Hydroponics using IOT and Machine Learning

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PROBLEM STATEMENT

Soil Erosion is a major challenge in modern-day agriculture and is one of the main necessities for agriculture to sustain, soil erosion also indirectly affects air and ware pollution due to the addition of pesticides into the soil for farming and agriculture purposes. Soil-borne pests prove to be a roadblock in farming and using pesticides can be harmful as mentioned, Pesticides from traditional soil-based agriculture methods runoff into rivers and streams and pollute the water, and are also harmful to living organisms that sustain in these water bodies. A solution that aims at minimizing this pollution and the issue of soil erosion is a much-needed solution for agriculture and farming to sustain, modern technology and the rise of Artificial Intelligence-based smart systems could prove to be a great solution to such a problem.

AIM

Agriculture affects a nation's economy substantially. Hydroponics is on an increase because of current agricultural strategies that allow plants to be developed without soil by utilizing supplements. Presently towards controlling the hydroponics plant development, some measure of exploration has been done in applying machine learning algorithms like Neural Networks and Bayesian networks. AI has helped in automating plant development where some minimal measure of research has been completed. Based on conventional techniques for developing plants, there is no attention to the soil. However as long as these prerequisites are satisfied, plants can develop, and this brought the possibility of hydroponics cultivation.

Hydroponics is a sort of cultivating in which plants are developed without soil. This technique permits homesteads to follow the cultivators to the Urban region. The Internet of Things empowers Machine to Machine communication as well as independent and insightful control of the Hydroponics framework. We aim to develop an intelligent system that decides the best control activity for a hydroponic climate based on one of many information inputs.

METHODOLOGY

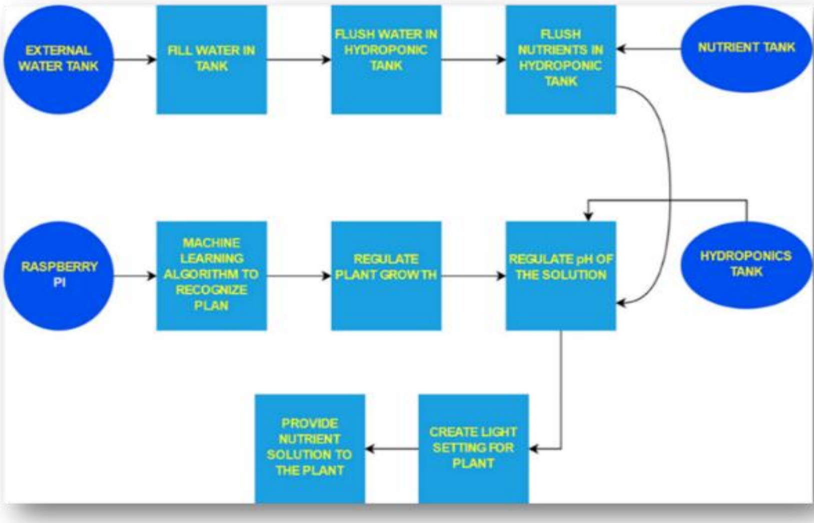
In the proposed methodology, IoT and Machine Learning works in parallel to achieve the common goal of optimal plant growth. Both aspects serve a distinct purpose and are equally vital.

With the introduction of IoT, it has enabled farmers to automate the entire procedure of hydroponics. Different tasks involving monitoring of PH level, water level, temperature, and light intensity can be regulated with IoT without manual intervention. The data collected by sensors present in the hydroponics tank will be delivered to an ARM 7 Microcontroller, which performs continuous monitoring for optimal plant growth. Additional functionalities can be added by connecting this system to our phones for remote control. The sensors present in the hydroponics task will be interfaced to an Arduino. This device called a Pi3 acts as the interface between the cloud and microcontroller. It uses data from sensors to manage the hydroponic environment.

ML algorithms have various uses in the field of artificial farming in general. It is used in hydroponics to control plant development and optimize EC values in the nutrient solution. Popular models like the Bayesian network can be implemented accurately controlling and observing environmental events. These models can work upon a dataset collected over a month, for predictive analysis. This analysis is utilized for crucial output decisions for autonomously controlling the system.

