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Automated Hydroponics System Using Machine Learning

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Abstract : *This study aims to develop an automated hydroponic system that provides optimum artificial climate conditions and supplies sufficient amounts of nutrients to the plant at the right time. The automation of the hydroponic system is very much necessary because if the farmer adapts to the hydroponic system for the plants growth , he may or may not be able to supply a well-balanced nutrient solution at exact time intervals and also cannot afford appropriate climate conditions for the plant's healthy growth. Several parameters must be controlled during the growth process, including lighting during the unavailability of sunlight, concentration of nutrient solution, pH, temperature and electrical conductivity. Hydroponic systems can be considered as an advantage over traditional farming only when these parameters are intact and healthy yield is produced. This objective is achieved by the proposed automated system. The automated system consists of a microcontroller integrated with various sensors. These sensors collect data on the climate conditions, which is then fed into a machine learning model that predicts the state of the pump based on the climate conditions. The machine learning algorithm used here is logistic regression. Accuracy of about 90% was obtained with the proposed system.*
Keywords - *Embedded system, Hydroponic System, Machine Learning**,** Logistic Regression*

I. Introduction

The terms hydro and ponos from the word hydroponics are Greek words that signify water and work respectively. Hydroponics is a method of growing plants without the usage of soil, in which the nutrients usually obtained from soil for the plant's growth are artificially provided to the plants in the form of nutrient solution. In this hydroponics gardening culture, the roots of the crops are frequently soaked in the nutrient solution. LECA (Lightweight Expanded Clay Aggregate) balls are used here as a media to help plants absorb the moisture content. It creates a false bottom and keeps the plants roots at a height from the bottom of the growth tray which does not allow the roots of the plant to stay in water all the time thereby preventing overwatering and rotten roots but only the necessary moisture content is absorbed by the plants at its own pace. Water is conserved as it is reused and recycled in the process. In the upcoming years, to meet the population demands, agricultural production must increase by 50% which might result in shortage of water and organic food. As a result, we seek an alternative agricultural method that produces high-quality organic food while using less water [1]. Because we are doing hydroponics, we only use 10% of the water for agriculture. At each stage of the plant's growth the concentration of nutrition required by the plant varies. Therefore the amount of Nutrition solution to be supplied should be changed according to the age of the plant [2].

II. Literature Survey

The idea proposed by R, Vadivel et.al includes the fields like Hypaponics, Aquaponics, Agriculture and poultry[1]. Monitoring and controlling of the system was done with the help of internet of things and machine learning. The data collected by sensors are stored in the cloud for remote monitoring and later the data is fed to the machine learning model for predicting the output. The machine learning technique is utilized to forecast the plant's health. The algorithm used the system is simple linear regression algorithm. In [2],the idea proposed by A.Nursyahid et.al is a plant age identification system, which is based on the image processing technique. The image of a sample of the plant is used to predict the age of the plant. Plant growth is monitored till the time of harvest. By applying hue, saturation and value color components with the approach of the Otsu thresholding, the background of the image can be separated from the plant image. It also included noise reduction techniques such as erosion and dilation, resulting in clean image results. An accuracy of 81% was achieved for this plant age identification system. T. Kaewwiset et.al.[3] proposed a automatic control of EC and pH system that was implemented at reservoirs. The automatic control system performs the required function whenever there is an output signal given by the microcontroller. The EC and pH adjusting equation takes EC and pH measurements as input and computes the amount of A&B solution or Nitric acid needed. Later an output signal is sent to the control solenoid valve. The study conducted by B. Siregar et.al[4], discuss about the system which includes microcontroller to monitor light intensity, air temperature, water temperature and pH values. The data received by the microcontroller is converted from analog data to digital data. The transmission of the data takes place by internet with the help of GSM/GPRS shield. A graphical visualization will be displayed on a web page periodically for the purpose of monitoring. There is a threshold set for the plant growth, if the data received is greater than the set threshold value, an alert is notified to the user by the system.

III. Block Diagram And Working Principle

The proposed system consists of two sections, embedded system and machine learning process.

