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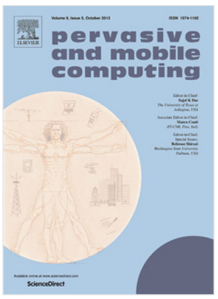

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Attitude Estimation for Indoor Navigation and Augmented Reality with Smartphones

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Abstract

We investigate the precision of attitude estimation algorithms in the particular context of pedestrian navigation with commodity smartphones and their inertial/magnetic sensors. We report on an extensive comparison and experimental analysis of existing algorithms. We focus on typical motions of smartphones when carried by pedestrians. We use a precise ground truth obtained from a motion capture system. We test state-of-the-art and built-in attitude estimation techniques with several smartphones, in the presence of magnetic perturbations typically found in buildings. We discuss the obtained results, analyze advantages and limits of current technologies for attitude estimation in this context. Furthermore, we propose a new technique for limiting the impact of magnetic perturbations with any attitude estimation algorithm used in this context. We show how our technique compares and improves over previous works. A particular attention was paid to the study of attitude estimation in the context of augmented reality motions when using smartphones.

Keywords: Attitude Estimation, Smartphone, Inertial Sensors, Augmented Reality Motions, Magnetic Field, Perturbations, Benchmark.

1. Introduction

Pervasive applications on smartphones increasingly rely on techniques for estimating attitude. Attitude is the orientation of the smartphone with respect to Earth's local frame [1]. Augmented Reality applications [2, 3, 4], pedestrian dead-reckoning systems for indoor-localisation [5], and photo sphere creations and previews [6] constitute examples in which precision and stability of attitude estimation matter. For example, in the Pedestrian Dead Reckoning (PDR) process, the attitude estimation is used to determine a user direction. If this information is coupled with a step detection algorithm [7], the relative position of a user can be determined (Fig. 1). Augmented Reality (AR) is another example where the reliability of attitude estimation is important. AR is a live view of a real world environment where virtual objects are shown over the camera image of a hand-held device. Geo AR [8] (or Gravimetric AR) is an AR method which

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