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SPUD

Detection and Quantification of Potato Late Blight

Using Object Detection and Instance Segmentation

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ABSTRACT

The detection of Potato late blight (PLB) disease is a challenging task for farmers, who currently rely on traditional methods such as visual observation that are usually slow and subject to human error. This has led to the quick spread of the disease and significant yield loss. Adding on to that, due to wrong judgments made by farmers, fungicide wastage has also been increased which has led to an increase in expenses over the years. Further investigations found that plant pathologists in the country face another serious problem when quantifying the PLB disease. Even though a protocol exists to quantify the disease, due to the variations in individual experience in the field, the quantification of the disease will differ from one pathologist to another. A faster, more accurate solution is needed to help both farmers and pathologists to detect and quantify PLB disease early so that it will be possible to control its spread and reduce yield loss.

A novel approach has been suggested in this study to build a solution for the above problem. This approach employs object detection and instance segmentation techniques to identify and quantify the disease. This will be solved in two stages. Stage one will use a deep learning model based on the Mask R-CNN architecture to extract leaf instances from an input image which also includes complex backgrounds such as soil, weed plants. For the second stage, another similar model based on the same architecture will be built to segment the healthy and diseased regions from the extracted leaf instances. Afterwards a calculation will be made based on the total heathy and unhealthy area of the identified leaves to quantify the disease.

In the first stage, the novel model was trained on a dataset using different types of augmentation techniques, achieving a mean average precision (mAP) of 75%. In the second stage, a model was trained using masks obtained from the stage 1 model, yielding a mAP of 81%. The severity calculation was made based on the pixel area of both healthy and unhealthy areas of the leaf instance. The study found a higher correlation between the manual severity values and the value generated by the proposed model. The results demonstrate the potential of the proposed model in accurately detecting and assessing the severity of plant diseases, with implications for precision agriculture and sustainable farming practices.

Keywords: Deep Learning, Object detection, Instance segmentation, Image Classification, Potato Late Blight, Severity Quantification, Mask R-CNN