Short Term Mobility Program 2010

Final Report

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Beneficiary: Dr. ANNALISA MILELLA, Researcher, Institute of Intelligent Systems for Automation (ISSIA-CNR), Bari, Italy

Host Institution: Australian Centre for Field Robotics (ACFR), University of Sydney, Australia

Period of stay: November 18th – December 18th 2010

Title of the research program:

Multi-sensor data integration for navigation and localization of mobile robots in unstructured environments.

Description of the research activity:

Sensor fusion is a key issue in the field of mobile robotics. Integration of heterogeneous data coming from various on-board sensors is crucial for the correct execution of autonomous navigation tasks, since it guarantees the necessary level of accuracy and reliability.

The research activity carried out in the context of the Short Mobility Program 2010 at the Australian Centre for Field Robotics (ACFR) was aimed at studying and developing

data fusion methods for safe navigation and environment learning and interpretation, by an autonomous mobile robot operating in non-structured environments.

The activity included the following main phases:

1.   *Analysis of the datasets:*

First of all, an analysis of the available datasets was carried out. The datasets consist of time-synchronized data obtained using an unmanned ground vehicle equipped with a wide variety of sensors, including: multiple laser scanners, a millimeter wave radar scanner, a color camera and an infra-red camera. The data were acquired in different environmental conditions. The following problems were specifically addressed:

- sensor calibration;

- possible failure conditions of the various sensorial systems.

Issues related to the integration of the different sensor modalities were successively analyzed, in order to improve the vehicle perception system in terms of:

- completeness of information,

- measurement accuracy;

- reliability.

2.   *Algorithm development:*

In this phase, a method to fuse different sensor modalities for the purpose of ground segmentation and characterization was developed. Ground segmentation is a key capability for a vehicle to safely traverse natural terrain, since, by properly identifying the ground location in the scene, the vehicle can find the safest path to reach a goal position, as well as detect obstacles. In addition, the developed approach allows us to construct a model of the ground, in order to estimate the ground properties and evaluate the traversability of the terrain by the vehicle. To achieve this aim, various types of visual features extracted by visual patches of the ground were analyzed. These features include:

- texture features, based on first and second order statistics;

- color features, using RGB and HSV color spaces;

- Histogram of Oriented Gradient (HOG) descriptors.

Using the different feature sets, different classifiers were successively implemented and tested, including Naïve Bayes, k-nearest neighbour, and Neural Networks.

It is expected that the results of the research will lead at least to one scientific publication. Future developments of the proposed models and measurement methods will be aimed at reaching improved environment perception and navigation capabilities of field robots. Furthermore, the research program will lead to collaboration opportunities between ACFR and CNR ISSIA. The results of such collaborations could bring significant advances in the context of outdoor mobile robotics and of its numerous application fields ranging from inspection, to agricultural robotics, disaster rescuing, and planetary exploration.

Bari, 14/01/2011

Il fruitore:

Dr. ANNALISA MILELLA

Il proponente:

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