Different Stages of Maturity Detection of Oyster Mushrooms Growing Indoor Chambers

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January 13, 2023

Abstract

Oyster mushrooms are nutritionally beneficial delicious fungi that can be consumed on daily basis. Harvesting the right mushroom in optimal time is significant because consuming the wrong mushrooms can cause serious health issues. The not matured,matured are the different stages of the mushrooms. Not matured stage are the baby mushrooms which are not fully grown can be poisonous that cause health issues. Oyster mushrooms are grown in chambers with a controlled environment where cameras are attached to observe the growth stages. Deep learning object detection methods are used to detect the mushrooms and identify whether they are ready to harvest or not.The Mushroom image data set was made from the images that are produced from the cameras fixed inside the chamber and labeled using image annotation tool.The experiment set up was arranged in replica to vertical farming consuming less space and ensuring sustainability as climate change causes less yield, this arrangement was designed in the DIGIT lab in Goslar, Germany.

Keywords— . Object detection, Images, Deep learning, Image recognition, Oyster mushrooms,mushroom, data set.

1 Introduction

Indoor farming is adopted as a result of climate change, relying on the polluted weather is not optimal for the farmers to meet desired outcome [1].Indoor vertical farming aims for more food in less space even though the initial start-up cost is high. Indoor farming guarantee high-quality food besides seasonal and non-seasonal crops [2] as the resources can be efficiently utilized moreover manageable. The idea of vertical indoor farming is to bring the expensive foods to the normal people costs effectively cultivated in less space. This idea can be adopted regardless of the urban or rural area. The initial implementation cost which is highly reliable technology and can produce tons of yields in less space.

This project was done as gourmet mushrooms are expensive moreover, their availability is great in demand. Deep learning is a branch of machine learning where it can detect the object from images or videos and classify them to labeled or unlabeled categories using neural networks [3]. These emerging method make the identification and classification of objects precise by learning from the data

set feeding into it. The images of mushrooms are loaded into the method, it learn from the observation and derive a conclusion by itself, unlike traditional programming paradigm how to solve the problem is not mentioned [4]. There are several methods in Deep learning for object detection, image recognition, localization and classification with its own peculiarities and accuracy rates it distinguish from one another. Some of them are discussed in this project to identify the oyster mushroom from the digital images fabricated from the camera fixed in the growing chambers.

2 Experimental Set-up

Two chambers were arranged as the traditional indoor vertical farming linking digital twin.The one was stacked within reusable plastic bags, the second one with the plastic buckets. Both chambers have a controlled environment as the humidifier and temperature were monitor throughout the day. A mist maker attached where pumping water to maintain the humidity inside the chambers from water tank placed in-front of the chambers. Proper cuts and holes were made to the plastic bags and buckets respectively as expecting mushroom pop-ups from the desired breaks similar to the wild mushrooms popping out from the earth surface or from a tree branch.Three cameras were attached at the angle that covers all sides of the buckets and bags where cuts are made. The cameras clicks pictures every one hour[5]. The pictures below are taken from the lab during the harvesting stage as in Figure 1 -(a) the reusable plastic buckets are stacked on top of each other which consumes less space replica to vertical farming and the oyster mushrooms are ready to harvest from the reusable buckets in Figure 1-(b).

(a) substrate bucket stack

(b) Ready to harvest oyster mushrooms

Figure 1: Experimental setup

The mushrooms project was done completely in the DIGIT lab from beginning, creation of mycelium to the end stage of the harvesting by adopting the traditional mushroom farmers [6]. Pressure-cooked raw wheat as a process of sterilization were used as the substrate and mycelium was transferred to them

after cooling down. Substrate are kept for about inoculation about 10 to 15 days then transfer to the growing chambers where the environmental situation was controlled and observed by sensors.Two chambers with vertically arranged mushroom pods are checked by three cameras fixed inside at different angles to observe the growth of mushrooms from the reusable plastic buckets. Magnesium carbonate, calcium carbonate along with gypsum were added to the substrate as they supposed to increase the yield.

