International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 2, March-April-2021, ISSN (Online): 2395-566X

Advance Glass House Monitoring and Controlling Using Deep Learning

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***Abstract*- In current era, Faster Region-Convolution Neural Networks (Faster R-CNN) are desperately improved localization, identification and detection of objects. Recent days, Big data is evolved which leads huge data generation through modern tools like surveillance video cameras. In this project, it focused on tomato growing stages and plant health condition in the agricultural field, monitor the temperature, soil moisture, light intensity and sends the notification message to the user. Agriculture is one of major living source in India. By using impro ved and customized Faster R-CNN model (improved-detect), this project had trained datasets of Tomato and Plant. In this project, Tomato plant is mainly used for model training and testing. This project have experimented on plant image data set and tomato growing stages. Expe rimental results are compared with state of the architectures like Mobile Net, Dark Net-19, ResNet-101 and proposed model out performs in location. O btains best results in computation and accuracy. In the below results sections, we have presented the results with suitable models.**

***Keywords*- Internet of Things, Glass House, Image Processing, Deep Learning, Tomato Growing Stages, Plant Health Conditions.**

I. INTRODUCTION

The global population is increasing rapidly together with the demand for healthy fresh food. The greenhouse industry can play an important role providing fresh food, such as fruits and vegetables being high in vitamins and minerals. Greenhouses allow a high crop production per area combined with a high water use efficiency per unit of produce. Worldwide, the area of glasshouse production is increasing.However, the glasshouse industry encounters difficulties finding enough skilled labour to manage crop production.

A glasshouse protects the crop from outside influences, such as rain, wind, low temperatures, or pests. A modern high-tech glasshouse is equipped with active control of actuators (e.g., heating, lighting, irrigation) in order to create a favourable growing climate. Of course, this comes at the cost of resource consumption (e.g., fuel, electricity, water).

Growing tomato in greenhouse is different from outside environments because the temperature will not drop at night, and leaves will not get wet from raining so the root can absorb water and nutrient effectively. These growing factors have impact on developing the growth of tomatoes and harvesting time. However, controlling and monitoring these growth factors is necessary in order to produce good quality crops and to avoid any bad conditions leading to an abnormal growth.

In this study, we proposed the IoT system basically to monitor the growth using camera as an IoT devices capturing images for further analysis. In data analytics, we considered and examined fruits regions in tomato plant images. Since the dataset of tomato plants images includes the background of soils and leaves, this study will detect and extract only the fruits regions, then these regions will be classified in different growing stages.

II. RELATED WORKS

The implementation of the IoT system is used to solve problems in various fields such as agriculture, health care, smart city, and so on. This system was made to solve problem regarding to agriculture. IoTOMATO was proposed as an IoT system for a tomato monitoring using temperature sensor, soil moisture sensor, light sensor and camera nodes.

Data analysis is another important part in IoT which supports the users in deeper view of the data such as tomato monitoring and analyse the growth of tomato and plant health condition. It used to collect and analyse data of daily images of tomato growing stages and health condition of tomato. Moreover, deep learning has been utilized to detect health condition of the plant.

In this project, we extended the previous IoT system to collect images and detect the plant health condition. In this deep learning model, it was trained to detect these fruits region and plant leaves. Analyse the fruit condition and

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plant condition and then sends the Notification message to the user about the plant growing stages and the health condition. The dataset of tomato plants images from Kaggle website that is used in this study.

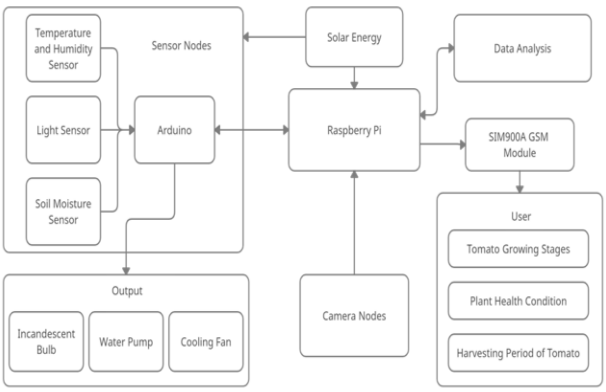

Fig 1. System Architecture of Advance Glass house Monitoring and Controlling Using Deep Learning.

