CREATING A MACHINE LEARNING BASED PREDICTION ALGORITHM FOR PREDICTING THE AMOUNT OF WATER RESOURCE REQUIRED FOR A HYDROPONICS SYSTEM

[1] PRAWIN RAJA.E , [2] RAGAVI.E, [3] V.R.KAVITHA
Department of Computer Science and Engineering,
Prathyusha Engineering College
Aranvoyal Kuppam,
Thiruvallur - Poonamalle Road,
Thiruvallur, Tamil Nadu, India-602025

Abstract: In this exponentially increasing population and decreasing productive agriculture land, the need for sustainable food security is at highest priority. Hydroponics is the system of growing plants without soil, on a water medium with air, light and nutrients. In this thesis the sensors like temperature, humidity, pH, luminosity and water pump are introduced to the hydroponics system. Theses sensors measure, collect and store the appropriate values to the database. This collected data is used in a supervised machine learning time series analysis and forecasting based ARIMA (Autoregressive Integrated Moving Average) model to predict the amount of water resource needed for the hydroponics system for the next seven days.

***Index Terms* - IOT, Hydroponics, Machine Learning, Supervised Learning, Time Series, ARIMA**

I. INTRODUCTION

Humans require air, food, water, and living space in order to survive. These things are not endless in nature and thus humans are dependent upon the optimization of land area and the preservation of biodiversity. The human population is increasing and predicted to expand from 7.0 billion to 9.5 billion people within the next 40 years (Sahara Forest Project, 2009). An ever increasing demand for food species is implied, and it is estimated that food production will have to be doubled in order to compensate and provide availability to all.

The word "Hydroponic" defines as any means to grow plants via a medium that does not include the use of soil but involves inorganic nutrients or nutrient solution. Gericke who described methods of growing plants in liquid media (nutrient solution) introduced the term Hydroponics. Besides Gericke, many attempts were made to adopt the methods of soilless growing plants during thirties. However, technological progress was too inadequate due to insufficient knowledge about the nutrients and high cost involved in the process. Despite of all, countries like USA and others were keen to adopt this technology so that growing plants indoors without the favorable soil required as well as controlling the nutrient is possible.

One of the basic principles for vegetable production, both in soil and in hydroponic systems, is to provide all the nutrients the plant needs. Several chemical elements are essential for growth and production of plants, in sixteen elements: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, manganese, iron, zinc, boron, copper, molybdenum and chlorine. Among the elements mentioned above, there is a division according to their origin: organic, C, H, O and minerals; broken down into macronutrients, N, P, K, Ca, Mg, S, and micronutrients, Mn, Fe, B, Zn, Cu, Mo, Ni, Cl (Malavolta, 2006). In hydroponic crops, absorption is usually proportional to the concentration of nutrients in the solution near the roots, being much influenced by environmental factors such as salinity, oxygenation, temperature, pH and conductivity of nutrient solution, light intensity, photoperiod and air humidity.

