Predictive analysis of city based crops using Internet of Things based Hydroponic system

S A HARIPRASAD NIKHIL K| YOKESH BABU S | SCOPE

Introduction

The need and demand for crops and food is growing up but the area to grow is going down. Due to this alarming scenario, hydronic agriculture has risen in popularity and practice. It is a form of agriculture in which the plants are grown with restricted water supply.

Motivation

As the population of the city grows significantly the need to feed the city heavily lays on the need of agricultural land. As most of the agriculture lands are dried up due to lack of water the need for starvation increases. Hence cities have to start cultivating crops and the need for automated farming in cities becomes crucial.

SCOPE of the Project

The traditional methods practiced by people may result in huge wastage of water. Hence, the concept of robotized farming with a mix of IoT has been developed. The technological advancements began to increase the efficiency of production remarkably thus, making it a reliable system. The knowledge of properties of soil determines the water supply to be driven in a smart way. The practice of agriculture in a smart way helps to acquire knowledge of soil and temperature conditions. Developing the smart agriculture using IoT based systems not only increases the production but also avoids wastage of water

Methodology

In the following proposed system, the analogue and digital sensors collect information from the hydroponic setup. With the help of Arduino Mega 2560 data is send to spreadsheet in a very smooth and effective manner. The data is collected and saved in database using a WIFI module. The block figure is represented for the proposed system.

An innovative form of hydroponic farming is used. A coco pit is used as an soil replacement as the water retention capacity is much higher in this compared to general soil. The coco pit is connected to water supply which is regulated. Six different sensors are connected to the system. The sensors being, pH sensor which monitors the pH of the water in the coco pit. The water in coco pit pH initially at the time of laying it down was 6.5. The second sensor used is Luminous Intensity Sensor. This sensor monitors the amount of luminescence around the setup. The third sensor is Humidity sensor, this sensor monitors the humidity in the surroundings of the setup. Next sensor used was temperature sensor, this sensor monitors the temperature of the surroundings. The fifth sensor used was soil moisture sensor, this sensor measured the amount of moisture in coco pit throughout the experiment. The final sensor used is water level sensor, this sensor measures the amount of water provided to the system daily. The seeds used were coriander seeds as they take less time to grow which afforded us a chance to cross verify the results by repeating the experiment.

Figure 5:Architecture Diagram

In the present fast pace world, the form of hydroponic farming is taking over. The ongoing research paved new ways and paths for a better and substantial way of farming. Noticing the ways and researching the present trends, mainly followed in metropolitan cities and technologically advanced countries makes lives a lot easier in terms of hydroponic farming.The work done by us addresses the key issues of automation and IoT integration into the way of sustainable farming in constraints such as limited water supply and space.

Water-Level Sensor : A water-level sensor is a device used in the detection of the water level. Maintaining Water level helps the root absorb correct amount of water and makes sure that the plant doesn't gets spoiled.

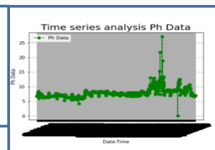
pH Sensor : Optimal pH levels are critical to healthy plants and high yields in both soil and hydroponics gardening. Maintaining those optimal levels, especially in soilless growing systems, calls for frequent, accurate pH testing. Ideal pH levels maximize a plant's nutrient uptake. Those nutrients, in turn, increase a plant's vigor and productivity.

Soil Moisture Sensor : This soil moisture sensor can be used to detect the moisture of soil or judge if there is water around the sensor, let's you know if the plants in the mesh pot require water or not. The units used in calculating is bars.

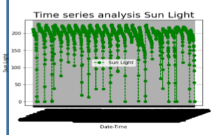
DHT22 Temperature/Humidity Sensor : The DHT22 is a humidity and temperature sensor with a single wire digital interface. The sensor is calibrated so you can get right to measuring relative humidity and temperature.

Luminous Intensity Sensor : Helps to capture the amount of sunlight hitting the product

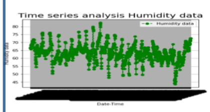
Results



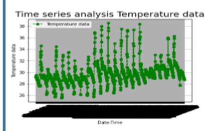
The minimum value recorded is 5.5 on the ph scale and this was recorded during the Initial phase of the experiment. The maximum recorded is 13 and it was recorded during the growth phase due to the addition of mineral water to the water supply, it became more basic. After the growth phase we supplied general water again so, the pH dropped gradually making it more neutral.
Ideally the crop grows in soil's with a PH value of 7-8 which has been followed in the hydroponic system.



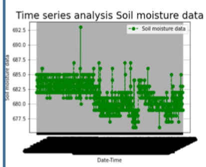
The least recorded is Zero as during the night, it is made sure that the experimental setup is not exposed to any form of light energy.
The highest value recorded is around 250 candela during the day.
The recorded values only account for the amount of sunlight received by the crop.
Ideally the crops grown in field receives sunlight from 225-250 candela which has been the case for an hydroponic system as well.



