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Explorer

A system that supports and utilizes active maps of indoor location

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ABSTRACT

The applications which have become prominent for outdoor navigation and exploration are moving indoors. These include not only maps, positioning and route planning, but 3D models, updated images, video feeds, and layers showing important dynamic information such as traffic, path closures, etc. We have developed a system for supporting these kinds of applications for indoor spaces, which consists of a dynamic model of the spaces, viewers for web browsers, mobile devices, and large displays such as kiosks, and a back end which performs sensor fusion over many inputs to dynamically update the model and maintain its history. The applications provide not only navigational assistance, but location based awareness (e.g. is a given conference room in use? are people in the lobby? What did this whiteboard look like yesterday?) and social awareness (e.g. is Joe in his office?) This paper describes the system with particular emphasis on the sensor and server aspects of the system.

We have deployed the system at two research lab locations, a 15 story office building, and are in the process of developing deployments for a conference center and exhibition center showroom space. A 3D model for each space is used for viewer applications, and also as the basis for sensor fusion and integration. A spatial graph derived from the model is used to generate paths for navigation assistance, and to provide the structure of a hidden Markov model used to fuse localization sensor information. The Explorer back end is configurable to accommodate a variety of infrastructure components such as surveillance cameras and trackers, display capture, sound systems, and a variety of sensors such as CISCO, etc. which vary greatly across facilities.

An android App shows a map or model of the space with updated dynamic layers, such as positions of people or occupancy of rooms, and also collects audio samples, wifi scans, motion data, and images, which are uploaded to a server to determine position of the device and to update the spatial model. Image SIFT features are used to determine device position, and also to allow model textures, such as bulletin boards, to be updated. Audio samples are compared with acoustic background models, or known controlled sounds, to estimate position and to update the background models. The locations estimates are combined using a spatial HMM and a modified Viterbi algorithm, in which sparse observations are provided by both the device being tracked and statically placed sensors.

KEYWORDS: Applications of Location Awareness & Context Detection, Framework for Hybrid Positioning.