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PROPOSITION DE SUJET DE THESE

Intitulé : Développement des algorithmes de navigation adaptative aux indicateurs de changement de contexte et analyse de ses performances et intégrités

Référence : **TIS-DTIS-2019-01**
(à rappeler dans toute correspondance)

Laboratoire d'accueil à l'ONERA :

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Sujet : Développement des algorithmes de navigation adaptative aux indicateurs de changement de contexte et analyse de ses performances et intégrités

This thesis focuses on a realization of a navigation system based on tight-integration of a monocular vision system with a Global Navigation Satellite System (GNSS). Harsh environment such as urban context presents significant challenges for satellite positioning. On one hand, because of the proximity of various obstacles, the user might require a higher positioning accuracy in an urban environment than in open sky areas. On the other hand, the urban environment creates difficulties in the GNSS signal reception, particularly due to satellite masking and multipath phenomena. As a consequence, the GNSS receiver delivers a position that can be biased by an error of several tens of meters.

In the last decade in the robotics community, one can find an intensive research work devoted to vision-based navigation in such a cluttered environment (visual odometry, visual SLAM). Most of the existing approaches on vision-based navigation exclude GNSS availability as they are designed as an alternative navigation solution in GNSS-denied environment (such as indoor). Meanwhile in the GNSS research community, a tight integration of IMU/GNSS has been widely investigated for improving the navigation integrity by detecting and eliminating multi-path effects. However, up to now, a very few work has been done for tight integration of vision sensors and GNSS.

In this context, this thesis aims to develop new algorithms of tightly-integrated vision/GNSS navigation which is robust and adaptative to changement in its operating environment (called "context") such as indoor-outdoor transitions with possible GNSS occlusion and degradation. This new "context-aware" navigation approach will integrate monocular vision with GNSS at different levels:

1) Fusing visual odometry measurements for pose estimation to GNSS positionning. This first step will allow to improve global positionning and more particularly the attitude of the vehicle by using classical image processing methods in order to detect relative camera motion.

2) Using semantic perception of the environment for detecting the "context" of evolution of the vehicle. The detection results given as a context indicater (such as an urban, natural or open-sky environment) will be used to adjust/adapt fusion approaches (selections of sensors, observation models) or sensor confidence parameters used in the navigation filter.

3) Visual detection of GNSS NLOS (Non-Line-of-Sight). Due to vehicle attitude changes but also to the encountered context (urban canyon, forest, etc.), the probability of GNSS signal occlusion can be high. Considering this, visual perception is also used to detect obstacle occlusion in order to give information about GNSS satellite visibilities (such as masking and multipath risk) to the navigation filter so that it can fuse only available and reliable satellite signals for improving the navigation precision and integrity.

As a result, this thesis first dvelops and applies different image processing algorithms to detect the environmental contexts (motion estimation, scene analysis and semantic perception) which will aid the navigation. Then, adaptive navigation algoritms, which reconfigures sensor fusion approaches and parameters in function of the detected context, will be developed.

The developped algorithms will be tested on real sensor data acquired with experimental platforms available at ISAE-SUPAERO. Data recording will provide accurate ground truth localization (GPS-RTK) to be compared with our positionning method.

Collaborations extérieures : ISAE-SUPAERO

PROFIL DU CANDIDAT

Formation : école d'ingénieur, master de recherche

Spécificités souhaitées : Connaissance de la domaine automatique et de la traitement d'images