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AN AUTOMATED CLIMATE CONTROL SYSTEM FOR GREENHOUSE USING DEEP LEARNING FOR TOMATO CROP

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ABSTRACT-**The agricultural growth or crop growth depends on the climate variables in environment. Due to diseases, there is decreasing in crop growth. An Automated Greenhouse is an important factor in the crop growth of agriculture. We consider the six climate variables for the greenhouse, i.e. Temperature, Humidity, Soil Moisture, CO2 Concentration, Light Intensity and pH scale for Tomato crop. Tomato is an economically the important vegetable crop on the world. The rules and regulation of tomato crop environment and production of the greenhouse are difficult and to minimize these difficulties. For that difficulties to identify a problem first and provide the solution as quickly as possible. The main difficulty in the tomato crop is diseases. The aim of our project is to find out the pathogens of diseases using the climate variables. To finding the impact of climate variable, we use Deep Neural Network System. Because of DNN system shown the outstanding performance compared to traditional machine learning. The Deep Neural Network is used to design system that can be trained and test with high performance.**

Keywords: Greenhouse for Tomato Crop, DNN Classifier, Climate Variables.

I. INTRODUCTION

The agricultural growth or crop growth depends on the climate variables in environment. Due to diseases, there is decreasing in crop growth. The farmers face the problem of crop diseases. So, the determination of reasons behind the unhealthy or diseased plant is important [2]. The solution of the above problem is automated greenhouse. We provide the solution for Tomato crop, because tomato is economically the important vegetable crop of the world [23]. The rules and regulation of tomato crop environment and production of the greenhouse are difficult and to minimize these difficulties. For that difficulties to recognize the problem first and provide the solution as speedily as possible [5]. Tomato crop disease's identification is a critical topic. The aim of our project is to find out the pathogens of diseases using the climate variables and to produce the healthy tomato crop.

The climate control systems automate growth using devices installed in the specific greenhouse with specific tomato crop, which collects sensor data. Most of the advanced commercial climate control systems currently in use contain multiple. Heuristic rules and usually manage hundreds of defining parameters related to weather trajectories and actuators [Base Paper].

The proposed method has a best training performance, faster convergence rate, as well as a best recognition ability than the other model. We used the DNN Models as a controller, because the DNN Models are powerful prediction tools for the relation between the external climatic data and those inside the greenhouse parameters [11]. By using DNN Model to predict the internal Temperature, Humidity of air, Soil Moisture, CO2 Concentration, Light Intensity and pH Scale for Tomato crop with external climatic data in tomato culture.

A. Greenhouse

A Greenhouse has basically one purpose that is to provide and maintain a growing environment that will result in optimum crop production at maximum yield. Greenhouse technology provides a controlled and favorable environment for crop to grow and yield high in all the seasons. Environments can be suitably modified as per the requirements of the crop.

The greenhouses are equipped with a sophisticated device of regulation. Many greenhouses are still controlled manually and require the intervention of the grower [6]. But the Automated Greenhouse climate control system can be used in order to reduce disease infection and to influence plant development in quickly. A Tomato Crop growth in greenhouse is basically determined by the climate variables within the environment like Temperature of air, Humidity of air, Soil Moisture, CO2 Concentration, Light Intensity and pH scale.

B. DNN Classifier

The Deep Neural Network systems have shown outstanding performance compared to traditional machine learning or computer vision algorithms. In DNN, Classifier uses the number of hidden layers, by using the number of hidden layers to increaser the accuracy of the result than other classifier. The DNN Classifier is a more powerful tool. The DNN Classifier is used for training and testing. For our system to multilayer feed-forward deep neural network (DNN) algorithms and back propagation neural network (BPNN) algorithms for training purpose. The BPNN Algorithm is used in our project, because it is ease and strength in execution for large training data set [23]. For those algorithms to require the number of neurons in the input layers, output layers and hidden layers. The number of nodes in the hidden layer is calculated using the Equation [24].

$$N = \frac{(I+O)}{2} + y^{0.5}$$

Where,

N= Number of Nodes in Hidden Layer.

