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Real Time Precision Farming through Cloud Computer Vision and Deep Learning

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Abstract : Current paper introduces an innovative approach that will automatically detect the disease on any plant leaves. Currently, phytopathologist rely mainly on naked eye prediction and a disease scoring scale to detect the diseases. This manual grading is not only time consuming but also infeasible. Hence, the current paper proposes an image processing based approach to automatically grade the disease spread on plant leaves through employment of relevant CNN. Also, we present a product counting pipeline which combines image acquisition, segmentation, frame to frame tracking to avoid redundancies in product counts. Our pipeline works on image and video streams from a high resolution camera, and relevant data streams from other sensors onboard. We first train a Fully Convolutional Network (FCN) and segment video frame images into their respective categories. The results are observed to be accurate and satisfactory in contrast to manual grading.

Keywords —Agriculture, Computer vision, Deep learning, Feature extraction, Image processing, Neural network, Plant disease, Plant disease identification, Segmentation.

I. INTRODUCTION

India is an agricultural country, where a large population are farmers and is dependent on agriculture. The Agriculture sector and structures is one of the main source of income and serves the entire human race for survival.The poorer strategy among farmers suffer due to the lack of awareness and their incapability to utilize the methods modern science has readily made available to the masses.Vegetables and fruits are the most important agricultural products from customer view. The economical profit depends on a product quality which depends on the quality of a soil, seeds and fertilizers. So for increasing the profit farmers mainly focus on these three main things. Instead there is one more thing which affect on the production, that is diseases. We have to control these diseases to reduce the loss. It is important to detect and control such diseases in a specific period which is at their initial state to prevent spreading. Such diseases must be destroyed before it will affect on some basic operation of plant body. One best technique for early detection and notification of disease is through image processing. Image processing can detect a pest's attack from the image of plant. The detection and classification of plant diseases are important task to take precautionary measures and to increase plant productivity. These activities cannot be done manually when the scale is large, hence automation is required. The ability to obtain fruit counts from videos allows growers to optimize their decisions. Despite recent progress in using deep learning to improve fruit detection from static images, counting from videos still remains a challenge due to redundant data points and outliers originating from fruit tracking and localization errors,[1], [2], [3].

Using this model to the fruit counting problem is challenging for a variety of reasons. Firstly, the model needs to generalize across different fruit types and environments that can vary greatly based on illumination conditions, tree shapes, orchard arrangements, etc. While, most previous algorithms use hand-engineered options for each specific state to discover the fruit [5], recent works exploit deep learning algorithms that perform well across a variety of conditions [2], [6], [7]. Second, after obtaining

detections for each image frame, these individual detections must be tracked across the frames in order to prevent over-counting of the same fruit. This step is additionally difficult in unstructured environments, as double-counting of fruit will result from occlusion or illumination variation.

II. PREVIOUS WORK

Paper [1] proposes a fruit counting pipeline along with tracking of frames and 3D localized mapping of the farm to obtain accurate fruit count. Firstly, the machine is trained using FCN's (fully convolutional network) which then

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divides the video sequence to fruit and non-fruit pixels. These image sequences are used in tracking using the Hungarian algorithm. SfM Algorithm (structure from motion) is used to get proper estimate of fruit count relative to 3D locations. Various techniques have been used to detect and remove the redundant product counts. This idea of obtaining fruit count from video helps in optimizing the management and harvest decisions.

Paper [2] concentrates on disease detection as it is observed that plant disease can lead to a tremendous loss in productivity and economic losses.Early detection is necessary to improve the quality and quantity of the product.This paper is restricted to grape leaves, K-means algorithm is used for segmentation. The disease is detected from this segmented image. Fallacious diagnosis and results may lead to improper use of pesticides. The results are improved using Back Propagation algorithm.

The third paper we referred is [3] Segmentation of Pomegranate Leaf for Detection of Disease Using Image Processing T.N. Shaikh, Dr. S.M. Mukane, published on 4 June 2017. The main highlights of this paper are, it's employment of the K-Means Clustering for segmentation of Pomegranate leaves. It only differentiates between healthy and unhealthy leaves. One of the drawbacks of this model include, as it exists right now, it only differentiates between healthy and unhealthy leaves. It's incapable of detecting the disease name or type.