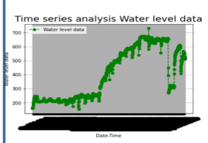
The humidity in the surroundings of the setup.
As the experiment setup was in a coastal city, the humidity is relatively high but is under the normal humidity levels for the city.
The lowest recoded is 45% and the highest is around 80%.
To make sure that the humidity level doesn't go overboard, we conducted the experiment during early summer.



The temperature kept on raising during the experiment gradually.
The lowest recoded temperature was 26 degree Celsius and highest was 36 degree Celsius.
The lowest average temperature was during the initial phase and the highest average was during the harvesting phase.
The ideal temperature for crops the grow is 28-32 degrees which has been mostly observed in our system.



During the initial phase the moisture level was between 682-686.
The moisture level was highest during the growth phase which ranges between 680-692.
The moisture level during the harvest phase is lowest in terms of average, its range varies from 676-680.
Soil moisture is normally very high in a hydroponic system and even with high temperature the coco pit was able to retain moisture and keep the soil moisture constant throughout the growth of the crop.



The water level gradually increases till the growth phase and decreases there on.
The water level during the initial phase was between 160 and 240ml, during growth phase it is between 200ml and 650ml.
During the harvest phase, the water level required is low , it ranges from 200-500ml.
The trends were similar to crops grown in fields hence it will be ideal for plants to grow easily In a city based hydroponic system.

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=23.667 MASE=1574.28 RMSE=39.67 R2=-0.0871	MAE=3.77 MASE=26.197 RMSE=5.118 R2= 0.0070	MAE=1.162 MASE=3.1117 RMSE=1.764 R2=0.0277	MAE=1.375 MASE=3.4744 RMSE=1.863 R2=0.2968	MAE= 70.152 MASE=13362.83 RMSE=115.597 R2=0.589
SUNLIGHT	MAE=1.0190 MASE=2.469 RMSE=1.571 R2= -0.1476	X	MAE=3.674 MASE=22.97 RMSE=4.7930 R2=0.171	MAE=1.0661 MASE=2.232 RMSE=1.494 R2=0.2434	MAE=1.857 MASE=5.101 RMSE=2.258 R2=-0.155	MAE=163.11 MASE=34396.27 RMSE=185.46 R2=-0.0659
HUMIDITY	MAE=1.032 MASE=1.956 RMSE=1.398 R2=-0.219	MAE=22.217 MASE=1540.602 RMSE=39.250 R2=0.1037	X	MAE=0.961 MASE=1.620 RMSE=1.272 R2=0.3378	MAE=1.906 MASE=5.624 RMSE=2.371 R2= -0.1596	MAE=162.59 MASE=36533.3 RMSE=191.13 R2=-0.152
TEMPERATURE	MAE=0.911 MASE=1.703 RMSE=1.305 R2=0.11710	MAE=17.664 MASE=1005.81 RMSE=31.714 R2=0.0440	MAE=3.0675 MASE=16.238 RMSE=4.0296 R2=0.3001	X	MAE=1.650 MASE=4.224 RMSE=2.055 R2=0.0587	MAE=147.269 MASE=29019.5 RMSE=170.351 R2=0.1299
SOILMOISTURE	MAE=0.9751 MASE=2.7447 RMSE=1.656 R2=0.0873	MAE=20.854 MASE=1216.04 RMSE=34.87 R2=0.00587	MAE=3.995 MASE=28.318 RMSE=5.321 R2= -0.0553	MAE=1.0834 MASE=2.619 RMSE=1.618 R2=0.109	X	MAE=112.74 MASE=20885.92 RMSE=144.519 R2= 0.3583
WATER LEVEL	MAE= 0.706 MASE=1.328 RMSE=1.152 R2=0.210	MAE=23.019 MASE=1913.38 RMSE=43.74 R2=0.0553	MAE=3.665 MASE=25.972 RMSE=5.096 R2=0.0735	MAE=1.1366 MASE=3.302 RMSE=1.8172 R2=-0.2404	MAE=1.253 MASE=2.836 RMSE=1.684 R2=0.4258	X

Decision Tree Regression Between Parameters for Full Phase of Coriander Plant Growth

From Table , it can be inferred that water level and pH are the most corelated parameters in the full phase analysis of the experiment as MAE=0.706. This means, with a given water level, we can predict the pH required for a good yield.
The parameters that cannot be corelated are water level and sunlight as the MAE=163.11, this means that the value of Water level cannot be predicted with a given luminous intensity.

Conclusion

In conclusion, our whole work can be split into two main part. The first one being the growth of plants and creation of data set, in this we have grown the crops and taken the data with the help of sensors. In this aspect, there is minimal automation. The dataset is then created by taking the data and cleaning it to make sure that the anomalies are removed. With the help of this data set, we then move onto the second phase of the work. The second phase of this work is processing of the data set created and corelating the data to establish the best scenario for plant growth and good yield. With the help of Linear Regression, Support vector regression and Decision Tree Regression, we have established the parameters which are best corelated.

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