Proposta Tesi de Màster

Director principal: Dr. Domènec Puig

Grup de recerca: RIVI – Robòtica i Visió Intel·ligents

Títol de la tesi de màster: Single Camera Simultaneous Localization and Mapping.

Estudis on s'ofereix: MIA

Treball assignat a l'alumne: Xavier Gironés Sancho

Descripció de la tesi de màster:

The Intelligent Robotics and Computer Vision (RIVI) group of the URV has been working in the past years in an active research line for the computer vision and robotics community. This line is referred to as Simultaneous Localization and Mapping (SLAM) [Davison, 2001] [Durrant, 2006].

SLAM is a technique used by robots and autonomous vehicles to build up a map within an unknown environment (without a priori knowledge) or to update a map within a known environment (with a priori knowledge from a given map) while at the same time keeping track of their current location.

The ability to both recognize landmarks and to accurately estimate the robot own movement through space is traditionally one of the more difficult problems in robotics. Usually this kind of thing is done using laser scanners or other high precision optics which are much too expensive to become practical consumer products, and also contain moving parts which could potentially fail during the rough-and-tumble of robotic life.

However, recently, a new topic has emerged as a new important topic for the scientific community. This is the Single Camera SLAM or MonoSLAM (vision-based, monocular, bearing-only SLAM, in full 3D and without inertial sensing) [Davison, 2007]. This is technology that could provide cheap real-time localization for domestic robots, humanoid robots, wearable sensors, game interfaces or other devices.

Some of the potential advantages of MonoSLAM with respect to the classical SLAM 3D are due to the use of a single low cost camera it's not restricted to only moving in certain ways (such as pan/tilt directions), which means that it could potentially be attached to a robot having any degree of mechanical complexity.

This Master Thesis is oriented to the study of the MonoSLAM in comparison with the classical SLAM 3D and the reliability of the former for real-time robotics localization and exploration tasks.

The specific goals of this Master Thesis are:

1. Report an introduction to SLAM.

2. Summarize the state of the art in Visual SLAM.

3. Revision of the visual features for robot localization and other technical requirements (such as, camera calibration and distortion correction [Hartley, 2007] [Civera, 2009]).

4. Perform the state of the art in MonoSLAM.

5. Study the main drawbacks of Visual SLAM with 3D cameras.

6. Revise the standard implementations of MonoSLAM.

7. Propose possible improvements on the standard MonoSLAM methodology in order to increase the localization and scene reconstruction capabilities of autonomous robots during an exploration task.

8. Finally, if it is possible, the work developed in this Master Thesis will be published in some related conference or scientific journal

References:

[Civera, 2009] J. Civera, D.R. Bueno, A.J. Davison and J.M. Montiel. "Camera Self-Calibration for Sequential Bayesian Structure From Motion". In Proc. ICRA 2009.

[Davison, 2001] A.J. Davison and N. Kita. "Sequential Localization and Map-Building for Real-Time Computer Vision and Robotics". Robotics and Autonomous Systems, 2001.

[Davison, 2007] A.J. Davison, I. Reid, N. Molton and O. Stasse. "MonoSLAM: Real-Time Single Camera SLAM", IEEE Trans. PAMI 2007.

[Durrant, 2006] H. Durrant-Whyte and T. Bailey. "Simultaneous Localisation and Mapping (SLAM): Part I The Essential Algorithms". Robotics and Automation Magazine 13: 99-110, 2006.

[Hartley, 2007] R. Hartley, S.B. Kang. "Parameter-free radial distortion correction with center of distortion estimation". IEEE Trans. PAMI, 29(8): 1309-1321, 2007.