship between EC and pH in a hydroponic nutrient system to obtain the nutrient solution adjusting equation value using linear regression analysis.

Nutrient Film Technique (NFT) Hydroponic Monitoring It Based on Wireless Sensor Network (Nursyahid et al., 2016). It is designed to make it easier for farmers to monitor hydroponic agriculture in real time using WSN. The EC sensor is used in this system to determine the value of the nutritional solution. The purpose of this work is to offer an autonomous hydroponic fertiliser control system employing a linear regression algorithm and an analogue TDS sensor. This system is controllable in real time.

Product Description
The product can be called as Solar NFT system. The N.F.T. system (Nutrient Film Technique) is one of the method to planting leafy vegetables that popular among home growers either in urban or rural area. This is mainly due to its fairly simple design and easy to install by own self. However N.F.T. systems are best suited for, and most commonly used for growing smaller quick plants like different types of leafy vegetables like lettuce, mustard, bakchoy, Chinese kale and spinach because this crop can be harvest after 40-50 days after planting. In addition, by applying solar pump is one of the method to reduce the electric consumptions of the grower and reduce the pollution.

Product Design and Features

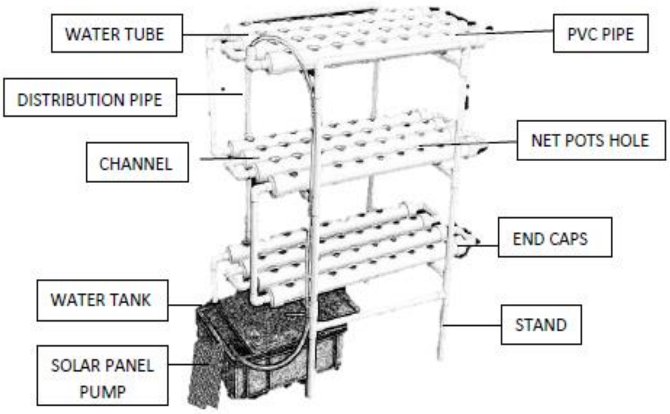

Figure 3: Solar NFT system

Way the System Works
The system for Solar NFT system work efficiently. In this NFT system, the water will be recirculating from the tank and move to every tier of the channel. But for the first step usually the water will fill at the upper part and then will fill the lower part of the channel. The water moves by the pressure through the solar panel that create the energy.

Furthermore, the roots of the crops will hang down to the bottom of the channel where they come into contact with the shallow film of the nutrient solution and absorb the nutrients from

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them. The thin film of the nutrient solution allows the plants to be watered but not entirely soaked. This thinness also allows the upper part of the roots to remain dry and have access to oxygen in the air.

Meanwhile, in the grow tray, there are net pots that contain the growing media to hold the plants and reserve nutrients from the nutrient solution. The grower also should have the EC meter in order to measures the electrical conductivity in a solution. Usually the reading of the meter for backhoy plant are around 1050-1400 ppm and it also depends on the type of crops that will be plant.

Thus, there are two ways to place the seedling. Firstly, by place the seedlings directly into the holes of the PVC pipe or channel or secondly, by put seedlings into net pots for greater stability and place them into the holes.

The source of energy of this system are directly from the sun with the help of the solar panel that were installed. Solar power is energy from the sun that is converted into thermal or electrical energy which can reduce the cost of electricity.

In this study, the linear regression approach is used to identify the values of a and b using sample data, so that the equation may be obtained and used in the system. To measure the rise in TDS value of nutrient solution, the sample data collection experiment was performed 20 times trial of each A solution and B solution. This experiment was done out on a 30 litre nutritional solution tank with pump delays of 0.5s, 1s, 1.5s, and 2s. The sample data test result for A solution is depicted graphically in Fig.4.

