Plant Disease Diagnosing Based on Deep Learning Techniques: A Survey and Research Challenges

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Abstract—Agriculture crops are highly significant for the sustenance of human life and act as an essential source for national income development worldwide. Plant diseases and pests are considered one of the most imperative factors influencing food production, quality, and minimize losses in production. Farmers are currently facing difficulty in identifying various plant diseases and pests, which are important to prevent plant diseases effectively in a complicated environment. The recent development of deep learning techniques has found use in the diagnosis of plant diseases and pests, providing a robust tool with highly accurate results. In this context, this paper presents a comprehensive review of the literature that aims to identify the state of the art of the use of convolutional neural networks (CNNs) in the process of diagnosing and identification of plant pest and diseases. In addition, it presents some issues that are facing the models performance, and also indicates gaps that should be addressed in the future. In this regard, we review studies with various methods that addressed plant disease detection, dataset characteristics, the crops, and pathogens. Moreover, it discusses the commonly employed five-step methodology for plant disease recognition, involving data acquisition, preprocessing, segmentation, feature extraction, and classification. It discusses various deep learning architecture-based solutions that have a faster convergence rate of plant disease recognition. From this review, it is possible to understand the innovative trends regarding the use of CNN's algorithms in the plant diseases diagnosis and to recognize the gaps that need the attention of the research community.

Index Terms—Deep learning, Plant disease diagnosis, Plant disease detection, Plant disease recognition.

I. Introduction

Plants are a crucial part of life on Earth as they provide humans with breathable oxygen, food, etc. Furthermore, they provide food for insects and other animals, facilitate weather change, provide clean air, balance the ecosystem, and regulate flooding. In most countries, agriculture crops have become the chief source of economic development. Agriculture plant or crop cultivation has quickly developed in terms of quantity and quality of food production. However, a wide range of factors affect agriculture production such as occurrence of pests and diseases on crops, which, in turn, requires increasing food security. Unfortunately, such diseases are not always detected at an early stage (Fina, et al., 2013).

Plants have been reported to have the following organs: leaf, stem, root, fruit, and flower. In agricultural plants, leaves are an important organ of plants for providing information about the amount and nature of gardening crop (Saleem, et al., 2020). Numerous studies have been conducted on plant leaves as a comparative tool for different purposes such as classification and identification. This is because leaves are often the basis for identification and can be easily perceived, as they are usually green and flattened. Plant diseases can be understood as an unusual state that can interrupt usual plant growth (Shruthi, Nagaveni and Raghavendra, 2019). Plant disease prevention and control have been broadly discussed, because plants are susceptible to diseases and are affected by their outer environment. Normally, plant disease diagnoses have a significant role in monitoring farming systems accurately (Sun, Jia and Geng, 2018).

Plant disease identification is an important mechanism for preventing plant diseases in a complicated environment. Farmers often recognize the symptoms of plant diseases using traditional means, for example, by making naked eye observations and referring to the information in books and internet. (Shruthi, Nagaveni and Raghavendra, 2019). Furthermore, traditional methods such as microscope and DNA sequencing-based approaches have been used to