I= Number of Input Parameters.

O= Number of Outputs Parameters.

y= Number of Inputs Pattern in the Training Set.

II.RELETED WORK

A study of existing theories and practices (literature) in the chosen area or domain helps to know about it more deeply. It also helps in identification of gaps or deficiencies in knowledge and in scoping the study by identification of limitations and assumptions. All this helps in framing the problem statement.

The Cañadas, Joaquín, et al authors are demonstrated how fault detection and control functionality can be incorporated into an integrated system using a mature and experienced method, such as rules, as a common design and implementation technology for the cultivated land. To provide an integrated system for climatic growth control incorporating fault detection, control and expert supervision techniques can supplement automated control systems in intensive knowledge tasks where the variables decisively influence crop growth. They use a fuzzy controller for controlling the system in [22nd Feb. 2017] this is a base paper.

The authors describe the crop disease diagnosis is the directory for find out the reason of the crop is unhealthy. This is complex to determine the result of the crop using the history of crop as well as a result of the various examination procedures. By using this information provides the best result, and authors show the diagnostician in [2] [1995] paper.

The authors Fox, R. T. V explained, How to identify crop diseases first? And controlling the crop disease is most effective as well as economically importance to the expert or farmer. It is difficult to show and detect before any effect to a farmer. For that you know the knowledge about the pathogens in details and impact of these pathogens. This information is sufficient for easy to find out the crop diseases. The main aim of [3] this paper is identification and detection of the crop diseases with describe the pathogens in detail.

The author introduced the fault detection and diagnosis in [4] [March 1997] this paper. It was starting from the consideration knowledge based procedure based on analytical and heuristic information. For that fault detection, so many Methods are considered. The fault diagnosis task considers types of the fault with many details like fault size, location and time of detection. The main goal of this paper is early detection and diagnosis with enough time for the other operation, reconfiguration, maintenance or repair. This paper also introduced the basic problems and methods in supervision, fault detection and fault diagnosis.

The authors describe the technique for greenhouse as well as how use with this technique for disease identification. The disease identification is the main aspect of greenhouse technology. In this [5] [2nd May 1997] paper author developed the six vegetable expert system with providing diagnosis and treatment for diseases. To use the system for Mediterranean area with specific crops like Tomato, Cucumber, Bean, Lettuce, Pepper. This expert system is developed during the last decade for the farmer to identify disease with providing diagnosis and treatment for diseases.

Lafont, Frédéric, and J-F. Balmat. Author of [6] [2002] paper, describe the experimental greenhouse system (structure, sensors, etc.), then they propose their method of comparison of the regulators (basic and optimized fuzzy) which we studied in simulation. They use the fuzzy controller for controlling system and fuzzy controlling system is work on numeric data, and these data are converted into a symbolic form through a database is called as fuzzification. Also authors use the input process with Takagi-Sugeno set of rules from the measured data for automatically generate a fuzzy partition. The implementation of the system with decision making and providing the symbolic answer, it must be converted into numerical data is called as defuzzification. Also show the successful result of greenhouse climate using the fuzzy controller.

The author says importance of climate variables using literature and study provide very much information for the greenhouse control. Furthermore, show the relation between greenhouse climate variables, water vapor production and canopy microclimate with step by step the approach. The plant density is a first important parameter to control disease and irrigation system is second important parameter. If the plant density and irrigation system are optimal that time to reduce the risk efficiently in greenhouse. In this [7] [2003] paper authors concentrate on climate parameters and irrigation system for disease control in greenhouse.

In this paper [9] [2007] authors use the fuzzy controller with the optimization algorithms for greenhouse system. By using the fuzzy controller to display a result from the greenhouse. They use the MIMO system for control the efficient approach of greenhouse. To declare the climate variable for greenhouse and show result using the fuzzy controller.

