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Autonomous navigation in cotton fields using deep learning.

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Abstract

Autonomous navigation in agricultural environments presents a unique challenge due to uncertainties of outside environment. Different techniques have been tried but each one has their unique challenges, like GPS guidance with availability issues and inability to avoid obstacles, or several vision guidance techniques with their sensitivity to changes in light, weeds presence, and crop growth stages. The emergence of deep learning technology has opened the potential for a powerful and robust way of discriminating between crop rows and paths between the rows through training the model with examples (images) of different environment scenery, this may be useful in detecting the pathway between the crop rows where the vehicle can navigate. To detect pathway between crop rows, the technique must be robust against the outside environment challenges. In this study, a fully convolutional neural network for semantic segmentation model chosen due to its robustness and fast predictions, was trained on cotton rows images from the field and used to detect paths between cotton rows. Then the predicted paths in the image domain were mapped to ground plane to determine the position of the rover. An experiment that tracks the position of the rover and compares it to the predicted position was performed. The result showed great performance of the method, especially on early stages of cotton growth. The method was able to predict the path and the rover position within 0.07m of the real position for early stages of cotton growth, and 0.12m of real rover position for late cotton growth stages. The model was proved to be robust against lighting conditions, shadows, cotton growth stages, and weed presence. Minor inconsistencies on paths occluded by extreme cotton leaves spread observed may be avoided by providing more labeled examples to the training process.

Keywords: Robotics, guidance, path planning, AI