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Assessment of Seeding and Weeding Field Robot Performance

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Abstract : Field robots are an important tool for enhancing efficiency and decreasing the climatic impact of food production. There exists a number of commercial field robots; however, since this technology is still new, the robot advantages and limitations, as well as methods for optimal using of robots, are still unclear. In this study, the performance of a commercial field robot for seeding and weeding was assessed. A research 2-ha sugar beet field with 0.5m row width was used for testing, which included robotic sowing of sugar beet and weeding five times during the first two months of the growing. About three and five percent of the field were used as untreated and chemically weeded control areas, respectively. The plant detection was based on the exact plant location without image processing. The robot was equipped with six seeding and weeding tools, including passive between-rows harrow hoes and active hoes cutting inside rows between the plants, and it moved with a maximal speed of 0.9 km/h. The robot's performance was assessed by image processing. The field images were collected by an action camera with a height of 2 m and a resolution 27M pixels installed on the robot and by a drone with a 16M pixel camera flying at 4 m height. To detect plants and weeds, the YOLO model was trained with transfer learning from two available datasets. A preliminary analysis of the entire field showed that in the areas treated by the robot, the weed average density varied across the field from 6.8 to 9.1 weeds/m^2 (compared with 0.8 in the chemically treated area and 24.3 in the untreated area), the weed average density inside rows was 2.0-2.9 weeds / m (compared with 0 on the chemically treated area), and the emergence rate was 90-95%. The information about the robot's performance has high importance for the application of robotics for field tasks. With the help of the developed method, the performance can be assessed several times during the growth according to the robotic weeding frequency. When it’s used by farmers, they can know the field condition and efficiency of the robotic treatment all over the field. Farmers and researchers could develop optimal strategies for using the robot, such as seeding and weeding timing, robot settings, and plant and field parameters and geometry. The robot producers can have quantitative information from an actual working environment and improve the robots accordingly.

Keywords : agricultural robot, field robot, plant detection, robot performance
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