In the previous, paper used the fuzzy control system as a controller for the greenhouse but so many disadvantages of the fuzzy controller. To remove these disadvantages using the Artificial Neural Network (ANN). So, authors use the ANN controller for their project and describe in details [11] [10th Sep 2008] paper. The main advantage of ANN is prediction. The author used the ANN for prediction of the internal parameters in greenhouse during a 7-days period. The author showed the result for prediction of internal climate variables like temperature and humidity using the external climate data for the tomato crop in the semi-arid area of Agadir in Morocco using the Black Box type model on the ANN Methodology.

In this paper [14] [Nov 2015] authors use the Extreme Learning Machine (ELM) algorithm and Kernel Extreme Leaning Machine (KELM). The ELM algorithm. The ELM algorithm is used prediction model for the microclimate variables in greenhouse and KELM algorithm is used for the neural network. The KELM provides the faster training speed as well as global optimal solution for the greenhouse. The ELM model can predict the greenhouse climate variables with high accuracy. That why author used the ELM model for their project and predict the suitable climate variables for greenhouse.

Lu, Yang, et al., authors present the paper for the rice disease identification. For that they use the deep convolution neural network. CNN is one of the techniques from the ANN (Artificial Neural Network). By using the CNN model to get the higher classification ratio. First analysis the structure and the parameter of the CNN. To train the CNN, gradient descent algorithms are applied. Author explained CNN model in the two steps. The first step is to find out the issues of the identification of rice disease. In this [18] [1st July 2017] paper authors recognize 10 common rice diseases, and they proposed method correctly. The result of the proposed model shows that CNNs method can improve the convergence speed as well as obtain the higher recognition accuracy. For this CNN model, authors use the images as input. These images are first converted to sparse-auto encoding and used to learn the features from images. Second they can classify images from a reduced dataset applying convolution and pooling.

Cheng, Xi, et al, authors describe how to develop an agricultural pest identification system based on computer vision technology and how to achieve pest identification with the complex farmland background, a pest identification method is proposed that uses deep residual learning. Compared to support vector machine and traditional BP neural networks, the pest image recognition accuracy with this method is noticeably improved in the complex farmland background; in [19] [18th Aug 2017] paper.

III. CLIMATE VARIABLES OF GREENHOUSE FOR TOMATO CROP

For our project, we are selected 6 climate variable of the greenhouse for Tomato crop, i.e. Temperature of air, Humidity of air, Soil Moisture, CO2 Concentration, Light Intensity and pH scale for Tomato crop.

A. *Temperature and Humidity of Air* [17]

The Air Temperature and humidity are very important environmental elements that must be controlled for healthy tomato crop. For Tomato crop range of Air Temperature is 18 – 28 °C and Air Humidity range between 50% and 70% in vegetative growth. If the temperature is goes on below 18 °C that time we need the heating technology for protecting the tomato crop. And air temperature is goes on the higher than 28 °C that time we need the cooling technology for also protecting the tomato crop.

In case of humidity is high that time to increase the risk of fungal diseases and reduced quality of the tomato crop. To measure the temperature and humidity by temperature sensor and humidity sensor or HUMICAP sensor.

B. *CO2 Concentration [17]*

For the healthy plant, we need the CO2 because the CO2 is used for the photosynthesis. Photosynthesis is the chemical process that uses light energy to convert the CO2 and water into sugar for the tomato crop. The CO2 is depended on the light intensity, and light intensity is control by transparent material of the greenhouse. The standard units CO2

C. *pH Scale* [17]

To measure the pH values by using the pH pens and this pen is directly placed into a sample of large enough to completely immerse the sensor. The ranges of pH values are 0 to 14. These values are classified into three categories, i.e. acidity, alkalinity and neutral. The pH value to the tomato crop is 6 to 7 means that we need the value of pH is slightly acidic or neutral in parts per million. The range of the CO2 is 70 to 85 ppm. To measure the CO2 by CORBOCAP sensor.

