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Smart Hydroponics system integrating with IoT and Machine learning algorithm

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***Abstract*—- As the population increases and natural resources decrease, the ability to serve humanity with a sufficient amount of food becomes increasingly difficult. The amount of agricultural land decreases proportionally to the increasing population, thus the amount of food produced will decrease significantly, and will be insufficient to serve the growing population. The orthodox methods of farming will not suffice in the near future. Thus, using modern technology and resources, a method of efficient farming must be introduced and employed in the agricultural field. This research makes use of an efficient farming method called hydroponics by adopting machine learning algorithms. The system that has been designed and built, is automated, and uses sensor data to make decisions by using KNN and Lasso Regression algorithm to benefit the crops being grown. With our system we hope to solve the potential food crisis and give everyone access to fresh produce all year round.**

Keywords— Hydroponics, IoT, Smart Farming, Automated Agriculture, Soil-less agriculture.

I. INTRODUCTION

Agriculture can be defined as the science or practice of farming for growing crops and rearing animals to produce useful products for humans[1]**.**Due to the exponential increase in population over a small span of time, and the development of several different industries, people started to move from the rural areas where agriculture was practiced to places where these industries were situated in. This led to the formation of cities where other such industries were started, and this phenomenon termed as urbanization led to several people practicing tasks other than agriculture. Due to this, subsistence agriculture was no longer sufficient in supporting the population. This led to the development of industrial agriculture, where farmers who lived in the rural areas grew and harvested surplus crops not only to support themselves but also to support the urban population who had other means of livelihood. Thus, the agriculture industry developed and is now considered as the backbone for the economy[2] of a country. Our motivation lies in improving the yield and quality of agricultural produce through the use of modern technology and research. Orthodox farming only allows limited control in the environment and conditions where the crops are produced. Due to the presence of pests, it is necessary to use pesticides and other chemicals to ensure that the crops aren't compromised during their growth, but these chemicals have been shown to have detrimental effects on their consumers. Modern research has shown that the production of crops can be exponentially increased by providing the optimum conditions and essential nutrients, which differs for each type of crop. Seasonal crops that can only be grown during a particular time of the year can now be grown at any time. It has been shown that storing produce over a long period of time leads to a loss in the nutritional value of the food.

A. Hydroponics

Hydroponics is a subset of hydroculture, which is the growing of plants in a soil less medium, or an aquatic based environment. Hydroponic growing uses mineral nutrient solutions to feed the plants in water, without soil[3].

B. Machine learning Algorithms

Machine learning algorithms make the decision based on the predefined data set values. In this paper used KNN and LASSO regression algorithm because KNN is a non-parametric algorithm, which means it does not make any assumption on underlying data. In LASSO regression, Regression analysis deals with two main problems namely, parameter estimation and variable selection. Parameter estimation is commonly carried out using OLS regression estimation method. Variable selection is yet another crucial part in regression analysis[4].

II. PROPOSED SYTEM

This paper full fill the bridge gap between controlled environment agriculture, IoT(Internet of Things), Computer Vision and Machine Learning. The intended outcome of this work is to develop a product for plant analysis that can be adapted to a wide range of products like small personal devices to large scale farms enabling the possibility to accurately measure the growth and physical traits of the plant.

In this paper implemented using the concept of hydroponics[3] where water will be used to grow plants inside our system. hydroponic farming, a method of growing crops directly in water without the soil medium, providing required nutrients to the plants directly through the nutrient solution. The advantage of implementing hydroponic farming is that it uses 90 percent less water when compared to normal farming.

The quality and yield of the crops grown in our system are maximized by providing the scientifically proven climatic conditions and nutrients depending upon the crop which is to be grown. In other words, we plan to provide end to end control of the environmental conditions to produce the maximum possible yield and grow high quality, nutritious produce which is pesticide free.

The proposed system develops the crops a controlled environment where the yield and the quality is maximized while consuming considerably fewer natural resources and ensuring the consumer is completely made aware of what he is consuming.

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III. DEVELOPING A MODEL

The system is going to implement the above objectives, we planned to build a small grow-box with the prime purpose of building an Operating System which completely automates the process of farming Our aim is to tap into the consumer market by building small grow-boxes affordable for people to grow their own high-quality crops. We also plan to design a large-scale hydroponic system with the sole purpose of democratizing the access to fresh food for all the people, which in turn leads to revamping the entire fresh food supply chain.

