Real-Time Multi-Sensor Localisation and Mapping Algorithms for Mobile Robots

by

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Abstract

A mobile robot system provides a grounded platform for a wide variety of interactive systems to be developed and deployed. The mobility provided by the robot presents unique challenges as it must observe the state of the surroundings while observing the state of itself with respect to the environment. The scope of the discipline includes the mechanical and hardware issues, which limit and direct the capabilities of the software considerations. The systems that are integrated into the mobile robot platform include both specific task oriented and fundamental modules that define the core behaviour of the robot. While the earlier can sometimes be developed separately and integrated at a later stage, the core modules are often custom designed early on to suit the individual robot system depending on the configuration of the mechanical components.

This thesis covers the issues encountered and the resolutions that were implemented during the development of a low cost mobile robot platform using off the shelf sensors, with a particular focus on the algorithmic side of the system. The incrementally developed modules target the localisation and mapping aspects by incorporating a number of different sensors to gather the information of the surroundings from different perspectives by simultaneously or sequentially combining the measurements to disambiguate and support each other. Although there is a heavy focus on the image processing techniques, the integration with the other sensors and the characteristics of the platform itself are included in the designs and analyses of the core and interactive modules.

A visual odometry technique is implemented for the localisation module, which includes calibration processes, feature tracking, synchronisation between multiple sensors, as well as short and long term landmark identification to calculate the relative pose of the robot in real time. The mapping module considers the interpretation and the representation of sensor readings to simplify and hasten the interactions between multiple sensors, while selecting the appropriate attributes and characteristics to construct a multi-attributed model of the environment.

The modules that are developed are applied to realistic indoor scenarios, which are taken into consideration in some of the algorithms to enhance the performance through known constraints. As the performance of algorithms depends significantly on the hardware, the environment, and the number of concurrently running sensors and modules, comparisons are made against various implementations that have been developed throughout the project.

Keywords: Mobile Robot, Localisation, Mapping, Sensor fusion, Image processing

Certification

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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