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VoroLoc: Location Estimation Using Particle Filters, Voronoi Graphs and Ambient Sensor Data

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ABSTRACT

In this paper we describe the design, implementation and evaluation of an indoor-tracking system that performs the estimation of user's location using an approach based on Particle Filters (PFs), Voronoi graphs and ambient sensor data gathered by an infrastructure of wirelessly-connected sensors.
In this approach to the indoor position estimation problem, users are not required to wear a transmitting device in order to be localized and therefore it is minimally invasive, potentially inexpensive and particularly suitable for home or independent living environments.
The main drawback of this approach is that it works only partially when more than one person is present in the environment. However, using PFs and proper motion models it is still possible to track more than one user at the same time under some conditions, e.g. all the users are detected in known areas and then they start to move, etc. This data association problem will be described in the full paper.
The key idea of this system is to use particle filters to estimate the locations of people on the Voronoi graph of the environment. This idea leads to two important advantages. Firstly, this version of PFs is far more efficient than unconstrained one. Secondly, the usage Voronoi graphs provides an efficient, and completely automated, discretization of the environment that can be easily integrated into PFs motion model.
The data-gathering network is based on the IEEE 802.15.4 protocol and it is based on a tight synchronization between energy-aware nodes.
The system is currently in use in an independent-living environment composed on four apartments with 15 users. The system has shown interesting results especially during the night, tracking users' movement with a good accuracy and precision. The full version of the paper will show the complete results of this approach.

KEYWORDS: Wireless Sensor Networks, Independent Living, Particle-Filter-based Localization, Context-Awareness, Indoor Localization.