IV. METHODOLOGY

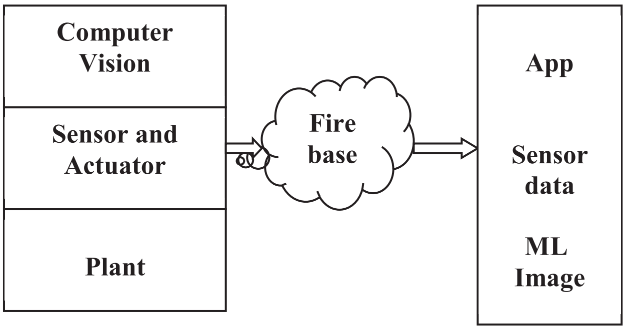

Figure 1 System Architecture

- Data reading and collection of real time data based on which the environment for the plant growth will be controlled.
- Analysis of the plant image using the OpenCV algorithm to determine the plant growth.
- Display of the data to the user through the Mobile Application.

The Software Development Life Cycle (SDLC) methodology adopted in due course of this paper development is AGILE methodology. It is a fast-paced process where in it promotes the continuous integration of development and testing throughout the software development lifecycle of the project. The Waterfall model develops the both model. It allows the teams to break the lengthy requirements, build, and test phases down into smaller segments, ultimately delivering working software quickly and more frequently.

The typical iteration process flow can be visualized by following way

a. **Requirements** - Define the requirements for the iteration based on the product backlog, sprint backlog, customer and stakeholder feedback

b. **Development** - Design and develop software based on defined requirements

c. **Testing** - QA (Quality Assurance) testing, internal and external training, documentation development

d. **Delivery** - Integrate and deliver the working iteration into production

e. **Feedback** - Accept customer and stakeholder feedback and work it into the requirements of the next iteration

For the duration of the product, while additional features may be fed into the product backlog, the rest of the process is a matter of repeating the steps over and over until all of the items in the product backlog have been fulfilled. As a result, the process flow is more of a loop and not a linear process.[4]

a. The agile software development emphasizes on four core values.
b. Individual and team interactions over processes and tools
c. Working software over comprehensive documentation
d. Customer collaboration over contract negotiation
e. Responding to change over following a plan

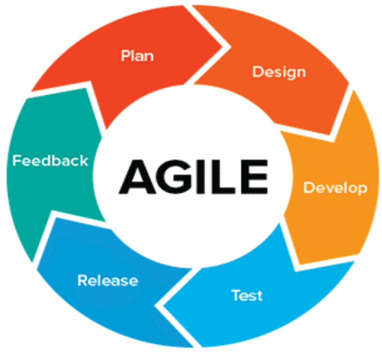

Figure 2 Agile Methodology

A. *Requirements:*

Hardware	Software
Raspberry Pi	Android Studio IDE
Water Temperature sensor	Adobe XD
EC sensor	OpenCV
DHT11 sensor	Anaconda IDE
pH sensor	Raspbian OS
Arduino Uno	Arduino IDE

B. *Machine learning model system design*

The Figure 3 shows the overall machine learning model system design. A front end has been developed where user can enter the input data and press a predict button. The machine learning models like Lasso Regression and KNN[3] are hosted on the flask server. The Training data is given to the machine learning model as a csv file. The data that is inputted by the user is pre-processed and given as input to the model. The model predicts the output i.e. the nutritional value in each plant and the predicted data is sent back to the frontend to be displayed to the user.

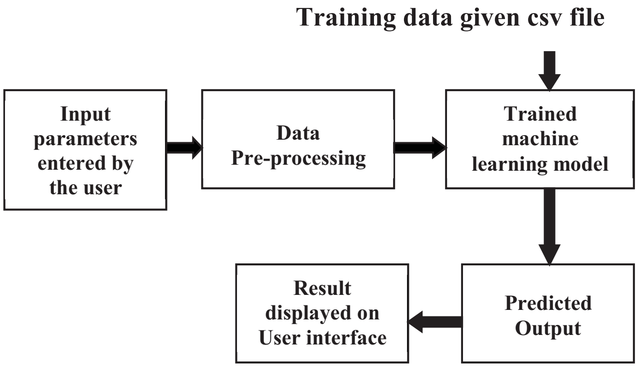

Figure 3. Machine learning model

C. Data Flow Diagram of the System

The Figure 4 depicts the flow of data between modules and how the data is processed and sent to other modules. The user enters his user information to log in to the system. Sensor data is sent to the system. This sensor data is sent to the sensor call-back, where the data is then sent to the actuator's module and area detection module. These 2 modules then send the data to the database, where it can be sent to the user for viewing. Machine learning is done on the data and analysis results are obtained. Multiple leaf detection[5] model gives the desired output depending the given input.

