Detailed description

The objective of the PhD thesis is to develop advanced techniques for 3D reconstruction of scenes containing numerous moving objects. Nowadays, it’s quite easy to reconstruct a scene in 3D using RGB-D sensors or stereoscopic cameras. Thus, we can obtain at each time a 3D information about the scene. The quality of this reconstruction and the part of the reconstructed scene strongly depend on the sensor we use. This is why, in order to enhance the quality and reconstruct large scene, it’s necessary to perform multiple acquisitions. These acquisitions are registered for obtaining a global 3D reconstruction of the scene. When the scene is fixed and the sensor is moving, the registration methods are well known and well validated [1]. The main part of these methods uses the ICP (Iterative Closest Point) [2] which allows to register two partial views of the same object. When some objects in the scene are also moving, the problem becomes more complex and the classical ICP is not appropriate. Some methods consider the mobile objects as outliers and propose some robust statistical tools for rejecting these data [3]. Nevertheless, these methods provide acceptable results only if few mobile objects are present in the scene. Indeed, when the scene is composed of numerous mobile parts, the statistical approaches are not able to separate the data in outliers and inliers classes, thus we have to propose other techniques able to deal with this problem. Recently, other methods have been proposed in order to register 3D clouds of points highly dynamic without assumptions about the proportion of fixed elements. These methods consist in partitioning the 3D space in 3D sub-spaces linearly independent which model each motion in the scene [4]. These approaches allow to register dynamic 3D clouds of points even with numerous moving objects. However, to decompose the 3D space in multiple 3D sub-spaces, we need to suppose that each moving object follows a rigid motion with 6 degrees of freedom (Rotation and Translation). Thus, when the scene is composed of mobile objects with no-rigid motion such as pedestrians, cyclists… these methods fall.

In this PhD thesis, we consider the case where the scene contains static and/or dynamic objects. We suppose that moving objects may follow rigid and/or no-rigid motion. The camera acquiring video is also moving (the camera is installed on a car), with rigid motion. To reduce the complexity, we will develop a new approach based on modeling the motion of each object using polynomial functions. Then, the objective is to conjointly estimate the registration due to the rigid motion of the camera and the registration due to the moving
objects present in the scene. Inspired from [5], the proposed approach should be robust to the error of acquisition and optimal in terms of convergence.

Applications of this research work include 3D reconstruction and 3D localization of a camera in a complex environment. It is envisaged to exploit the results in the framework of the intelligent vehicles project developed in the laboratory.

We expect close collaboration with Le2i laboratory (University of Burgundy) in the framework of an ANR project (French Agency) called pLaTINUM, where the goal is to reconstruct urban scenes in 3D. The project involves other partners: IGN (National Institute of Geography), LITIS Rouen and INRIA Sophia-Antipolis where the goal.

References


Keywords
3D reconstruction, 3D registration, ICP (Iterative Closest Point), rigid/no-rigid motion, structure from motion, polynomial functions based modeling, motion segmentation, video camera acquisition.

Experimental platform
The PhD student will benefit from the IRTES-ICAP experimental platform composed with vehicles, equipped with cameras, stereoscopic systems, 2D/3D Lidars, GPS, inertial navigation systems, etc.
Candidate profile
The candidate should have skills in the following disciplines: applied mathematics, computer vision/image processing. Strong skills in Matlab and C/C++ programming are also required. The candidate will be involved within an experimental platform (intelligent vehicles equipped with different sensors) and should participate to acquire data, test and evaluate developed algorithms/methods.

Contacts
The PhD candidate will be integrated into the PENA group (http://epan.fr/) of the IRTES laboratory (UTBM). Any inquiries (questions, papers, references, etc.) should be sent to: Prof. Yassine Ruichek (yassine.ruichek@utbm.fr).

List of papers published by the team in last 4 years (2012-2016)

- **Chapters in books:**

- **International journals:**
6. F. Dornaika A. Moujahid, A. Bosaghzadeh, Y. El Merabet, and Y. Ruichek, Object classification using hybrid holistic descriptors: Application to building detection in aerial orthophotos, Polibits, 51, pp. 11-17, 2015 (ISSN 2395-8618).

**International conferences:**


Awarded: Second Best paper


34. Y. Li, Y. Ruichek, C. Cappelle, Extrinsic calibration between a stereoscopic system and a lidar with sensor noise models, IEEE International Conference on Multisensor Fusion and Information Integration (MFI’2012), Hamburg, Germany, 2012.