D. *Light Intensity*

The range of light intensity for tomato crop is 150 to 270 lx for the greenhouse. The standard unit of light intensity is lux (lx) and footcandle (fc). The light intensity refers to the total amount of light is received into the plant. To measure the light intensity by light intensity sensor. It is converts electrical energy [17].

IV. PROPOSED CLASSIFIER FOR AUTOMATED MONITORING

The climate variables are important factors for the greenhouse. By using the greenhouse to control the climate variables. And use of this to decrease the diseases and increase the quality and quantity of the crop. Now days so many greenhouses are working manually, but it is difficult to handle. That why we design the automated greenhouse. For automation, we consider the number of sensors. By using these sensors to collect the data for the processing.

The goal of our work is to demonstrate the control of functionality can be incorporated into an integrated system using a mature and experienced method, such as rules, as a common design and implementation technology.

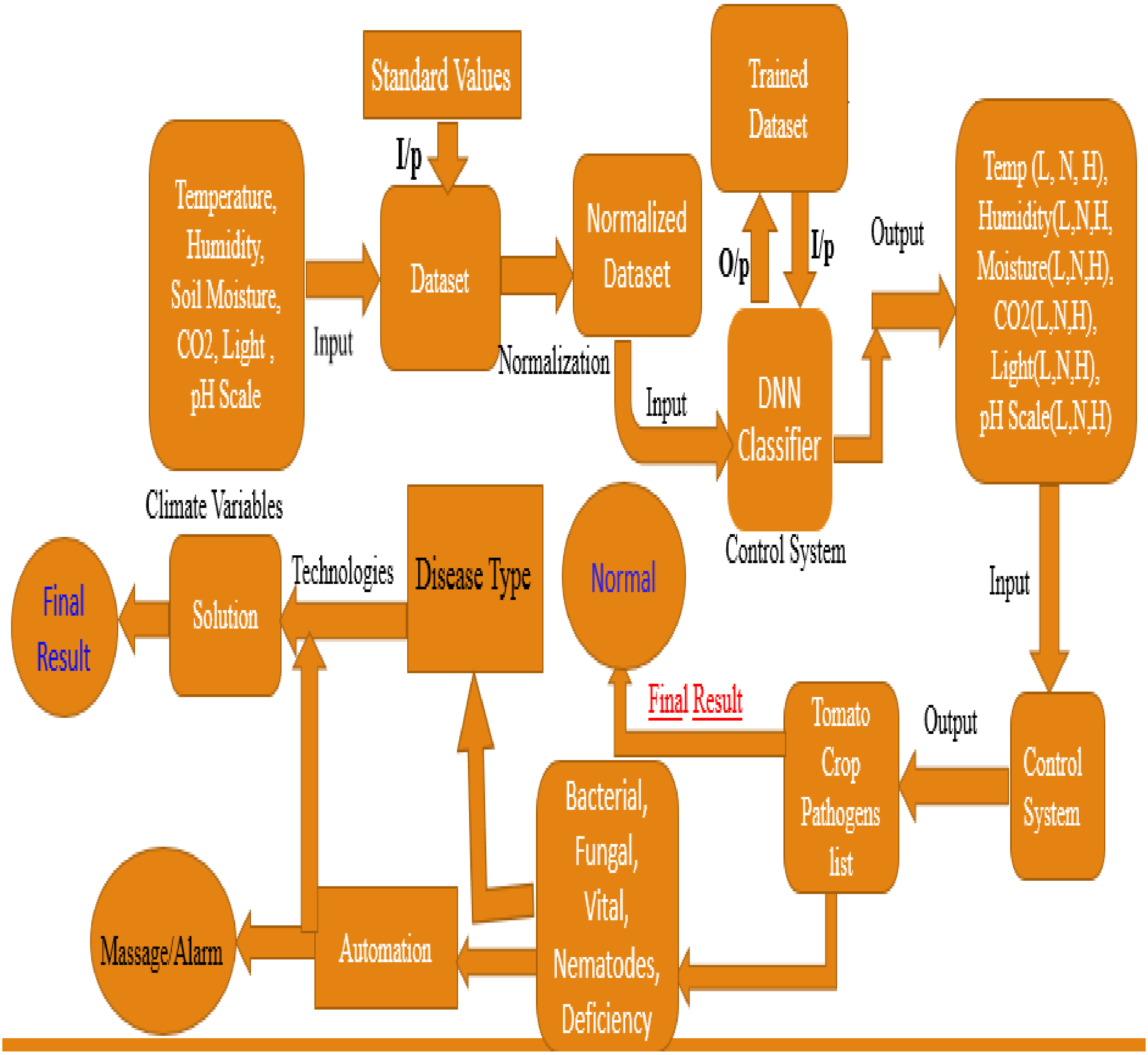

Fig. 1 Architecture of Project.

V. LITERATURE SURVEY

Author Name and Date of Publication	Title Name	Problem
[1] A. Dariouchy, E. Aassif, K. Lekouch, L. Bouirden, G. Maze. **10 September 2008.**	"Prediction of the intern parameters tomato greenhouse in a semi-arid area using a time-series model of artificial neural networks."	To predict internal temperature and moisture inside the greenhouse starting from external climate data using ANN. For Tomato Crop.

[2] David L. Ehret, Bernard D. Hill, Tom Helmer, Diane R. Edwards**. 29 July 2011.**	"Neural network modeling of greenhouse tomato yield, growth and water use from automated crop monitoring data."	To determine the crop response to changes in greenhouse environment with environment parameters like Temperature, Humidity and most important is CO2. These model is based on the physiological processes.
[3] Dawei Li 1, Lihong Xu 1, Chengxiang Tan 1, Erik D. Goodman 2, Daichang Fu 1 and Longjiao Xin. **10 February 2015**	"Digitization and Visualization of Greenhouse Tomato Plants in Indoor Environments."	To digitization and visualization of potted greenhouse tomato plants in indoor environments.