3 Related works

A study was conducted to understand similar studies in the mushroom community,from[7] Grey oyster mushrooms are classified into three different categories where Vgg-16 deep learning method was used.The color, size, pattern and damage situations of Grey oyster mushrooms are closely checked. The grades are assigned to the quality of the Grey mushrooms. In this paper a data set of Grey oyster mushroom are created which was not publicly available. Data set used contain manually clicked Grey oyster mushroom a total of 600 images where categorized into three classes 80% training images, 10% Evaluating images and 10% of testing images.

In [8] SSD deep learning method is used to analyze the oyster mushroom. This method is fast in detecting the mushrooms from grow bags placed in horizontal stacks. This algorithm is based on the CNN model which is rather faster and more accurate than other CNN models.Data set used in this study was collected from different greenhouses on different days.The matured mushrooms are having the size 8 to 16 cm were labeled and images with no mushrooms are not labeled.

In [9] using the SSD method as mentioned above. The image of oyster mushrooms are localized from the complex background which is acquired by multi layer CNN. Large and small mushroom are classified by large and small scale feature maps.Data set contain 4600 images out of that 4000 were used to train the algorithm by reducing the image size to 300*300 pixel results in better processing speed. Rest of the images where used to validate and test the algorithm.

In [10] Recursive YOLO version five is used to detecting the edible mushrooms from the vertical growing sticks.Using this method 98% accuracy is obtained in detecting the edible mushrooms this identification process was complicated as the mushrooms are located in different places with various sizes.The data set was created by collecting images from local farmers because the images where not publicly available.

In [11]Shiitake mushrooms are classified using a channel pruning mechanism of the YOLO method, human labor is much big when picking up shiitake mushrooms and this can be solved by identifying the right matured one. Compared to other YOLO versions and CNN methods used to classify the mushrooms this pruning mechanism is faster in detecting and classifying the shiitake mushrooms. The data set contain different variations of shiitake mushrooms a total of 3000 plus images were used to train and test the method.

4 Algorithms to Localize and Classify the Oyster Mushrooms from Digital Images

4.1 YOLO - You Only Look Once.

This method works on the basis of a Convolutional Neural Network abbreviated to CNN.You only look once is the most used algorithm to detect, localize objects from the images.It is faster and more accurate than SSD [12].This method works inputting the picture into grids called anchor boxes and calculating class proximity.The size of the image is reduced to small grids ,in conclusion, the image has large difference in original and training images.Nonexisting position in the images cannot be learned.The method should learn (train) images that is appropriate to the YOLO's characteristics.When the size of the image is reduced resulting a difference in ratio to the original image can cause poor performance of YOLO.

4.2 SSD - Single Short multi-box Detector

Single short multi-box detection algorithms are similar to the YOLO based on CNN can detect objects and localize the position faster[13].SSD as the name implies divide the image into multiple boxes called feature map, and identify the presence of objects inside the boxes based on CNN. The accuracy outperforms other CNN methods even with a small image input size. In other words, besides limitation to the accuracy when considering large-sized images this method is faster in detection.The anchor box, which is centered on each feature point grid, determine the presence of the object.

4.3 VGG-16 - Visual Geometry Group

The visual geometry group with 16 layers takes the input images to the pre -trained network model. 16 refers to the number of layers. Each layers support the object detection, and claim an accuracy of about 92.7% with a 3x3 kernel size.The 16-layer neural network takes the weight, bias, and related training procedure to the neural network. As there are more layers this increases the time to train the parameters.

5 Conclusion and Outlook

The comparative study was done to understand the performance of algorithms to detect the oyster mushroom growing in the indoor chambers.YOLO method is accurate moreover faster than other methods [14]. There are multiple version of Yolo guarantees a better performance than the older versions when taking the different features of the images. Yolo is also efficient when analyzing images from video streams[15], when it comes to small images, Yolo can not identify the accurately comparing to SSD.VGG 16 is the base of SSD and the image is divided into boxes and when it comes to speed and accuracy this method can also be used to detect the oyster mushroom.[16].Out of these algorithms variations of YOLO such as YOLACT ++ and Mask R-CNN can be also propose for object

detection as their identification rate is good even when the probability of noise is higher.

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