Embedded System

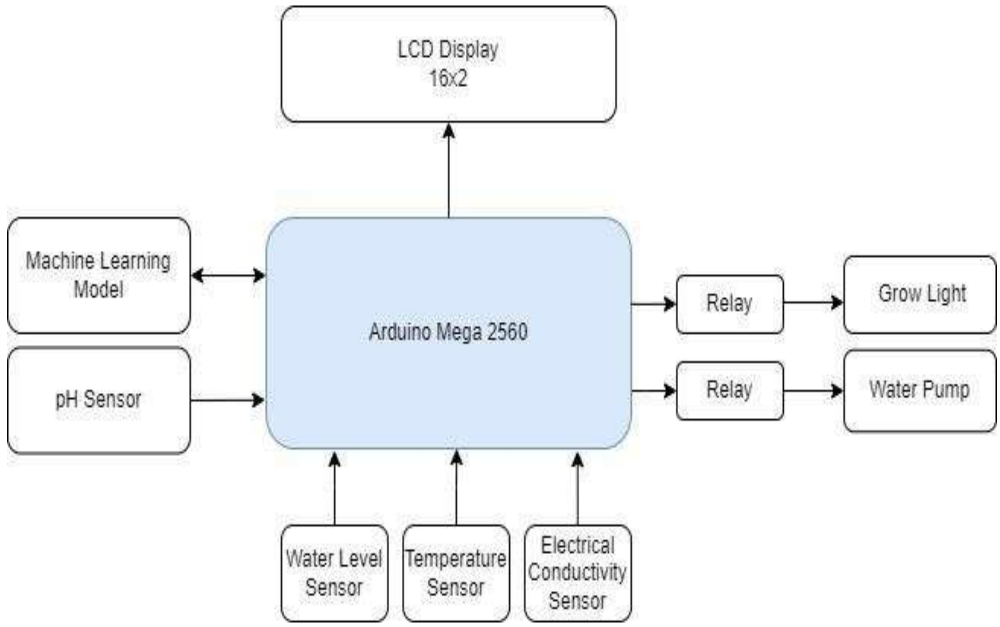

Fig 1. Embedded System Block Diagram

The Block Diagram of the complete idea is depicted in Fig.1. The microcontroller is connected to pH sensor, Water Level Sensor, Temperature sensor and electrical conductivity sensor. The grow light helps the plant in photosynthesis when the sunlight is unavailable. A 16x2 LCD display is used to display the values collected by sensor and state of the pump. The microcontroller used here is Arduino Mega 2560. SPDT (Single Pole Double Throw) relays are used here for controlling the water pump and grow light. The data obtained by the sensors are transmitted and stored in the computer. The transmission of serial data from microcontroller to computer is done with the help of USB TTL serial cable. Now this data is further sent to the machine learning model for prediction of the output based on the sensor data. The output of the model is the state of the water pump. This output signal is sent to the microcontroller and it performs the necessary action.

Machine Learning Implementation

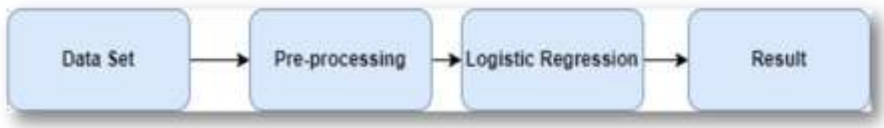

Fig 2. Flow of Machine Learning model

The real time sensor values are stored in CSV file format and are fed to the pre-trained machine learning model by the microcontroller as input. The dataset is divided into training and testing datasets. Only 80% of the data set are used for training purpose and the rest 20% are used for testing the model. Based on the real time sensor values the model predicts the output[7]. The output here is the state of the pump which is a binary value therefore logistic regression is used as the machine learning algorithm for prediction. The logistic regression based on the equation (1)

$$f(x) = \frac{L}{1 + e^{-k(x-x_0)}}$$

x_0 = x value of midpoint
L = maximum value
k = growth rate

…………………………. (1)

This procedure of the machine learning process includes the following steps: data preprocessing, fitting logistic regression to the training set, predicting the test result, and visualizing the test set result as shown in fig.2

IV. Results And Discussions

The setup of Hydroponic gardening and hardware setup are shown in fig 3 and fig.4. In this work, a cultivation method was proposed in which crops are grown without the use of soil, with the necessary nutrition supplied to the plants in the form of a nutrition solution. The plants' nutrient requirements were measured and fed to the nutrition tank, ensuring that the crops receive the same amount of nutrients from the tank as they do from the soil.