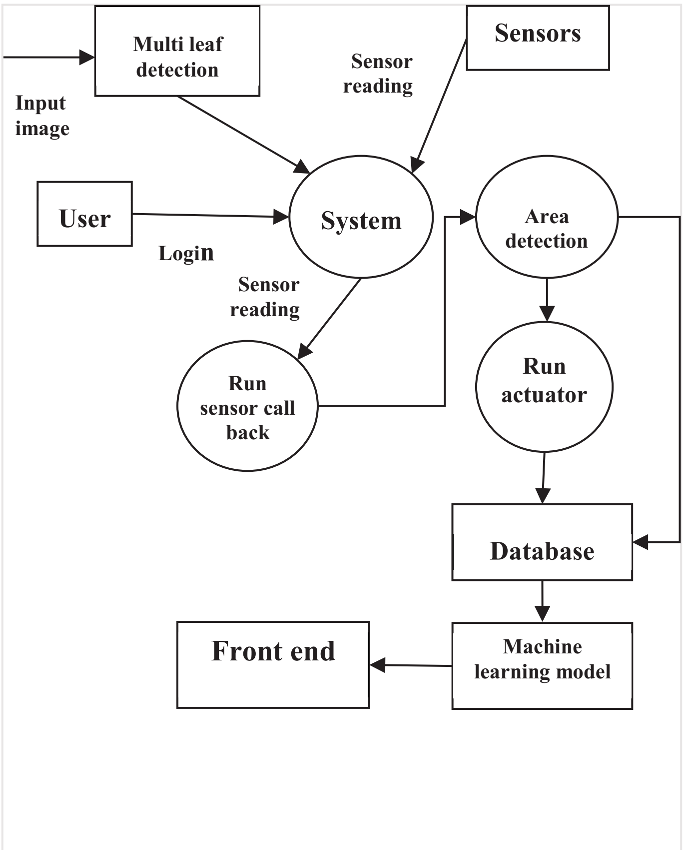

Figure 4.Data Flow Diagram

D. Sequence Diagram of the system

The Figure 5 describes the sequential procedure followed by the software to run the system. The user either logs in or registers to enter the user interface. Once in the user interface,

The system is started. The sensor data is read and fed to the sensor action module. The necessary actions are taken and the data is sent to the database. The picture is read and the growth progress information is determined and sent to the database. The user can view the data from the database. Machine learning is done on the data in the database and the analysis can be viewed by the user. User can also give input the multiple leaf detection model and get the desired results. The above design description has discussed how the software units are arranged and interact with each other to perform the required operations. Using the design, the complexities involved in building the system were simplified and easily done. Hence a good design document is always helpful in building a system.