The fourth paper we referred is [4] Leaf Disease Grading by Machine Vision and Fuzzy Logic by Arun Kumar R, Prema SY, SS Sannakki, VS Rajpurohit, VB Nargund. The main highlights of this paper are, The use of Fuzzy Logic to Grade the leaves. Capability of detecting the area of the affected leaf. The drawbacks of this model include, It's reliance on hard coded algorithms and models for detection and requires massive amounts of training data. It's current capacity to only detect the non-green portion of the leaf and considering it a disease symptom.

III. Proposed System

Our model combines the fruit counting pipeline with the leaf disease detection pipeline that's easy to scale up and add support for a variety of fruits and leaves.It is expected to increase yield of at least 10% and decrease water inputs by at least 30%.This can make a huge difference when the scale is large.

IV. Our approach

A. Image Acquisition

In the proposed method, images are collected from databases like Pomegranate Leaf Image Database Consortium, PlantVillage Dataset, manual image sourcing, etc.

Algorithm 1 Ground Truth Count

```
procedure GETCOUNT(Box, Centers, Windows)
    count ← 0
    c ← center in Centers that lie in Box
    for center in c do
        w ← window that contain center
        n ← 0
        for window in w do
            n ← n + 1
            count ← count + 1 n
    return count
```

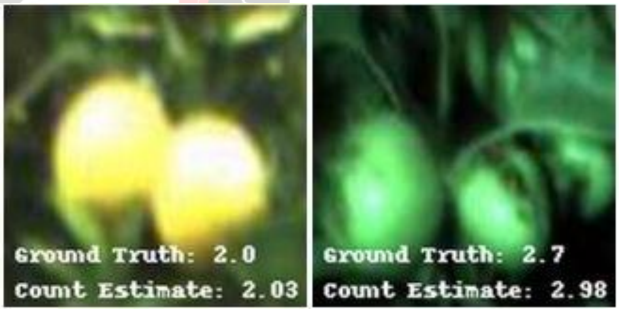

Figure: Model accuracy with respect to product count estimates and ground truth labels

Figure: Ground truth labels of healthy and unhealthy leaves.

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The datasets contains two types of images such as disease affected leaf images and healthy leaf images. There is a heavy reliance on ground truth labels for this model to function accurately. The Ground Truth Count Algorithm mentioned earlier is employed to ensure utmost accuracy and efficiency of our model.

B. Fruit Counting Pipeline and Blob Detection

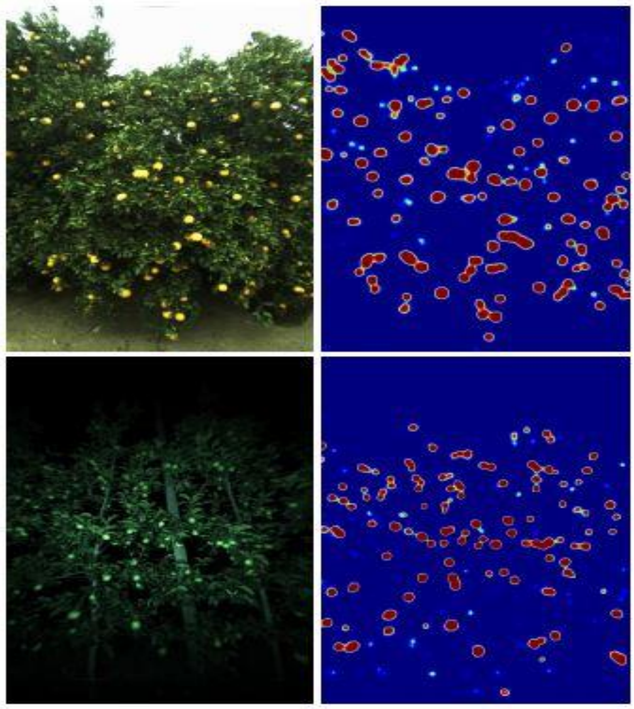

Figure: Top left: Example orange image; in natural lighting conditions, during daytime. **Top right:** Orange blob detection results. **Bottom left:** Example apple image; in controlled lighting conditions, during the night. **Bottom right:** Apple blob detection results.

