Deep Learning(U-net, Semantic segmentation) for Sorghum field and Other Crop Segmentation

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Sorghum is one of the world's top five crops extensively studied abroad due to its nutritional and functional potential. Considering climate change, food self-sufficiency, etc., basic research on the cultivation areas and production are necessary for agricultural supply and demand and price stabilization policies. However, there has been no basic investigation since 2009 because of the small scale of production in Korea. Therefore, in this study, a semantic segmentation model was developed to calculate the cultivation area for sorghum using the images acquired from UAV to increase the efficiency of the investigation of the cultivation area.

RGB camera(Zenmuse P1, DJI Technology, China) was installed in UAV(Matrice 300 RTK, DJI Technology Inc, China) and took the image at an altitude of 80m based on 1cm/pixel of GSD. In 2022, those were acquired five times at the area in Andong-si, Gyeongsangbuk-do(36°30'20.3"N 128°36'27.6"E, about 24.95ha, sorghum cultivation area 1.6ha) from 28 July to 2 September. Among them, the images acquired on 28 July were combined using PIX 4D Mapper(Pix4d S.A., Switzerland), then divided into eight images as 8,000 × 8,000 pixels containing the areas of sorghum cultivation to reduce the number of pixels that could cause the class imbalance for the machine learning. After each image was labeled as Sorghum and Background using Label-Studio(Heartex Inc, USA), 1000 images with a resolution of 512 × 512 pixels were extracted at random locations in each image

The data channel and format in the labeled images change to a one-hot encoding method. Then it was designated as the final dataset for U-net Semantic Segmentation. Callback Functions(Early Stopping and ReduceLRONPlateau) were used to prevent overfitting of the model and reach the optimal model. The performance of models was verified through Accuracy, Dice Coefficiency, Cross Entropy Loss for Training Metrics, and OA, Kappa, and F1 Score for the Evaluation Metrics.

As a result of semantic segmentation, Training Metrics were obtained as Accuracy = 0.954, Dice Coefficiency = 0.948, and Cross Entropy Loss = 0.142 at 31 Epoch with 2 hours and 41 minutes. Evaluation Metrics obtained very excellent performance as of OA = 0.986, Kappa = 0.972, F1 Score = 0.986.

The generalization performance will be compared by the models with time-different datasets acquired in 2022(8/13, 8/18, 8/25, 9/2) and the test dataset acquired in 2023.

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