別紙４－１（課程博士（英文））

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Department of Computer Science and Engineering	Student ID Number	D163373
Applicant's name	Shigemichi Matsuzaki	

Supervisors	Jun Miura Naoki Uchiyama

Abstract (Doctor)

Title of Thesis	Scene Recognition for Mobile Robots in Plant-rich Environments Considering Traversable Plants

Approx. 800 words

Majority of conventional mobile robots rely on scene recognition methods that consider only the geometric information of the environment. Those methods, therefore, cannot recognize paths as traversable when the paths are covered by flexible plants. This problem hinders application of mobile robots in unstructured plant-rich environments. To realize successful navigation in such environments, the robots need to have an ability to distinguish traversable plants from other obstacles. In this thesis, we describe a framework of scene recognition for robot navigation in plant-rich environments that explicitly considers traversable plants. This thesis consists of three key proposals.

First, we propose a method to train a deep neural network (DNN) for semantic segmentation that does not require manual annotation on target images. We work around the need for manual annotation by utilizing multiple publicly available datasets as source datasets from which to transfer knowledge about appearances of objects. Specifically, we exploit segmentation models pre-trained on each source dataset to generate pseudo-labels for the target images based on agreement of all the pre-trained models on each pixel. The proposed method allows for effectively transferring the knowledge from multiple sources rather than relying on a single dataset and realizes precise training of semantic segmentation model.

Second, we propose a method to estimate the traversability of plant parts covering a path and navigating through them. We employ an image-based DNN model with two decoder branches to estimate on each pixel the general object classes, and ¥textit{traversability} indicating how likely the object can be hit by the robot while moving. We train the traversability estimation branch utilizing the robot's traversal experience during the data acquisition phase, and thus the training procedure is free from manual annotation. A real-world navigation experiment was conducted using the proposed scene recognition method.

Third, we propose a method of online refinement of the scene recognitio n model to deal with misclassification that occurs during robot operation. In our system, misclassification may lead the robot to getting stuck due to th e traversable plants recognized as obstacles. Yet, misclassification is inevita ble in any estimation methods. To deal with the problem, we propose a fra mework that allows for refining a semantic segmentation model on the fly d

uring the robot's operation utilizing observation of a human's interaction wit h the traversable plant parts.

The proposed framework enables robot navigation in plant-rich environments by recognizing traversability plants. It also allows for easy deployment of the mobile robots in such environments by providing manual annotation-free training methods, and practical online refinement of the scene recognition model to easily deal with misclassification problem.