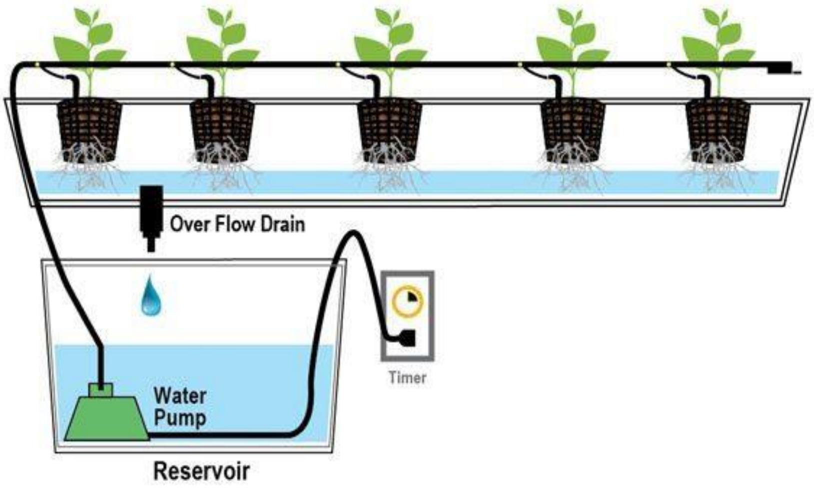

Fig 1.1 Model Hydroponics System

In this hydroponics system we have created an IOT system to collect and monitor the usage of resources like water, humidity, temperature and luminosity. And with the help of this data, a machine learning algorithm can be created to predict the amount of water resource needed for the upcoming week

II. Literature Survey

[1]**Chavan Akshay, Pawar Abhijeet, Wagh Pratik and Prof. Lalita Wani have published ISSN: 2320-9801, "IOT BASED HYDROPONIC SYSTEM" on International Journal of Innovative Research in Computer and Communication Engineering, Volume 5, Issue 4, Page 8286-8290, April 2017.**

In this paper they have successfully grown lettuce, fenugreek and spinach in hydroponics system by managing the water flow into the hydroponics using the data from the sensors of temperature, humidity, and water level sensor. They have also created an IOT module to view the current values of the sensors. But the data collected and viewed in the network is not stored. There is no estimation of the amount of water spend. There is no prediction system for the necessity of resources in the future.

[2]Ms.S.Charumathi, Ms.R.M.Kaviya, Ms.J.Kumariyarasi, Ms.R.Manisha and Mrs.P.Dhivya have published ISSN: 2455-9288,"OPTIMIZATION AND CONTROL OF HYDROPONICS AGRICULTURE USING IOT" on International Journal of Advanced Science and Engineering Research Volume 2, Issue: 1, Page 650-654, April 2017.

In this paper they have created a hydroponics system and have added the sensors like temperature sensor, Humidity sensor, ph sensor and Light sensor. They have also added a water spray system. The data collected from the sensors are sent to the computer through IOT system on the hydroponics. A graph of changing values are shown and the controls are given on the web module for the user to turn ON/OFF the air pump, water pump and light. So, in this model there is ample data collection happening but the data is not put use in its best condition. Though there is pumps of water, air and light source for creating suitable condition, at the end of the day the controls are manual and left with the user. And there is no prediction for the resource requirement for the future.

[3]Shreya Tembe, Sahar Khan, and Rujuta Acharekar have published ISSN 2229-5518 "IOT BASED AUTOMATED HYDROPONICS SYSTEM", on International Journal of Scientific & Engineering Research, Volume 9, Issue 2, Page 67-70, February 2018.

In this paper they have tested the hydroponics system with varying light bulbs with varying bulb colors. And they found that LED lights are best suited for growing the Hydroponics plant. In LED light the colors of RED and BLUE have helped the plant to grow optimally. They have derived this by collecting and monitoring data from the sensors of temperature, humidity, luminosity and pH. Though they have derived the optimal light source for grow there is no real time data collection and water management system present. With the added LED system the electrical energy will go up, there is no data regarding the time and amount of energy the system have consumed.

[4]Rahul Nalwade and Tushar Mote have published " HYDROPONICS FARMING" on International Conference on Trends in Electronics and Informatics, page 645-650, May 2017.

In this paper they have created a hydroponics system with all the common sensors like temperature, humidity and pH sensor. All the sensor data are passed onto the Arduino IDE and viewed for any unhealthy condition in the sensor values. And an SMS alert was set to inform the user about the uncertainty. There is data viewing option but that data is not stored on the system. There is automated water supply system but the amount of water spent is not calculated. There is no prediction system created thus the valuable data is not fully utilized.

