

Chapter 16

Identification of Tomato Plant Disease Using Faster R-CNN and RetinaNet

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ABSTRACT

Plant disease plays a significant role in the low productivity of tomatoes which leads to huge loss to the farmer and the country's economy. Identification of plant disease at an early stage can play a major role in producing good amounts and even good quality tomatoes. Identification of the disease sometimes gets difficult because of lack of knowledge or having multiple diseases or even wrong prediction of disease. The chapter contains implementations of two classification algorithms Faster R-CNN and RetinaNet. Both the algorithms are initiated from transfer learning and tested on different hyperparameters for better results. The work produces impressive results with average precision (AP)-50 as FR 93.11%, RN 95.54%. The preliminary results look promising and can be helpful for harvest quality and precision agriculture.

1 INTRODUCTION

Every year, India produces a significant variety of crops and vegetables. After China, India is the world's second-largest tomato grower, with 19.75 million tons produced from 7.89 lakh hectares with an average output of 25.05 tons per hectare. Andhra Pradesh is the world's greatest tomato grower, with the commodity presently retailing for Rs 100 per kg and anticipated to soar much higher (Vikaspedia, 2022).

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At the same time, India is dealing with a tomato disease that is destroying yields and costing farmers a lot of money.

It is found that these diseases which are very common to the tomato plants and can affect the growth and development of the crop which leads to reduced production of tomatoes which is the main cause of economic losses for a country. Mosaic virus is a virus that is mostly found in the leaves of plants, and it can be easily identified as it comes with a spotty appearance on the infected leaves of plants. It affects the growth of plants and also affects the leaves of the plants which can have deformities in some or other ways (Asif et al., 2022). Their leaves are crinkled or in a wavy pattern. It may exhibit shoestring syndrome which results in the edges of the leaves failing their ability to develop, with the leaf appearing as long narrow strips. Diseases causing fungus which is known as *Septoria lycopersici* produces a disease which is known as *Septoria leaf spot*. It is found on the leaves of plants severely where wet, warm (60-80 F) and humid weather is present for a prolonged period of time and is considered as a most harmful disease which brings a lot of destruction to the leaves of plants. This spreads rapidly and will result in removal of leaves and the weakening of plants resulting in being unable to bear fruit. Late Blight is a disease that is mostly present in potato and tomato plants under the areas where there is a high relative humidity with temperatures ranging from 4 degree to 29 degree (40 - 80 F) and mainly caused by the water mold *Phytophthora infectants*. It is a harmful disease which rots the plants within a week or two weeks. Lesions will appear on the stems, petioles and leaves. At the margin of the lesions under leaf surface we may find a whitish growth which is a spore producing structure.

In this technological era, people are surrounded with many tools and technologies that make our daily life easier. As in agriculture there have been a lot of enhancements on the technological side which has made the life of farmers easier. As it is known that the mainstream source of economy for all the countries is through agriculture. Artificial Intelligence solutions will help in the agriculture industry's evolution to increase efficiency as well ensure good quality and quantity for crops. AI can be used in correctly identifying the output yield of crops which can be further used to forecast the prices of crops for the upcoming weeks yielding maximum profit for farmers (Udawan. & Srinath, 2022). AI sensors can also be used for the detection of the areas on the crop that are generally affected by weed and then the herbicides are sprayed on the region that remained unaffected by the weeds which in turn reduces the usage of herbicides. Using mechanical robotic hands that are powered with AI can be used for harvesting large amounts of crops at higher volume reducing manual efforts. AI can be used in diagnosis and classification of disease which will help farmers to control and prevent the disease. It can also be used in monitoring crop health which forms the basis for diagnosis of pests/soil defects, nutrients deficiencies in soil (Udawan. & Srinath, 2022).

In this work, a computer assisted deep learning based model is designed to detect and to classify the tomato plant leaf diseases into three categories as Late Blight, Mosaic virus, Tomato *Septoria leaf spot*. The used samples are collected from the public dataset, which is open for research purpose. The research objectives have been achieved by implementing faster RCNN and RetinaNet deep learning model. After the implementation, the output of the system has been evaluated by the help of average precision (AP)-50, FR, and RN. The preliminary results look promising and can be helpful for harvest quality and precision agriculture.

This work is organized as started with the introduction where some basics of the plant disease is discussed and their correlation with the AI technologies is explained how AI can be helpful for detecting the plant diseases, next part is the related studies, where existing literature and previous methods are discussed for plant leaf diseases detection. In the next portion of the paper, the methodology of the

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