The Use of GPS for Handling Lack of Indoor Constraints in Particle Filter-Based Inertial Positioning*

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Abstract. Particle filter-based inertial positioning promises infrastructure-less positioning, but previous research have not provided an understanding of, how the positioning accuracy of such systems depends on the layout of building structures. This poster presents initial result for the impact of the layout of building structures on the positioning accuracy using a particle filter-based inertial positioning system named Pro-Position. We also consider methods for using GPS positioning with particle filter-based inertial positioning to improve accuracy in areas, where positioning is poor because of lack of constraints from the layouts of the building structures.

Keywords: Inertial Positioning, Particle Filter, GPS, Error Sources.

1 Infrastructure-Less Positioning Using Pro-Position

Applying the visions of ubiquitous computing to a variety of domains require indoor positioning independently of local infrastructures. Examples of such domains are fire fighting, search and rescue, health care and police work. A second reason is, that in many indoor areas satellite systems such as GPS, does not provide pervasive coverage and provides a poor accuracy when available [4]. Pedestrian inertial positioning is a technology promising infrastructure-less positioning by depending solely on sensing movement. The primary focus has been devoted to foot-mounted [1,5] and waist-mounted [3] inertial systems. In this work we present and evaluate an inertial positioning system called Pro-Position and we extend the system using GPS positioning to improve accuracy in large open indoor areas.

Pro-Position is a particle filter-based inertial positioning system for both indoor and outdoor positioning. Pro-Position consists of three elements: Firstly a waist-mounted Honeywell DRM 4000 that measures movement and a high sensitivity receiver U-Blox EVK-5H that measures absolute positions, secondly, layouts of building structures in 2.5 dimensions similar to those used in [5] and, thirdly, a particle filter. The Pro-Position particle filter is a Sampling Importance Resampling(SIR) algorithm using a fixed number of particles in each resampling step, which is done to maintain approximately the same computational speed for all iterations of the algorithm. The resampling strategy chosen is the systematic resampling algorithm [2].

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2 Accuracy of the Pro-position System and GPS Improvements

The results from our measurement campaign in three different buildings are listed in Table 1, the results for each path are divided into inertial sensor readings and Pro-Position results, for the median error. The results highlight that Pro-Position improves accuracy and that there are variations from building to building but also outliers for each building depending on sensor errors and human behaviors.

Table 1. Comparing inertial sensor readings with Pro-Position results for positioning errors given as the meter distance between the ground truth and the estimated position

		Mall 1	Mall 2	Mall 3	*Mall*	OO 1	OO 2	OO 3	*OO*	RO 1	RO 2	RO 3	*RO*
50%	Sensor	18.34	17.47	25.28	*21.40*	8.03	11.27	10.56	*9.19*	9.12	10.59	8.48	*9.30*
	PP	3.41	4.27	5.12	*4.61*	2.95	8.58	3.87	*5.13*	2.52	3.09	3.87	*3.16*

Pro-Position make use of GPS when available, firstly, for providing the initial position and, secondly, to correct the particle filter positions. The correction is only applied if there are any GPS events with a low estimated error and in the case of multiple events the system uses the one with the lowest GPS receiver estimated horizontal error. Figure 1 shows an example of the improvements for one of the paths in the evaluated mall.

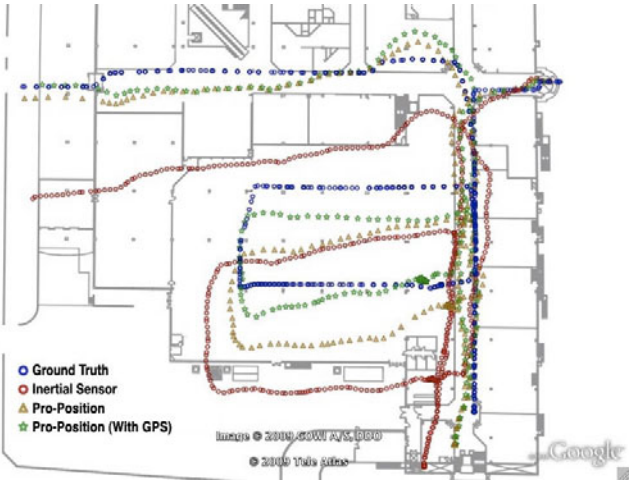

Fig. 1. Results from inertial sensor measurements, Pro-Position with and without GPS together with the ground truth path in a shopping mall

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