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Object Detection and Recognition in Unstructured Outdoor Environments

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Akademisk avhandling

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Abstract

Computer vision and machine learning based systems are often developed to replace humans in harsh, dangerous, or tedious situations, as well as to reduce the required time to accomplish a task. Another goal is to increase performance by introducing automation to tasks such as inspections in manufacturing applications, sorting timber during harvesting, surveillance, fruit grading, yield prediction, and harvesting operations. Depending on the task, a variety of object detection and recognition algorithms can be applied, including both conventional and deep learning based approaches. Moreover, within the process of developing image analysis algorithms, it is essential to consider environmental challenges, e.g. illumination changes, occlusion, shadows, and divergence in colour, shape, texture, and size of objects.

The goal of this thesis is to address these challenges to support development of autonomous agricultural and forestry systems with enhanced performance and reduced need for human involvement. This thesis provides algorithms and techniques based on adaptive image segmentation for tree detection in forest environment and also yellow pepper recognition in greenhouses. For segmentation, seed point generation and a region growing method was used to detect trees. An algorithm based on reinforcement learning was developed to detect yellow peppers. RGB and depth data was integrated and used in classifiers to detect trees, bushes, stones, and humans in forest environments. Another part of the thesis describe deep learning based approaches to detect stumps and classify the level of rot based on images.

Another major contribution of this thesis is a method using infrared images to detect humans in forest environments. To detect humans, one shape-dependent and one shape-independent method were proposed.

Algorithms to recognize the intention of humans based on hand gestures were also developed. 3D hand gestures were recognized by first detecting and tracking hands in a sequence of depth images, and then utilizing optical flow constraint equations.

The thesis also presents methods to answer human queries about objects and their spatial relation in images. The solution was developed by merging a deep learning based method for object detection and recognition with natural language processing techniques.

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Computer vision, Deep Learning, Harvesting Robots, Automatic Detection and Recognition

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