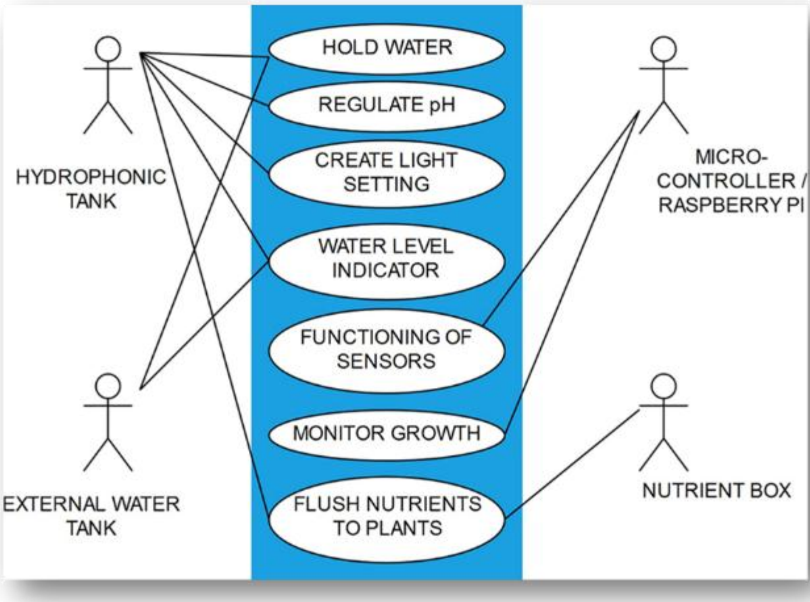
Therefore, Iot concentrates on controlling the hydroponic environment based on sensor data collected from hydroponic tanks using a microcontroller. Machine learning, on the other hand, concentrates on algorithmic level output prediction based on parameters gathered. As a result, IoT and ML work together in real-time to forecast the outcome and control the system.

Data Flow Diagram:



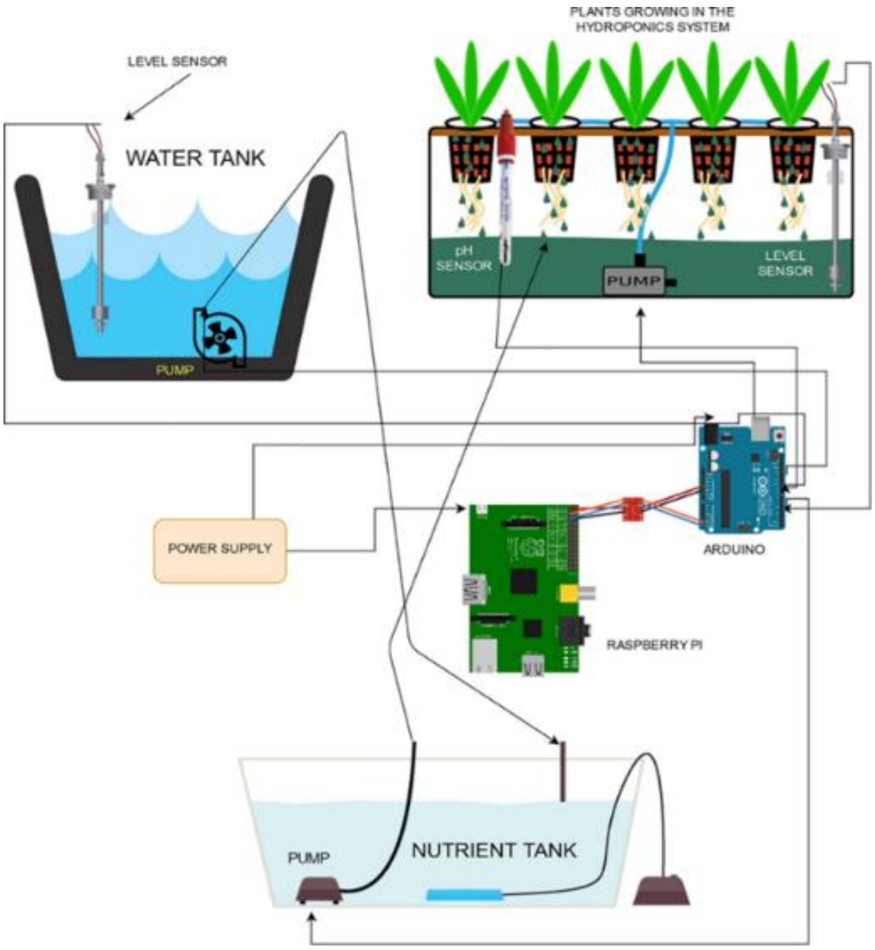
The data flow diagram comprises four main entities: the External Water tank, Nutrient Tank, Raspberry Pi, and Hydroponics Tank. These entities together run the entire structure of this system. The external water tank will be in charge of filling the tank with water, which will then flush water into the hydroponics tank. The nutrient tank will provide appropriate nutrients to the same hydroponics tank at the same time. These events collectively help in regulating the pH of the solution in the tank. From the other end, Raspberry Pi will be responsible for implementing machine learning algorithms to recognize plans, which will then regulate plant growth and ultimately again help in regulating the pH of the solution. The final steps include settings light plans and proving nutrients to the plants.

