Visual Location Awareness

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Location awareness is a critical task for an autonomous robot. Consider a situation in robotics when the machine's task depends on its location. For example, greet visitors when it's in a lobby, organize packages when it's in a storage area, or monitor server load when it's in a server room. Successful completion of such tasks requires establishing the current robot location as a first step. For the thesis, my goal is to evaluate the performance of SeeAsYou vision system at the task of determining the location of a robot; additionally I want to add and evaluate a Markov reasoning model for location awareness.

The problem of determining current location is commonly addressed in robotics. One family of approaches offers robot localization without explicit cartesian or topological map construction. Neural nets or lookup tables are used to correlate new measurements with measurements from previously known locations, and thus learn the location where the images were taken from. Alternatively, the problem is often put within a SLAM (Simultaneous Localization and Mapping) framework and solved with explicit cartesian or topological map construction using bayesian filtering methods. Such methods localize the robot in relation to other objects in the area. They are computationally more intensive and often require redundant expensive sensors; their main benefit in relation to map-less techniques is greater precision achieved by capturing the dynamic nature of robot localization process. The main drawback of map-based approaches is their lack of robustness to scene changes.

SeeAsYou is an object recognition system developed at CSU. It is similar to other state-of-the-art techniques in that it selects localized features in images and then matches them to features from previous images. To evaluate SeeAsYou capabilities for visually establishing the location of a robot, my approach is two-fold: (1) use TF-IDF metric (often used in information retreival) directly on the image matches produced by the system to determine the system's inherent capabilities for location awareness, and (2) augment the system with a localization module incorporating TF-IDF metric and Markov reasoning model over a graph of known locations and examine its effects. More specifically, I plan to gather 360-degree image panoramas from a number of indoor and outdoor locations, then match images from different locations using SeeAsYou and TF-IDF; furthermore, I will construct a graph representation of known locations and apply Markov reasoning framework over such graph aiming at improving location awareness provided exclusively by SeeAsYou and TF-IDF.

The contribution of this work will be an evaluation of SeeAsYou's image matching methods for robot localization using TF-IDF metric, and an evaluation of Markov modeling in the context of localization with SeeAsYou and TF-IDF. Another benefit is the possibility of designing a lightweight and generic vision-based approach to robot localization that's resilient to environmental changes and able to autonomously learn the environment.