III. Proposed System

In the proposed system, the hydroponics system will be connected with sensors like temperature sensor, water pH sensor, humidity sensor and luminosity sensor. All the data from these sensors are sent to the database using Wi-Fi module of Arduino Uno. By analyzing this collected data, a supervised machine learning using time series analysis and forecasting based ARIMA model would be created to predict the requirement of water and electrical energy needed for the hydroponics for the next week.

Architecture of Proposed System

IV. Module Description

1. Creating a Database of sensor values

The hydroponics system that has been created as shown in Fig 1.1 is fitted with the sensors like the Temperature sensor, pH sensor, Luminosity sensor, Humidity sensor and Water Pump ON/OFF. An Arduino Uno is used for collecting the data from the sensors fixed in the hydroponics system. This Arduino Uno is used because it is fixed with an in-built Wi-Fi module. Using the Wi-Fi module the Arduino sends the data collected from the sensor to the database created in the computer.

date	ph	waterleve	temperatu	humidity	mit
01-12-2018	10.23	23	45.5	210	185
02-12-2018	10.23	21	43	214	310
03-12-2018	10.23	23.66667	46	210.6667	1496
04-12-2018	10.23	30	82	78	303
05-12-2018	10.23	31	41.3	170	555
06-12-2018	10.23	31	41.9	160	456
07-12-2018	10.23	33	41.5	200	448
08-12-2018	10.23	34	41.2	210	702
09-12-2018	10.23	31	40.8	220	526
10-12-2018	10.23	32	40.8	222	1545
11-12-2018	7	29	40.9	225	567
12-12-2018	7	28	41	210	577
13-12-2018	6	31	41.5	200	400
14-12-2018	7	29	41.8	196	200
15-12-2018	8	28	41.4	188	300
16-12-2018	6	29	42	200	200
17-12-2018	6	29	41	210	123

2. Time Series Analysis and Forecasting ARIMA model

ARIMA is a word form that stands for Auto Regressive Integrated Moving Average. It is a generalization of the simpler Auto Regressive Moving Average and adds the notion of integration.

This acronym is descriptive, capturing the key aspects of the model itself. Briefly, they are:
• AR: Auto Regression. A model that uses the dependent relationship between an observation and a few variety of lagged observations.
• I: Integrated. The use of differencing of raw observations (e.g. subtracting an observation from an observation at the previous time step) in order to make the time series stationary.
• MA: Moving Average.
A model that uses the dependency between an observation and a residual error from a moving average model applied to lagged observations.
Each of these components are explicitly specified in the model as a parameter.
A standard notation is employed of ARIMA (p,d,q) where the parameters are substituted with integer values to quickly indicate the specific ARIMA model being used.

The parameters of the ARIMA model square measure outlined as follows:

• p: The number of lag observations included in the model, also called the lag order.
• d: The number of times that the raw observations are differenced, also called the degree of differencing.
• q: The size of the moving average window, also called the order of moving average.
A linear regression model is constructed including the specified number and type of terms, and the data is prepared by a degree of differencing in order to make it stationary, i.e.
to remove trend and seasonal structures that negatively have an effect onthe regression model.

In Python the stats models library provides the capability to fit an ARIMA model. An ARIMA model can be created using the stats models library as follows: 1. Define the model by calling ARIMA () and passing in the p, d, and q parameters. 2. The model is prepared on the training data by calling the fit () function. 3. Predictions can be made by calling the predict () function and specifying the index of the time or times to be predicted.

In this project the ARIMA has been implemented as shown in the below code.

agri_predict.py - C:\Users\PrawinRaja\Desktop\New folder (2)\Agri\agri_predict.p...