III. METHODOLOGY

1.Existing System:
Internet of things (IoT) plays a big important role in agricultural industry recently in order to provide a support to farmers such as growth monitoring system of temperature, humidity and water supply, and also early disease monitoring and detection system. To provide a smart farming solutions, this paper proposed an IoT system with notification system on tomato growing stages and plant health condition.

The tomato and plant leaf dataset was obtained from Kaggle website. The dataset has trained and tested the deep learning model to detect the fruit proposal region and plant leaf region. Then, the fruit proposal regions were detected and classified into 6 stages of fruit growth using the visible wavelength as a feature in Support Vector Machine (SVM) classification with the weight accuracy of 95.5%.

2.Proposed System:
In this system, Plants will be grown optimally inside the greenhouse with the help of IOT and Deep Learning algorithms. Sensors and equipment inside the greenhouse assist the plant growth by monitoring and giving optimal resource respectively. Sensors in greenhouse like temperature and humidity sensor, light sensor, soil moisture sensor and camera nodes used to monitor the temperature, humidity, sunlight, water requirements, tomato growth stages, plant health condition and harvesting period respectively.
Obtained data will be send to gateway (i.e Raspberry Pi) through the arduino where the data is stored and processed. Electric power used to operate the greenhouse is obtained from solar panel. So, it is fully green and pollution free. The stored data is processed in Raspberry Pi using Faster Region-Faster Region- convolutional Neural Network (Faster R-CNN).

3.Module Description:
In this project, all the information are about the plant's requirements and its growth stages. In this project the data are collected through sensory nodes and camera nodes and that is transferred to the gateway with the help of arduino, where it is saved and processed. Finally the data are processed and regarding information are send to the users through the notification system.

3.1 Sensor Nodes: In the sensor nodes the temperature sensor, humidity sensor, soil moisture sensor, light sensor are used to detect the temperature of the house, humidity, wetness and water in the soil, light present on the environment respectively. The data collected through the sensory nodes are transferred to the raspberry pi with the help of the Arduino where the data is going to be processed and stored.

3.2 Camera Nodes: The Pi camera module is a portable light weight camera that supports Raspberry Pi. It communicates with Pi using the MIPI camera serial interface protocol. It is normally used in image processing, machine learning or in surveillance projects. It is commonly used in surveillance drones since the payload of camera is very less. Apart from these modules Pi can also use normal USB webcams that are used along with computer.

3.3 Gateway: In this project, the gateway used is the **Raspberry Pi 4 Model B is a series of small single** – board computers developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices.

3.4 Notification System: Notification system is used to notify about the temperature, humidity, water level to the user as a SMS by GSM module with the help of the Arduino.

4. Data Analysis:
4.1 Tomato Growing Stages: Tomato fruits development can be divided into six different stages, there are Green, Breaker, Turning, Pink, Light Pink and Red.

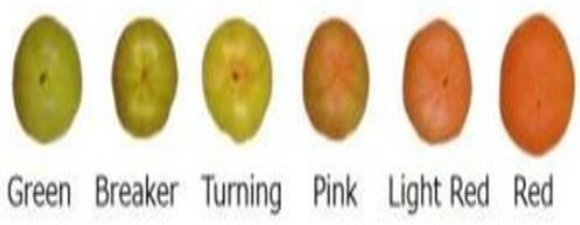

Fig 2. Tomato Growing Stages.

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These have several environmental conditions, such as temperature, moistures, water and nutrients, and lights that all have effects on fruit development.

4.2 Plant Health Condition: The analysation of plant health condition mean the studies of visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. It requires tremendous amount of work, expertize in the plant diseases, and also require the excessive processing time. Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification.

Algorithm written below illustrated the step by step approach for the proposed Image segmentation and disease classification processes.

- Image Acquisition
- Smoothening of Image
- Image Segmentation
- Feature Extraction
- Classification of disease

5. Deep Learning for Object Detection:
The deep learning was used to detect the tomato and plant leaf section on the images where we want to separate them from background noises in full plant. The detected regions from deep learning were pre- processed for removing the remaining background of uninterested section. For a simply pre-clustering, we specified K equals 2 in order to cluster 2 parts: fruits and uninterested region where most of the images included only 2 colors. Therefore, K-Means algorithm can be applied here.