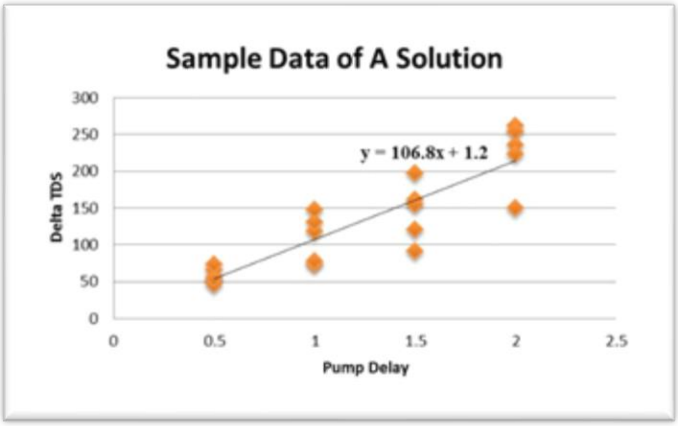

Figure 4: Sample Data Of A Solution's Test Result.

From data sample collecting experiment of A solution obtained the value of a=1.2 and b=106.8. The equation for nutrient solution A as follow:

$$Y = 1.2 + 106.8\,X$$

The result of sample data test for B solution shown through graph in Fig.5.

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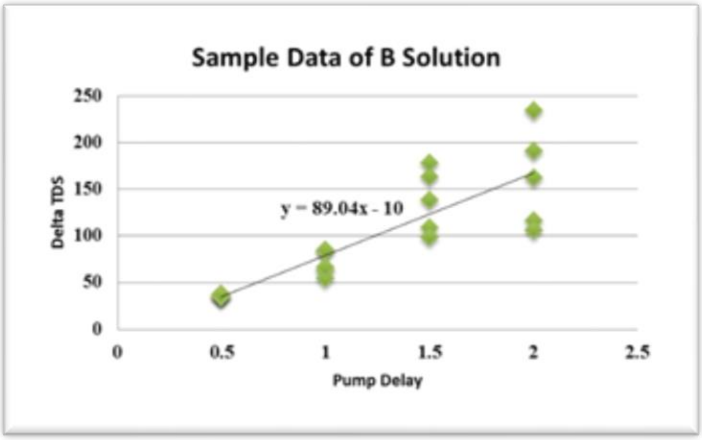

Figure 5: Sample Data Of B Solution's Test Result.

And from data sample collecting experiment of B solution obtained the value of a=-10 and b=89.04. The equation for nutrient solution B as follow:

$$Y = 89.04X - 10$$

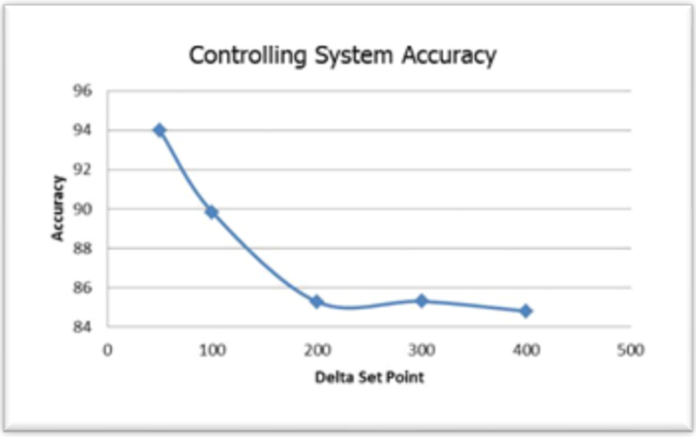

Figure 6: Graphic Of Controlling System Accuracy.

According to the graph in Fig 6, the greater the difference between the set point and the final TDS value, the greater the error percentage and the lower the accuracy %. This is due to sample data testing on 30 litre reservoirs that have not been used to NFT hydroponics. The NFT hydroponic greenhouse is being tested while the control system is being tested. The volume of nutrient solution in an NFT hydroponic greenhouse is bigger because nutrient solution is flowing to irrigate plant roots. The difference in water volume of 5 litres causes nutrient density solution management to be less than optimal.

Conclusion and Future Works

Analogue TDS sensors can be utilised as an indication and input to a control system. Sample data collected in a 30 litre tank with a pump delay of 0.5 to 2 seconds yields equation answers Y=1.2 + 106.8 X for the A solution and Y=89.04 X - 10 for the B solution. According to the study's findings, the regulating system using the linear regression method has an average accuracy of 87.84%.

The greater the delta set point value, the greater the average error and the lower the average accuracy. In order to create a better regulating system, the application of the linear regression

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approach should be monitored by adding more sample data and employing more variables to obtain the equation.

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