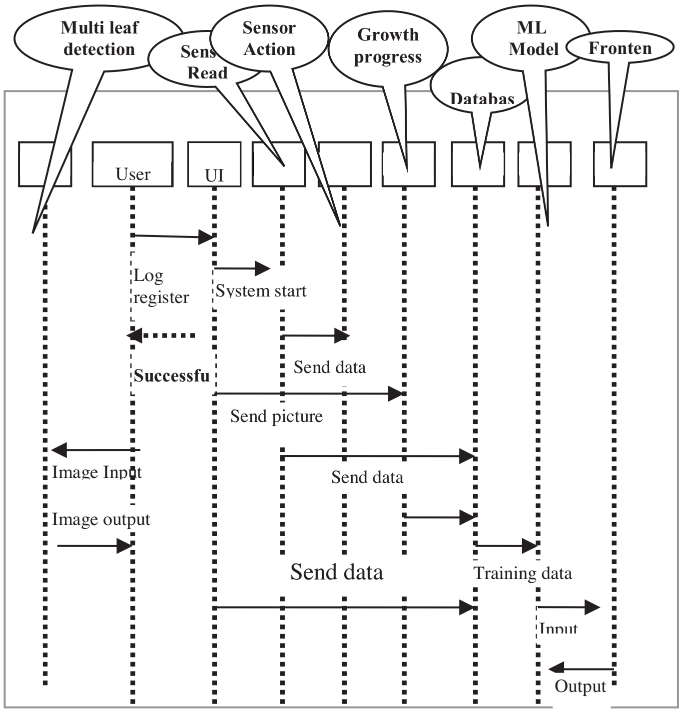

Figure 5 Sequence Diagram

V. Result

As the plant grows based on the KNN and LASSO regression algorithm the plant growth rapidly based on the requirement for the plant. The figure 6 shows the OpenCV Result. In figure 7 shows the Represents the predicted result given by the lasso regression model. The test data is given as a csv file as an input. The test data contains the EC, Ph and Water temperature as the dependent variables, the predicted variables i.e. the nutrients in the plant is given as the output i.e. tissue_% , tissue_% etc. as the output. In figure 8 is the front end for displaying the results of the machine learning model. The input data is entered and sent to the flask backend which hosts the machine learning trained models. For the given input the output is predicted and sent to the frontend to be displayed to the user. Figure 9 and figure 10 is show the information about the plant being grown. It also shows the point in time sensor data that is retrieved from the firebase. The figure 9&10 also shows the information about the plant and also its growth progress.

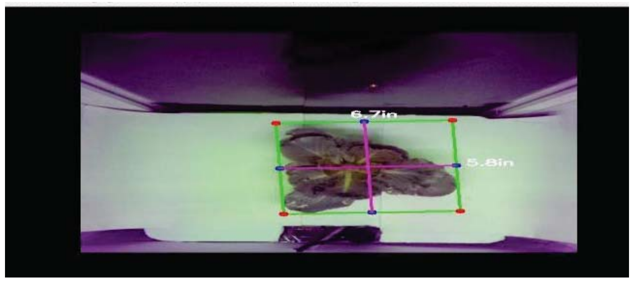

Figure 6 Open CV Result

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In [9]: data_rep2
Out[9]:
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	EC	h2o_temp_C	pH	tissue_N_%	tissue_P_%	tissue_K_%	tissue_Ca_%	tissue_Mg_%	tissue_Fe_ppm	tissue_Mn_ppm	tissue_B_ppm
0	1.996	25.47	5.988	5.65	0.887	5.947	2.096	0.714	76.959404	156.448131	45.175674

Figure 7 Prediction of Lasso Regression Model

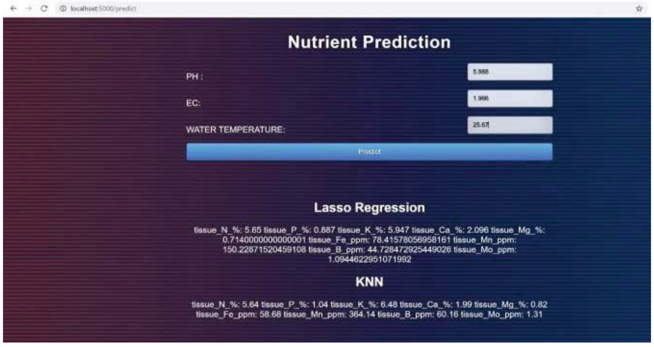

Figure 8 Frontend displaying result of Lasso Regression and KNN Model

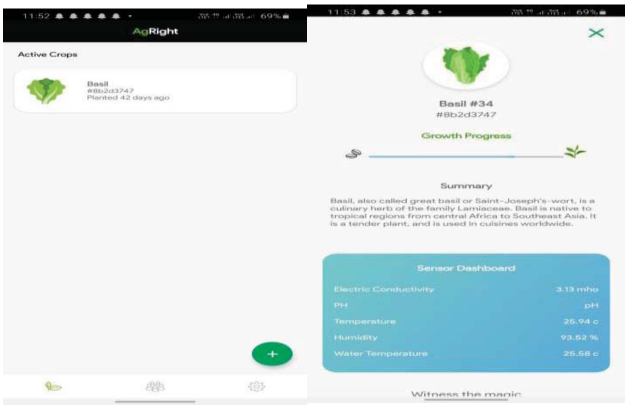

Figure 9 Screenshots of the app

VI. CONCLUSION

We hereby developed a product for plant analysis that can be adapted to a wide range of products like small personal devices to large scale farms enabling the possibility to accurately measure the growth and physical traits of the plant. By using hydroponic farming 90 percent less water is used when compared to normal farming. The quality and yield of the crops grown in our system are maximized by providing the scientifically proven climatic conditions and nutrients depending upon the crop which is to be grown. Considerably fewer natural resources are consumed.