File Edit Format Run Options Window Help

```
from statsmodels.tsa.arima_model import ARIMA
from pytz import timezone
from dateutil import parser


def parser(x):
        return datetime.strptime(x, '%d-%m-%Y')

series=read_csv("agrinew2.csv",header=0, parse_dates=[0], index_col=0, squeeze=T

res=series.mit
series['mit'].plot()
plt.show()

X = series.values
size = int(len(X) * 0.66)

predictions = list()

PREDICT_DURATION=7
for t in range(1):
        a1=series.mit.astype('float64')
        model = ARIMA(a1, order=(0, 1,0))
        model_fit = model.fit(disp=1)
        output = model_fit.forecast(steps=PREDICT_DURATION)
        yhat = output[0]
        predictions.append(yhat)
```

V. Result and Discussion

The Fig 6.1 graph shows the supervised learning of the pre-processed data. The Horizontal line represents the calendar date and the vertical line represents the micro-liter measurements of water.

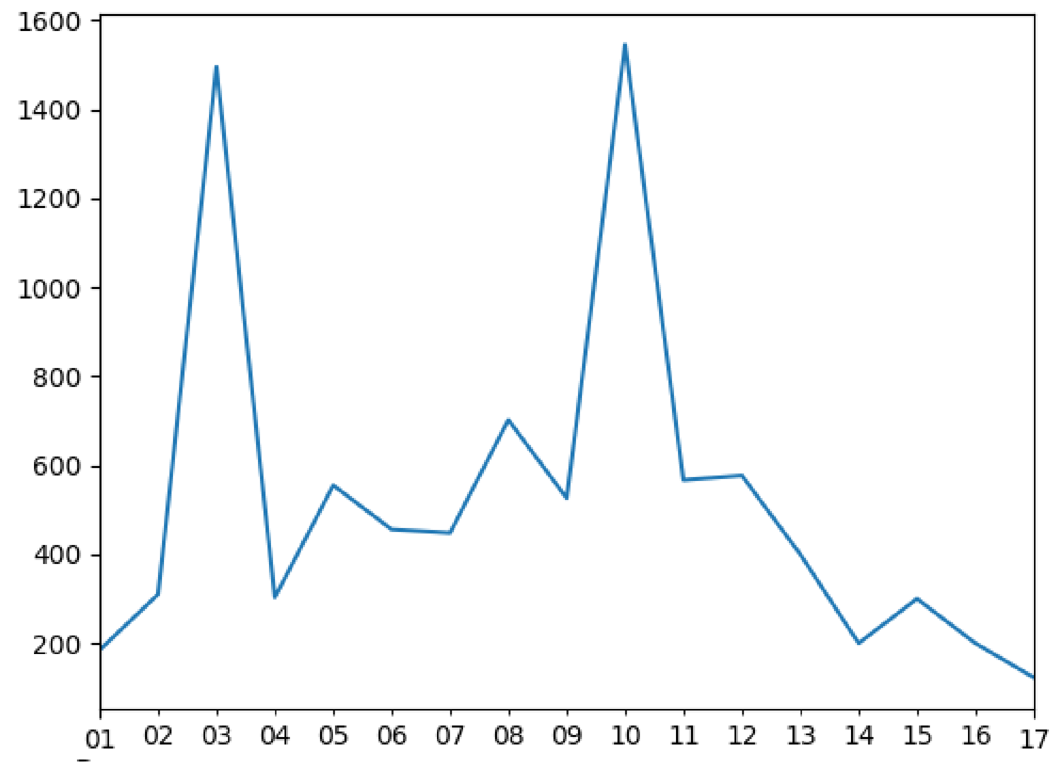

Fig 6.1 Learning Result

The Fig 6.2 shows the prediction made by the time series forecasting ARIMA model.