Our goal is to provide a data-driven fruit counting methodology that an agricultural enterprise can easily adapt and apply in unstructured farm settings. As a result, the proposed method emphasizes labeling and training speed, generalizability, and accuracy.

C. Image preprocessing

Image pre-processing include removing low frequency background noise, normalizing the intensity of particles,images, removing reflection and masking portion of images. It is the technique for enhancing data images prior to computational processing. Pre-processing required for shadow removal, image correction. Removing shadow is very important

Figure: Noise reduction filters

because Shadow may disturb segmentation and feature extraction.

D. Segmentation

Segmentation means it subdivides the image region into small regions.

V. ARCHITECTURE

First, the raw Video Stream from the UAV will be shot and sent to the Cloud, where the Video is converted into an Image Sequence. This Image Sequence is split into and frames and objects are tracked across these frames and segmented.

The segmented pixels will then be sent to their respective pipelines where further Preprocessing and Segmentation is done. Here, our pretrained ML models for each pipelines will act on the data and generate the respective outputs.

Once this step is done with, the system moves to generate Reports and Analytics on the gathered data and sends them to the Client.

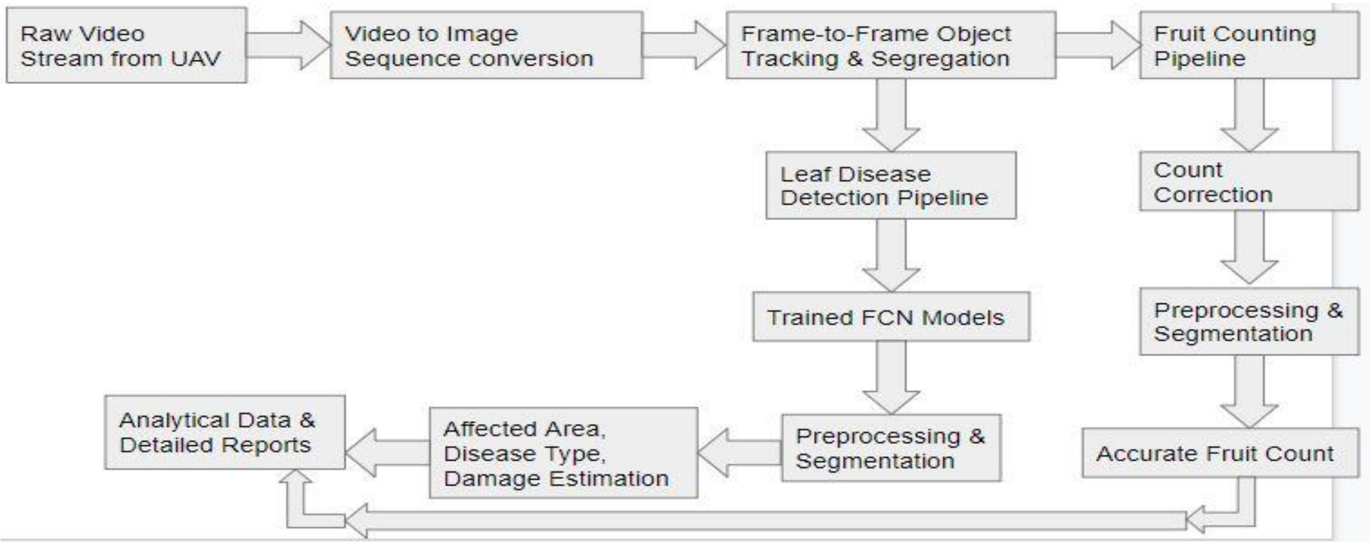

Figure: Architecture of proposed System

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VI. Conclusion

We have presented a pipeline that consists of segmentation and tracking accurately that counts visible fruits and other products across image sequences. To the best of our knowledge, this model is the earliest applications of a deep neural network in an algorithm that counts fruit across an image sequence and it also combines the fruit counting pipeline with the leaf disease detection pipeline that's easy to scale up; and offers support for a multitude of agricultural products and leaves. Our model optimises the production efficiency, the yield quality and minimises risk.

In short term, it improves the ability to diagnose crop production problems. In long term, data that has been collected and analyzed over time can be used to evaluate the effects of various management practices on yield.

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