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Application of Object Detection based on Deep Learning Model for Pest Behavior Patterns and Agronomic Traits in Soybean

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[Introduction]

Soybean (*Glycine max* (L.) Merr.) is a representative food resource. To preserve the integrity of soybean, it is necessary to protect soybean yield and seed quality from pests and diseases. The yield of soybeans is reduced by *Riptortus pedestris* primarily, recorded as causing greatest loss. Soybean pests cause not only direct yield reduction, but also negative impacts on plant growth. Therefore, it is important to reduce crop losses through analyze agronomic traits of soybean and insect pests. Traditionally, the diagnosis of agronomic traits has been carried out through the human own eyes. However, since human vision is subjective and temporary, it spends a lot of time, required a specialist, and had the inconvenience of being labor-intensive. Therefore, in this study, the behavior patterns of *Riptortus pedestris* and agronomic traits of soybean seed were detected as the sight of artificial intelligence. Time series image data were used to analyze the movement patterns of *Riptortus pedestris* according to pheromone treatment. In addition, classification was performed through visual analysis of soybean seeds based on a deep learning model.

[Materials and Methods]

In this experiment, *Riptortus pedestris* selected adults stage raised in artificial cages. Image data and video data, with 10 minutes of running time, according to pheromone treatment about *Riptortus pedestris* were used as train data set. A camera used in the experiment was a GoPro Hero 8 Black (GoPro Inc. USA). The programs used in the annotation process are Labelimg in python and RoboFlow. Deep learning is implemented with MRCNN, YOLOv3, YOLOv5 and Detetron2. The environment consists of Jupyter Notebook, Google Colab and Aanaconda prompts based on python. mAP was used as an indicator to evaluate the performance of the model, and precision, recall, and loss functions were also used. A portable application of a deep learning model was implemented based on the Flask web framework. For soybean seed experiment, Daewonkong (DW) with yellow seed coat color, landrace with black seed coat color (NG2), and inbreeding line with green seed coat color (NGT) were used as soybean seed sample.

[Results and Discussion]

As a result of the *Riptortus pedestris* behavior patterns according to the pheromone treatment, pest movements were observed to avoid the repellent pheromone in the 3D model. A result of deep learning model based on the *Riptortus pedestris* data set, the training iteration was 150 and the max-loss was 1.377 and the min-loss was 0.1240. The total learning time was 15h 6m 13s. The mAP was calculated as YOLOv3: 0.975, MRCNN: 0.957, and detector2: 0.944. In soybean classification model summary, learning time required for 2.7 s/Iteration, and the iteration per one epoch was 15 times. A total of 343 epochs were performed to generate model weights, and the running time was 3h 51m 31s. The mAP of DW, NG2, and NGT was recorded as 0.835, 0.739, 0.785, respectively, and DW was calculated as the highest value, and NG2 was the lowest value observed.

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