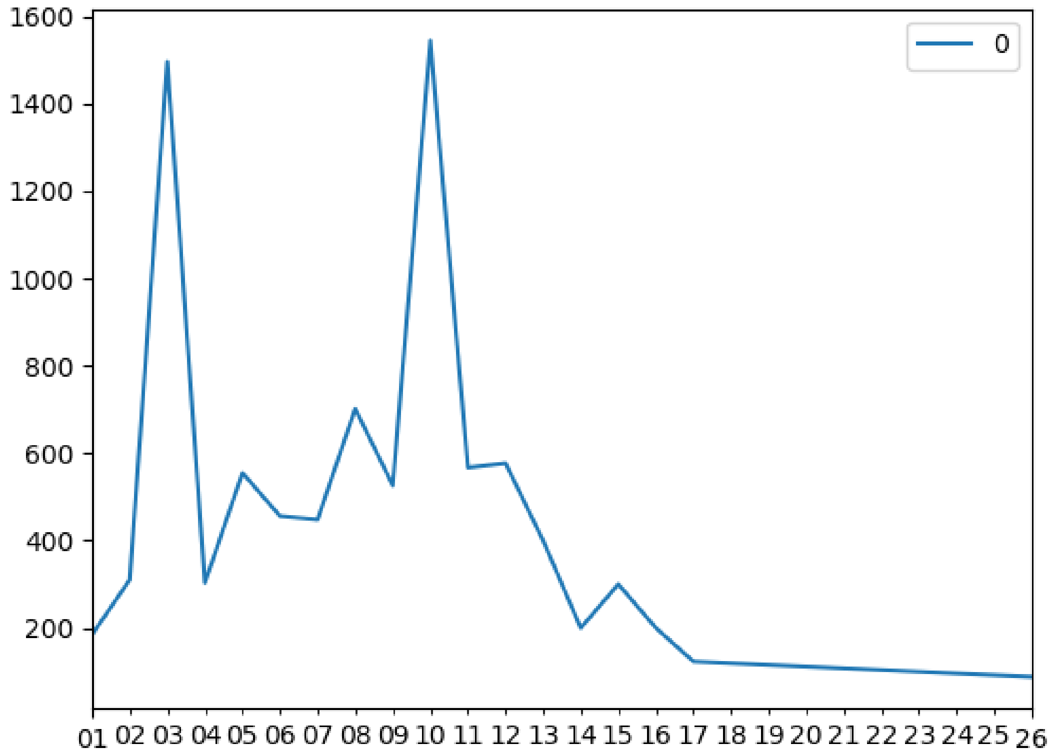

Fig 6.2 Prediction Result

The obtained output graph Fig 6.2 shows us the prediction trend. By viewing the trend of the graph we can come to the conclusion that there is a decreasing trend of water usage. For the upcoming week only < 200 micro liter of water per day is needed for the hydroponics plant.

VI. Conclusion and Future Enhancement

With the reducing productive land area and ever increasing population, Hydroponics is one of the hopeful method for sustainable food production. So there is a need to innovate and increase the efficiency of the system. As a future enhancement, an image processing technology can be added to monitor the growth of the plant. Also machine learning can be done to this image technology for detecting abnormalities of pest and disease affected on the parts of the plant.

VII. References

[1]Chavan Akshay, Pawar Abhijeet, Wagh Pratik and Prof. Lalita Wani have published ISSN: 2320-9801, “IOT BASED HYDROPONIC SYSTEM” on International Journal of Innovative Research in Computer and Communication Engineering,Volume 5, Issue 4, Page 8286-8290, April 2017.

[2]Ms.S.Charumathi, Ms.R.M.Kaviya, Ms.J.Kumariyarasi, Ms.R.Manisha and Mrs.P.Dhivya have published ISSN: 2455-9288, “OPTIMIZATION AND CONTROL OF HYDROPONICS AGRICULTURE USING IOT” on International Journal of Advanced Science and Engineering Research,Volume 2, Issue: 1, Page 650-654, April 2017.

[3]Shreya Tembe, Sahar Khan, and Rujuta Acharekar have published ISSN 2229-5518, “IOT BASED AUTOMATED HYDROPONICS SYSTEM”, on International Journal of Scientific & Engineering Research, Volume 9, Issue 2, Page 67-71, February 2018.

[4]Rahul Nalwade and Tushar Mote have published “HYDROPONICS FARMING” on International Conference on Trends in Electronics and Informatics, Page 645-650, May 2017.