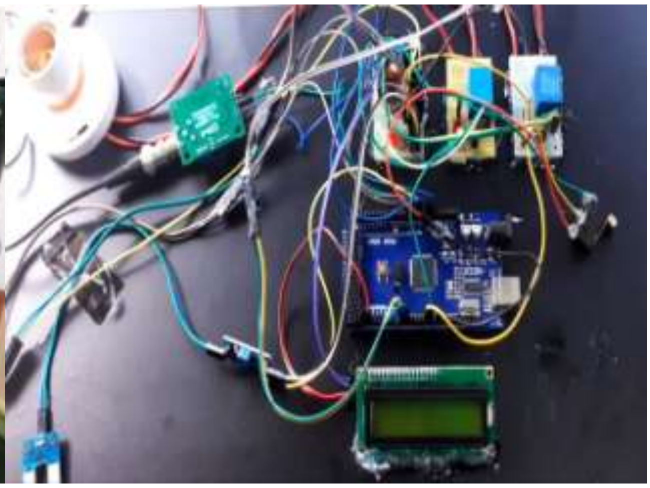

Fig.3 Hydroponic Gardening setup Fig.4 Hardware Circuit setup

```
 final_test =
     Temperature  Conductivity  Water-Level  PH
22            25           210            1   1
27            33           300            1   1
34            36           350            1   1
15            35            90            1   1
18            30           120            1   1

 Machine Learning Model Build


 22     1
27     1
34     1
15     1
18     1
29     1
32     1
30     1
10     0
1      1
41     1
Name: Label, dtype: int64
LR Alg Accuracy 90 Percent
Output Prediction LR =  [0 1 1 1 1]
```

Fig.5 Output of the Machine Learning model

When compared to traditional farming, hydroponic gardening helps to improve the rate of plant development [6]. The water content is also lowered by up to 60% of the amount of water utilized in traditional farming technique[5]. As a result, hydroponic farming has an edge over traditional farming techniques. In our proposed automated hydroponic system. The predictions obtained from the machine learning model showed accuracy of about 90% as shown in fig.5. Whenever the temperature, Electrical conductivity, pH and water level in the system were changed, then there was a change in state of the pump accordingly.

V. Conclusion and Future Scope

In this study, a cultivation method was proposed in which crops are grown without the use of soil and the required nutrition is supplied to the plants in the form of a nutrition solution. The necessary nutrients for the plants were measured and fed into the nutrition tank, ensuring that the crops receive the same amount of nutrients from the tank as they do from the soil. The sensor data collected from the hydroponic system were transferred to the Machine Learning model for prediction of the output. The health of the crops is regularly monitored with the help of data generated by sensors. In the future, a mobile application can be developed and integrated with the system where the user is given an option to select the plant to be cultivated. The model can be trained with plant specific climate conditions aiding in cultivation of a variety of different crops without any difficulty. An attempt can be made in increasing the accuracy of prediction of machine learning model by adapting other algorithms.

REFERENCES

[1] R. Vadivel, R. V. Parthasarathi, A. Navaneethraj, P. Sridhar, K. A. Muhammad Nafi and S.Karan, "Hypaponics - Monitoring and Controlling using Internet of Things and Machine Learning," 2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT), 2019, pp. 1-6, doi: 10.1109/ICIICT1.2019.8741487.

[2] A. Nursyahid, M. R. Wibisono, E. D. Wardihani, Helmy and T. A. Setyawan, "Plant age identification system of outdoor hydroponic cultivation based on digital image processing," 2017 4th International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE), 2017, pp. 213-218, doi: 10.1109/ICITACEE.2017.8257705.

[3] T. Kaewwiset and T. Yooyativong, "Electrical conductivity and pH adjusting system for hydroponics by using linear regression," 2017 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI- CON), 2017, pp. 761-764, doi: 10.1109/ECTICon.2017.8096350.

[4] B. Siregar, S. Efendi, H. Pranoto, R. Ginting, U. Andayani and F. Fahmi, "Remote monitoring system for hydroponic planting media," 2017 International Conference on ICT For Smart Society (ICISS), 2017, pp. 1-6, doi: 10.1109/ICTSS.2017.8288884.

[5] N. K. Bharti, M. D. Dongargaonkar, I. B. Kudkar, S. Das and M. Kenia, "HydroponicsSystem for Soilless Farming Integrated with Android Application by Internet of Things and MQTT Broker," 2019 IEEE Pune Section International Conference (PuneCon), 2019, pp. 1-5,doi: 10.1109/PuneCon46936.2019.9105847.

[6] M. J. Ibarra, E. Alcarraz, O. Tapia, Y. P. Atencio, Y. Mamani-Coaquira and H. A. HuillcenBaca, "NFT-I technique using IoT to improvehydroponic cultivation of lettuce," 2020 39th International Conference of the Chilean Computer Science Society (SCCC), 2020, pp. 1-7, doi:10.1109/SCCC51225.2020.9281277.

[7] H. Jaiswal, K. R. P, R. Singuluri and S. A. Sampson, "IoT and Machine Learning based approach for Fully Automated Greenhouse," 2019 IEEE Bombay Section Signature Conference (IBSSC), 2019, pp. 1-6, doi: 10.1109/IBSSC47189.2019.8973086.