Use case Diagram:



This diagram demonstrates the responsibilities of different components in the system and their contribution.

System architecture of IoT based hydroponics:



This entire system can again be divided into 3 major sections.

- First part contains the Arduino, where sensors pertaining to pH, humidity, light intensity, temperature, the water level in hydroponic tank captured are sent to the microcontroller. As the Arduino acts as the brain of the entire system, it is connected to every other component like water tank, hydroponics tank, nutrient tank, raspberry pi etc.
- The second part is the Raspberry Pi3 which got the Deep Neural network fitting model which has been trained in the cloud based on the data set collected. The Pi3's fitting model would make an intelligent decision in determining the output, which would then be passed to Arduino, who would activate the appropriate control system. Both Raspberry PI and the Arduino will be connected to a power supply.
- Third component would the hydroponics tank. This section would be responsible for maintaining a sustainable environment for plant growth. It will include several sensors, the data from which will be delivered to Arduino via a directed link.

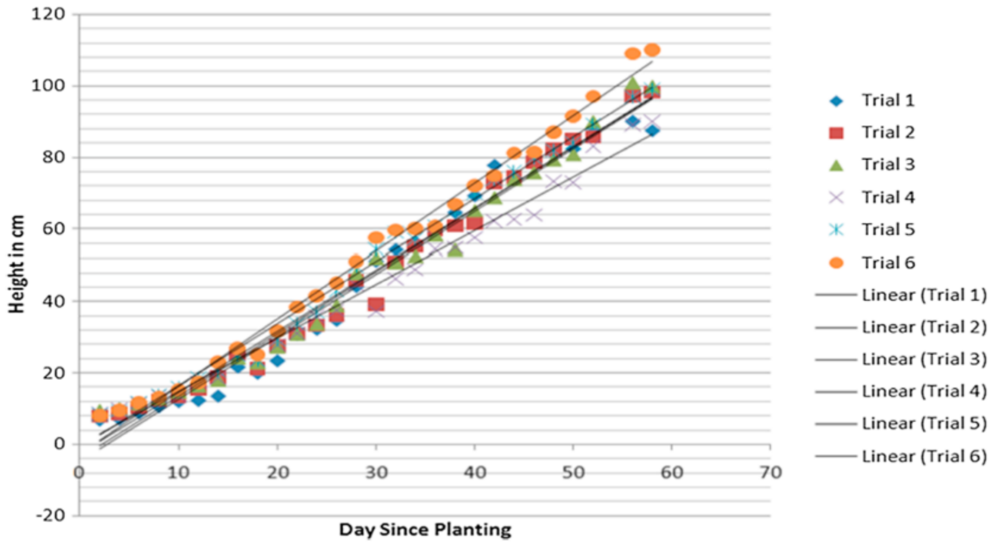
RESULT

The results of using hydroponics have unexpected advantages. The research on using Deep neural networks to analyze hydroponic parameters for controlling actions proved essential. The dataset consisted of 5000 real-time entries having values of parameters like pH, temperature, humidity, light intensity, and water level. The input trained over 10000 epochs produced the appropriate control action labeled 0-7. The deployment of the trained model over Rasberry Pi3 provided an output after sending it to Arduino. A cloud-based database (Firebase) stored the data and the predicted output.

