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Enhanced PCA-Based Localization Using Depth Maps with Missing Data

Experimental Validation

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Abstract In this paper a new method for self-localization of mobile robots, based on a PCA positioning sensor to operate in unstructured environments, is proposed and experimentally validated. The proposed PCA extension is able to perform the eigenvectors computation from a set of signals corrupted by missing data. The sensor package considered in this work contains a 2D depth sensor pointed upwards to the ceiling, providing depth images with missing data. The positioning sensor obtained is then integrated in a Linear Parameter Varying mobile robot model to obtain a self-localization system, based on linear Kalman filters, with globally stable position error estimates. A study consisting in adding synthetic random corrupted data to the captured depth images revealed that this extended PCA technique is able to reconstruct the signals, with improved accuracy. The self-localization system obtained is assessed in unstructured environments and the methodologies are validated even in the case of varying illumination conditions.

Keywords Mobile robots · Robot sensing systems · Sensor fusion · Principal component analysis · Kalman filters

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