REFERENCE

[1] L. Du, "The Application and Research of Developing Leisure and Sightseeing Agriculture Based on the Perspective of Multifunctional Agriculture," *Proc. - 10th Int. Conf. Meas. Technol. Mechatronics Autom. ICMTMA 2018*, vol. 2018-Janua, pp. 463–467, 2018, doi: 10.1109/ICMTMA.2018.00118.

[2] J. Zhang, X. Qu, and A. K. Sangaiah, "A Study of Green Development Mode and Total Factor Productivity of the Food Industry Based on the Industrial Internet of Things," *IEEE Commun. Mag.*, vol. 56, no. 5, pp. 72–78, 2018, doi: 10.1109/MCOM.2018.1700789.

[3] C. J. G. Aliac and E. Maravillas, "IOT hydroponics management system," *2018 IEEE 10th Int. Conf. Humanoid, Nanotechnology, Inf. Technol. Commun. Control. Environ. Manag. HNICEM 2018*, pp. 1–5, 2019, doi: 10.1109/HNICEM.2018.8666372.

[4] A. P. Salim, K. A. Laksitowening, and I. Asror, "Time Series Prediction on College Graduation Using KNN Algorithm," pp. 1–4, 2020, doi: 10.1109/icoict49345.2020.9166238.

[5] N. M. Yusoff, I. S. Abdul Halim, N. E. Abdullah, and A. A. Ab Rahim, "Real-time hevea leaves diseases identification using sobel edge algorithm on FPGA: A preliminary study," *2018 9th IEEE Control Syst. Grad. Res. Colloquium, ICSGRC 2018 - Proceeding*, no. August, pp. 168–171, 2019, doi: 10.1109/ICSGRC.2018.8657603.

[6] I. B. Mustaffa and S. F. B. M. Khairul, "Identification of fruit size and maturity through fruit images using OpenCV-Python and Rasberry Pi," *Proceeding 2017 Int. Conf. Robot. Autom. Sci. ICORAS 2017*, vol. 2018-March, pp. 1–3, 2018, doi: 10.1109/ICORAS.2017.8308068.

[7] Sardare, Mamta D., and Shraddha V. Admane. "A review on plant without soil-hydroponics." International Journal of Research in Engineering and Technology 2, no. 03 (2013): 299-304

[8] Naik, P. K., B. K. Swain, and N. P. Singh. "Production and utilisation of hydroponics fodder." Indian Journal of Animal Nutrition 32, no. 1 (2015): 1-9.

[9] Kumari, Shalini, Pratibha Pradhan, Ramjeet Yadav, and Santosh Kumar. "Hydroponic techniques: A soilless cultivation in agriculture

[10] Mickens, M. A., E. J. Skoog, L. E. Reese, P. L. Barnwell, L. E. Spencer, G. D. Massa, and R. M. Wheeler. "A strategic approach for investigating light recipes for 'Outredgeous' red romaine lettuce using white and monochromatic LEDs." Life sciences in space research 19 (2018): 53-62

[11] Zabel, Paul, Matthew Bamsey, Daniel Schubert, and Martin Tajmar. "Review and analysis of over 40 years of space plant growth systems." Life sciences in space research 10 (2016): 1-16.

[12] Alipio, Melchizedek I., Allen Earl M. Dela Cruz, Jess David A. Doria, and Rowena Maria S. Fruto. "A smart hydroponics farming system using exact inference in bayesian network." In 2017 IEEE 6th Global Conference on Consumer Electronics (GCCE), pp. 1-5. IEEE, 2017

[13] Suakanto, Sinung, Ventje JL Engel, Maclaurin Hutagalung, and Dina Angela. "Sensor networks data acquisition and task management for decision support of smart farming." In 2016 International Conference on Information Technology Systems and Innovation (ICITSI), pp. 1-5. IEEE, 2016.