Subject of the thesis: Fully automatated metrology with UAV photogrammetry, as well as precise permament and onboard GPS. Application to dyke monitoring.

Doctoral school : MSTIC -Université Paris Est

Host laboratory : Laboratoire d'Opto-Electronique, Métrologie et Instrumentation (LOEMI),

Supervisors of the thesis : Marc Pierrot Deseilligny (HDR-LOEMI) , co-directeur Christian Thom (LOEMI)

Co-supervisors of the thesis : Olivier Martin (LOEMI) et Paul-Henri Faure (ingénieur CNR).

Funding: CNR-funded scholarship

Industrial partners : Compagnie Nationale du Rhône, Lyon. Concessionnaire du Rhône pour la production d'électricité (www.cnr.tm.fr).

1-Scientific context

The research subject is at the crossing of two technological contexts that have been undergoing a revolution in the last decade : the development of the unmanned aerial vehicles (UAV) and the development of algoritms apt for automated 3D modeling from images.

Today, in many aspects, the production of 3D models that are visually appealing is no more a question of research, and there exist numerous private companies that offer such services, using some of the commerically available software tools.

Nonetheless, if the 3D models shall be used for metrology purposes, their production still poses several problems that are unsolved today, especially when precision/accuracy, robustness and automated processing is of interest.

2-Application and related work

The thesis is a research project formed within the partnership between CNR (concessionnaire du Rhône) and IGN. The objective is to devise a system which – using images – will allow to reconstruct the geometry of dykes, with accuracy below a centimeter.

A former thesis (Vincent Tournadre 2012-2015) has proved that employing suitable data processing techniques (camera calibration model), geometry of image acquisition (nadir and oblique views), as well as appropriate hardware, it is possible to derive the geometry with the accuracy at the level of several centimeters, even with a reduced number of control points. Considering the Public Works (Batiment Travaux Public), another thesis (Mehdi Daakir 2014-2017) attempted to show that while deploying an onboard GPS of decent precision (GéoCube), it is feasible to achieve accuracy of 2-3cm with a single control point.

3-Scientific contribution and the activities planned

The objective of this work is to obtain a centimeter (or below) accuracy, without any field measurements, and relying solely on photogrammetry and the network of permament GPS points from the GéoCube.

The workflow to start with will consist of :

– familiarization with the work of Mehdi Daakir, who, fusing the onboard GPS with photogrammetry obtained accuracy of 2-3cm ;

– perform automatic and accurate (milimeter?) detection of permament GPS points, given the estimated poses of the cameras/images ;

– familiarization with the work of both M Daakir & V Tournadre regarding the optimised compensation of observations from photogrammetry, the onboard GPS and the permament GPS.

It is believed to be able to promptly arrive at an operational system so long there is a suffiecient number of permament GPS points. Then, to have a system applicable on a large scope, with a low number of points GPS, certain innovation will be required. Among the possible roadmaps there are :

– improvement of the tie points, notably by taking advantage of the predicted 3D model of the terrain and selecting points that are homogenously distributed, of high intersection multiplicity and image measurement precision below 1/10th of a pixel ;

– the use of new camera calibration models that allow to correct the high frequency systematism.

The thesis will involve a lot of experimental and field work. The processing and algoritmic developments will rely on the photogrammetric workflow of the open source tool MicMac/Apero, developed at IGN. As this thesis is part of an industrial research project and will serve the third party objectives, all developed methods will require scrupulous documentation enabling non-specialist users to interact with it.

4-Profile of the candidate :

– interested in applied research

– with a good background in mathematics

– capable or at least with strong interest in programming and basic command of C/C++

– familiarity with image processing ;

– an ideal candidate will have graduated in photogrammetry/computer vision or geodesy (GNSS)

5-Encadrement et conditions

The thesis will be carried out within a collaboration between Compagnie Nationale du Rhône and l'Institut Géographique National. The PhD student will be employed by IGN and his/her usual workplace will be located at l'Ecole Nationale des Sciences Géographiques (ENSG) in Marne la Vallée.

Frequent trips between Lyon and the site of the experiments indicated by the Compagnie Nationale du Rhône are expected.

The salary will follow the IGN doctoral allowances, which for today summs up to 1684 Euro brutto per month, which can rise up to 2024 if the student will be involved in teaching (ca. 1340 and 1610 Euros net).