The images of segmented regions were converted to hue plane scaled from 0 to 360 degree in Hue-Saturation-Value (HSV) color space. Then, we extracted the features of the visible light wavelength from 530 nm to 620 nm. This range defines color of green, yellow, orange and red respectively.

Table 1. Characteristics of Tomato Development.

Stages	Colour Classification On Tomato Surface		
	Green	Orange or Pink	Red
1. Green	Completely	-	-
2. Breaker	Almost	Less than 10%	-
3. Turning	Some	10 – 30%	-
4. Pink	Little	30 – 60%	Little
5. Light Pink	-	60 – 90%	Some
6. Red	-	More than 90%	Almost

Finally, the extracted features of visible wavelength is used to classify the ranges of wavelength to 6 stages of tomato growth as shown in Table I and plant leaf condition using Support Vector Machine (SVM).

IV. RESULTS

1. Tomato Dataset:
Our data was selected 360 images periodic taken for 30 days at 1280 x 720 pixels. The dataset was captured at daytime using the fixed camera at the same position. We re-sized the images to 400 x 225 pixels which help decreasing in time processing in deep learning step, then randomly divided the dataset into 80% training set and 20% testing set. In total, there were 3,796 region proposals in training set manually labelled as a tomato class.

In this study, we trained and tested the data using MATLAB. The green house is used to grow the plants optimally with using minimal resource with the help of the IOT and Deep Learning. Since this is automated need of resource, man power and wastage is very low.

2. Tomato Detection:
The object detection of tomato fruits region is use the Faster R-CNN. Almost all proposal regions could be detected as fruit regions with precision up to 85%. The problem is that some region could not well define whether foreground or background so that it could not get detected and some green leaf was detected as a green tomato.

However, this method could detect the tomato fruits from leaves and floor background.

Fig 3.Tomato Detection.

3. Plant Detection:
All the experimentation and paper related work is done in Matlab. Datasets are prepared with taking multiple images of each disease. Images are taken from different sources of camera, and at various locations, along with this images some standard images from different agricultural institutes are also used in preparing dataset.

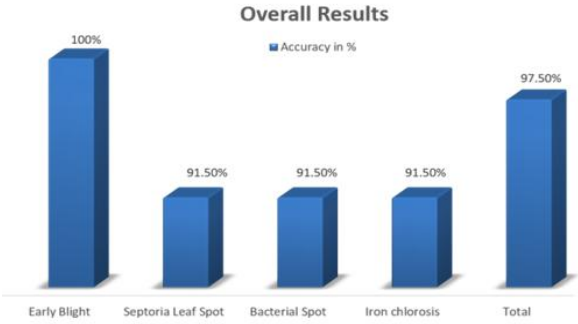

Fig 4. Overall Results.

4. Notification System:
Notification system is used to notify the users about plants growth stages, steps taken by automation system, plant health conditions, plant harvesting time, humidity, temperature and soil moisture. It is done using the GSM module which is connected with Arduino and Raspberry pie.

Fig 5. User Notifications.

VI. CONCLUSION

In this work, the system is to provide the automation for the green house and related information to the users through the notification system. It has been developed to make automated green house for growing plants with less efforts and minimum man power. This also used to determine the harvesting period of the tomatoes.

1. Limitation of the Project:
The limitations of the project are, the disadvantage of the system is limited to the tomatoes only. So using this system other plants cannot be grown. Soil alkalinity and acidity cannot be monitored.

2. Advantage of the Project:
The advantages of the projects are, it is optimized for the full plant's growth instead of the fruit's growth, it can detect the diseases of plants throughout its life cycle, also used to determine the harvesting period of the plants and as it uses the solar power, it is totally green as per its title.

3. Future Enhancements:
Soil alkanity and acidity can be checked with help of soil alkanity sensor, inspite of growing a single variety of plant, multiple types of plants will be grown in a single green house and seed sowing machine may introduced in it.

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