IMPROVING GPS LOCALIZATION WITH VISION AND INERTIAL SENSING

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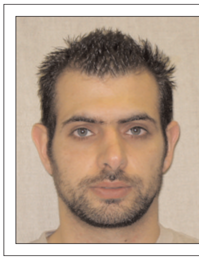
Inertial sensors and cameras are two sources of odometry that can provide a means of continuous localization when the GPS signal is blocked because of jamming or interference. Furthermore, they augment the GPS localization with orientation (heading) information. Although there have been many approaches to fuse GPS with vision and inertial measurements, most of these approaches are still subject to many conditions, assumptions, and specific applications that do not guarantee the most accurate localization from inferred measurements of the available sensors at all times. We propose a comprehensive framework to fuse GPS intelligently with vision and inertial data by automatically, and adaptively, selecting the best combination of sensors and the best set of parameters. Our framework, based on multiple hypotheses, is a roadmap for real time systems that provide high accuracy, outlier robustness, and scalability when mapping a large number of 3D points.

Les capteurs inertiels et les caméras sont deux sources d'odométrie qui fournissent une méthode de localisation en continu lorsque le signal GPS est bloqué à cause d'un brouillage intentionnel ou d'interférence. En outre, ils améliorent la localisation du GPS avec de l'information sur l'orientation (le cap). Même s'il y a eu plusieurs approches pour fusionner le GPS avec des mesures visuelles et d'inertie, la plupart de ces approches sont encore assujetties à de nombreuses conditions, suppositions et applications précises qui ne garantissent pas la localisation la plus exacte des mesures inférées des capteurs disponibles en tout temps. Nous proposons un cadre approfondi pour fusionner de façon intelligente le GPS avec les données visuelles et les données inertielles en choisissant, de façon automatique et adaptative, la meilleure combinaison de capteurs et le meilleur ensemble de paramètres. Basé sur des hypothèses multiples, notre cadre est une feuille de route pour les systèmes en temps réel qui fournissent une grande exactitude, une robustesse centre les valeurs aberrantes et une variabilité dimensionnelle pour cartographier un grand nombre de points tridimensionnels.



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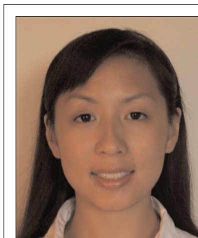

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1. Introduction

Mobile mapping vehicles, as well as pedestrians, equipped with GPS are often subject to satellite shading and signal dropout when operating along tree-lined streets, in wooded areas, and environments where tall buildings can block reception. Vehicle mounted GPS positioning is further hindered by structures which cause satellites to go in and out of view, limiting a GPS receiver's ability to provide continuous and accurate position information. In addition, multi-path problems encountered as a result of signals bouncing off reflective surfaces often cause GPS systems to be unable to provide reliable positioning information in this type of area. One way to provide uninterrupted measurements of the position, roll, pitch, and true heading of moving vehicles is to integrate precision GPS with advanced inertial technology, similar to what planes and rockets use; however, such technology is unfeasible for the automotive or pedestrian sector due to the expense.

As humans, we are very successful in navigating, localizing, and finding our way with our eyes and inertial system (vestibular system). In this investigation, we mimic sensor fusion algorithms that combine the results of computer vision algorithms with the outputs of GPS and inexpensive inertial sensor measurements. Our system is fast, scalable, and flexible; it selectively fuses measurements from the given sensors in a robust, probabilistic, multi-hypothesis approach that always gives the best possible localization and mapping. We also include a magnetometer (i.e. compass) in the system apparatus. The magnetometer, providing information about absolute orientation, enhances the ability of the system to avoid large drift after losing the GPS signal. Our system is not tied to any specific image feature detector and tracker. Therefore, any feature detector can be used to detect features in the images and any tracker (or matcher) can be used to track those features between images. Our system is resilient to the problems and failures of the feature tracker; firstly, it uses multiple hypotheses and, secondly, it uses additional information from the other sensors. We provide preliminary results to prove the validity and feasibility of our proposed approach.