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# DEVELOPMENT OF WEEDING ROBOTS USING AI IMAGE RECOGNITION TECHNOLOGY

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## ABSTRACT

In this study, a laser weeding robot was developed to remove weeds, one of the factors that interfere with the growth of crops in agricultural fields. The driving unit controlled the speed of the DC motor using an Arduino-Mega (MCU). The weed recognition unit calculated the location information of the weeds using the cabbage and weed image recognition model (YOLO-v8) mounted on the control device (Jetson-Orin). The calculated location information was transmitted to the MCU through serial communication. In the laser weeding unit, laser head transfer and laser irradiation were conducted through the MCU using ATOMSTACK's X40 Pro 210W product. As a result of conducting a weeding performance test using a simulated object printed on a two-dimensional plane through this study, the target recognition rate was 95.7%, and the laser irradiation accuracy for weeds was 95.3%.

**Keywords:** Precision agriculture, Weed recognition, YOLOv8, Laser irradiation, Weed removal

## INTRODUCTION

In crop management, weeds are obstacles to crop growth. On farmland, weeds compete with crops for nutrients, space, light, and moisture resulting in a 20-50% reduction in production of growth crops. There are weeding methods such as chemical, mechanical, and biological to solve this problem, but these weeding methods have limitations, such as environmental pollution problems and problems with poor accuracy of weed removal. In contrast, laser weeding technology is attracting attention as a sustainable weeding method by reducing soil pollution and minimizing the input of chemicals. In the agricultural environment of Korea, there are difficulties in managing growth crops due to the decrease in the farm population, aging, climate change, and low field agriculture mechanization rate. To solve this problem, an autonomous weed removal technology is required, and a laser weeding robot that can be used in field agriculture has been developed. Through this study, it was intended to develop a small-sized, self-propelled laser weeding robot suitable for field agriculture with the aim of solving environmental pollution problems and lack of agricultural labor during weeding and improving the mechanization rate of Korean field agriculture.

## MATERIALS AND METHODS

The weeding robot consisted of a driving unit, a weed recognition unit, and a laser weeding unit. The driving unit was driven using a DC motor. The driving speed was set to 0.36 m/s based on preliminary tests showing optimal weed recognition and removal rates. In the weed recognition unit, an RGB camera to recognize weeds, an artificial intelligence model operation, and a control device (Jetson-Orin) was used to transmit the location of the weeds through serial communication by connecting the control device and the MCU (Arduino-Mega). The artificial intelligence model recognized weeds by producing a YOLO-v8 model. To produce a weed recognition model, a total of 224 images of weeds and growth crops were acquired at 3-day intervals for 1 month. In the laser weeding unit, ATOMSTACK's X40 Pro 210W product was used. The maximum output of the laser module was 48W, and the working speed was 0.5 s. An MCU was used to operate the driving unit and the laser irradiation unit. A safety shutoff and temperature monitoring system were implemented to prevent laser overheat.

## RESULTS & DISCUSSION

Table 1. Performance Metrics of YOLOv8 Model on Test Datasets

| Model | Class | Inference | Accuracy | Precision | Recall | F1 Score | mAP @0.5 |
|---|---|---|---|---|---|---|---|
| YOLOv8 | Cabbage Seedling | 51.9ms | 0.66 | 0.98 | 0.85 | 0.91 | 0.93 |
| | Weed | | | 0.98 | 0.76 | 0.85 | 0.53 |

Table 2. Laser Weeding Rate

| Target | Target recognition rate | Laser irradiation accuracy |
|---|---|---|
| Weed | 95.7% | 95.3% |

As a result of model production of cabbage and weeds using the YOLO-v8 model, the results shown in Table 1 were found. Accuracy was 0.66, which showed a low overall model accuracy. When comparing the recognition performance of cabbage and weeds, Recall, F1 score, mAP@0.5 values showed relatively low weed recognition performance, and mAP@0.5 values showed the lowest result in weed recognition performance, which is the reason for misrecognition due to the overall number of data and inaccurate labeling of weeds. The results of Table 2 are the test results for a simulated object on a 2D plane. The target recognition rate was 95.7%, and the laser irradiation accuracy was 95.3%.

## CONCLUSIONS

Through the results of this study, there is a disadvantage in that it is not possible to determine the accuracy of model performance according to the field applicability and variables for the external environment. By supplementing these points, the experiment will be conducted by applying them to the field.

## REFERENCES

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