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Detection and Classification of Soybean Insects Pest, *Riptortus Pedestris* (Heteroptera: Alydidae) and Forecasting Platform using Deep Learning with ActionCAM on RC Vehicle

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[Introduction]

Soybeans, a representative food resource in the world, have various uses throughout the industry, from food to health functional food to cosmetics. Increasing the yield of soybeans is a major task for breeders, but soybeans are vulnerable to pests such as stink bugs, beetles, mites, and moths that reduce yields. Among them, *Riptortus pedestris* has been reported as a pest causing great damage to pods and leaves during the overall growing season of soybeans. By the time Riptortus pedestris is found in the field, it may have already spread enough to cause significant damage to soybean growth. Therefore, forecasting of soybean pests is essential to reduce yield losses. In this study, an experiment was conducted to detect objects of Riptortus pedestris and understand the distribution pattern by developing a surveillance platform based on RC vehicle and deep learning technology.

[Materials and Methods]

The experiment was conducted on the field of Pusan National University(PNU) (35°30'07.8"N, 128°43'16.2"E) at the Miryang. R1~R6 (before flowering) data collected from same conditions as the input data, and R7~ R9 (maturity) data is a group of data collected in the state of yellow color condition of soybean leaves after flowering. Laboratory condition data is a group of data collected in the environment for rearing insect pests, artificially created inside the laboratory. The RC vehicles used in this experiment are Devastator Tank Mobile Platform (DFrobot Inc. China) and Mpotow Large Remote Control Car (Mpotow Inc. USA). Devastator Tank Mobile Robot(DMR) is a robot platform using Raspberry pi 3 B+ and implemented as a Python code-based project. Deep learning is implemented with MRCNN, YOLOv3, and Detetron2. The environment consists of CUDA, NVIDIA, GPU 2080ti and Aanaconda prompts. Python coding is based on the Jupyter notebook sheet. In MRCNN, time-lapse image data is used as a train set and a test set.

[Results and Discussion]

As a result of training the Deep learning model based on the *R. pedestris* dataset, the training iteration is 150 and the max loss is 1.377 and the min loss is 0.1240. The total learning time was 15 hours, 6 minutes and 13 seconds. Confidence socre is an index indicating whether the AI accurately derives the target output through the convolutional network. C/I is a value derived by analyzing the precision and recall of objects in each image detected for object detection prediction through each Deep learning model. The confidence score for period R1~R6 calculated as 0.998, C/I indicator is 0.994, whereas, the Confidence score of the R7~R9 period was 0.958; the C/I was 0.794. In case of laboratory conditions, the confidence score got a 0.971, and C/I recorded as 0.842. The mAP values were calculated as 0.975, 0.957, 0.944 in YOLOv3, MRCNN, detectorn2 respectively.

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