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Deep Learning Plant Health Monitoring (using Photos)

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***Abstract*—Plant health remain a major aspect to food security in many parts of the world. The yield and quality of plants are greatly influenced by conditions such as plant water stress, diseases and pests. Deep learning has made significant advances in digital image processing in recent years, far superior to traditional approaches. By using sensors and digital image processing, plant health can be monitored and problems can be identified. Researchers are interested in using deep learning technology to identify plant health problems. This paper focuses on identifying plant diseases and pests and makes a comparison to conventional techniques for doing so. These can be successfully achieved from perspectives of classification networks, detection networks, and segmentation networks, and summarizes both the advantages and disadvantages of each method. Several common data-sets are introduced, and existing studies are compared. Therefore, this study discusses practical challenges in applying deep learning to plant disease and pest detection. In addition, several suggestions are provided for resolving the challenges and developing new research ideas. Lastly, this study analyzes and predicts the future trends in plant health monitoring using deep learning.**

I. Introduction

Detecting plant diseases and pests is also a key area of research in the science of machine vision. It is a system that gathers photos of plants using machine vision equipment and determines whether any pests or illnesses are present. Plant diseases and pests detection tools based on machine vision are currently being used in agriculture and have partially replaced the old-fashioned naked eye identification methods. Traditional image processing algorithms or human feature creation combined with classifiers are frequently employed for machine vision-based methods for detecting plant diseases and pests. In real complex natural environment, plant diseases and pests detection is faced with many challenges, such as small differences between the lesion area and the background, low contrast, huge variations in scale and type of lesion, and a lot of noise in the lesion image. Additionally, when photos of pests and diseases are taken under natural light, there are a lot of disturbances.

In the recent years, with the successful application of deep learning models represented by convolutional neural networks (CNNs) in many fields of computer vision (CV, computer vision), it is common to use deep learning methods to detect plant diseases and pests in agriculture, and some domestic and foreign companies have developed photo recognition software and We-chat applets that use deep learning to detect plant diseases and pests. Hence, a deep learning-based method for detecting plant diseases and pests is not only important for academic research, but also greatly applicable to the market.

II. Definitions

A. Plant diseases and pests:

Natural disasters such as plant diseases and pests can adversely affect the normal growth of plants and may even result in plant death during the entire plant's growth cycle, In machine vision tasks, plant diseases and pests tend to be concepts from human experience rather than purely mathematical descriptions.

B. Plant diseases and pests detection:

The requirements of plant diseases and pests detection are very general, as compared with the precise classification, detection, and segmentation tasks in computer vision. The requirements can actually be broken down onto three distinct levels: what, where, and how. "What" in the initial step is equivalent to the computer vision classification task. According to Fig. 1, It is labelled with the category to which it belongs. In this stage, the task is classification, which identifies only the image's category. This stage is the rigorous sense of detection in the second stage. "Where" is the location task in computer vision. This stage not only determines what types of diseases and pests are present in the image, but also where they are located. Figure 1 shows a rectangular box marking the plaque area with gray mold. During the third stage, "how" relates to segmentation in computer vision.In Figure 1, gray mold lesions are separated from the background pixel by pixel, which can be used to obtain a series of information, including the size, location, and length of the gray mold lesions, which can be used to evaluate plant diseases and pests at a higher severity level. As a result of feature expression, classification describes an image globally, and then determines whether it contains a particular type of object through classification operations; whereas object detection focuses on local descriptions, that is, identifying what objects exist in

which positions in an image. Therefore, apart from feature expression, object structure is the most obvious difference between object detection and

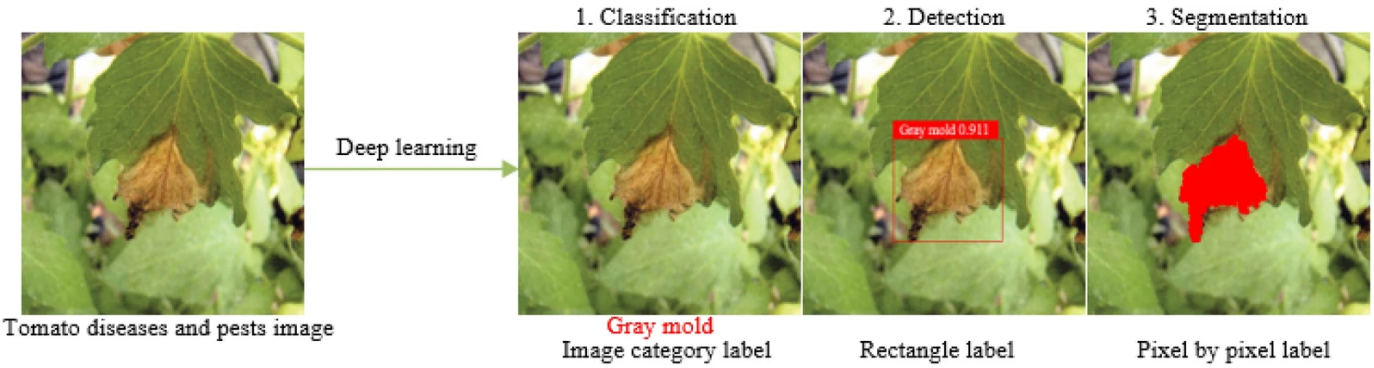

Fig. 1. Definition of plant diseases and pests detection problem

object classification. In other words, object classification focuses primarily on feature expression, whereas object detection focuses primarily on structure learning. Accordingly, the following text refers collectively to plant diseases and pests detection as a convention, with terminology differing only when different network structures and functions are used.