[4] Ginne M. James, Punitha S. C. **10 July 2017.**	"Tomato Disease Segmentation using K-Means Clustering."	To detect tomato diseases using segmentation algorithm. There are six different types of tomato disease are focused in this work such as Anthracnose, Bacterial canker, Bacterial speck, Bacterial spot, Early blight and Late blight.
[5] Alvaro Fuentes 1, Sook Yoon 2 3, Sang Cheol Kim and Dong Sun Park. **4 September 2017**	A Robust Deep-Learning-Based Detector for Real-Time Tomato Plant Diseases and Pests Recognition	This system introduces a practical and applicable solution for detecting the class and location of diseases in tomato plants, which in fact represents a main comparable difference with other methods for plant diseases classification.
[6] Joaquı´n Can adas , Jorge Antonio Sa´ nchez-Molina, Francisco Rodrı´guez, Isabel Marı´a del A´ guila. **22 February 2017**	Improving automatic climate control with decision support techniques to minimize disease effects in greenhouse tomatoes	To design more robust control strategies to reduce crop damage. They use images as input are processed by a real-time hardware and software system using graphical processing units as well as to control tomato crop disease using fuzzy controller.

VI. CONCLUSION

A crop growth in the greenhouse is basically determined by climate variables within the environment. For that we consider the six climate variable for the greenhouse like Temperature of air, Humidity of air, Soil Moisture, CO2 Concentration, Light Intensity and pH scale for Tomato crop. Tomato is economically the most important vegetable crop worldwide, and its production has been substantially increased through the year. An Automated Greenhouse is an important factor for the growth of agriculture plants. For that system, we use the DNN Classifier as a controller, because Deep Neural Networks system has shown outstanding performance compared to traditional machine learning.

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