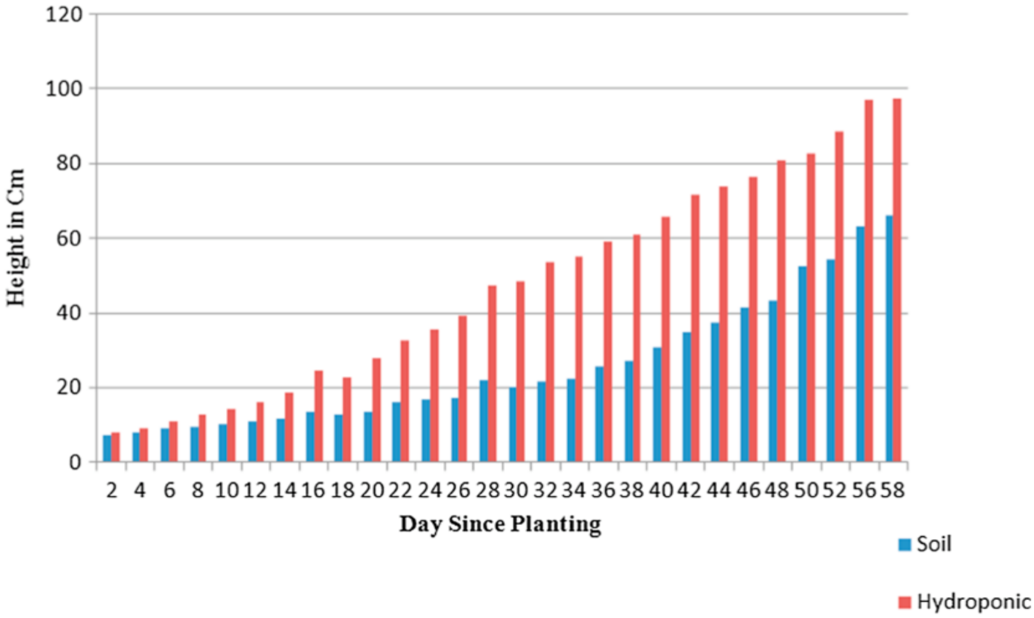
A six-trial process on tomato plants gave different outputs in each trial. The comparative factors were the height of plants and the number of days from the start. The first trial ended at 85cm on the 60th day.

The height increased between 80 cm and 100cm until the last. The last trial witnessed a height of around 110cm on the 60th day.

It proved that the neural network learns after every trial and produces better results. The accuracy of the model was 88.5 percent.



The comparative study of hydroponically grown tomato plants and soil-grown gave unexpected results. The initial 12 days saw similar growth, but the later days witnessed marginal development of the hydroponic plant. The duration between the 30th-32nd day saw more than 50 percent growth compared to the soil-grown plant. On the final 60th day, the hydroponic plant grew to around 95 cm while soil-grown ended at 65cm. The above research highlights a significant advantage of hydroponics over traditional systems. The integration of Deep learning provides results that can help eliminate its environmental disadvantages.



CONCLUSION:

Agriculture has a large effect on the country's economy. Now that the Internet of Things (IoT) has made it possible for machines to communicate with one another, an IoT-based automated irrigation system has been developed, with intelligence relating to KNN machine learning deployed at the edge in predicting soil condition based on moisture and irrigating the field with water. Currently, agricultural advancements are focusing on hydroponics and aeroponics, which allow plants to thrive in a variety of environments, such as hanging or suspended, without the use of soil. The difficulty with such a system is that it needs manual plant monitoring in order to spray the proper nutrients for effective growth.

As a result, with the advent of IoT, a number of IoT-based hydroponic monitoring systems have been created, each with a mobile application for control. Some study has been done using Bayesian Network and Artificial Neural Network in terms of applying intelligence in terms of machine learning in assessing the data set acquired for managing the parameters for appropriate development of the plant in hydroponic. With all of this in mind, we need to regulate the parameters of the hydroponic system autonomously without the need for human intervention in order to produce a proper plant in hydroponics.

So, using the tomato plant as a case study, we designed an intelligent IoT-based hydroponic system where pH, temperature, humidity, level, and illumination are among the five characteristics used to govern the hydroponic environment. The Deep Neural Network is used to train these parameters in order to provide the proper control action, which is labelled. These characteristics are gathered in real-time over many weeks and trained 10,000 times in order to achieve an 88 percent accuracy in predicting the appropriate output action.

The cloud stores the projected control action for real-time data. The Raspberry Pi 3 serves as the edge, where the Deep Neural Network model is used to forecast output and communicate with the Arduino. This was created as a proof of concept. In the future, the system might be expanded by deploying an intelligent IoT-based hydroponic system with a Deep Neural Network for additional hydroponic-grown plants, allowing for more precision. The system might also be expanded by growing more hydroponic plants in other tanks and training the parameters accordingly to provide the necessary control action using intelligence. This could be done on a big scale, allowing the system's accuracy to be calculated for a wide range of hydroponic plants.

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