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Localization of Classified Objects in SLAM using Nonparametric Statistics and Clustering

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Simultaneous Localization and Mapping (SLAM) is the problem of localizing a moving robot in an unknown environment while constructing a discernible map of the surroundings. An important remaining challenge is to represent and incorporate semantics in the mapping of an environment, so it can be used for navigation, interaction, grasp planning, etc. This perceptual learning is a major challenge for the integration of robotics and artificial intelligence.

The map produced by most SLAM algorithms consist of estimated geometric features such as points, planes or lines without any semantic meaning or information [1], [2]. The aim of our work is to combine semantics and mapping structure in a coherent representation of the environment. Common semantics include the classification of spaces (rooms, corridors, halls) and objects (table, chairs, signs, etc). The semantics are added by recognizing the object instances and registering those consecutively in the estimated map.

The problem addressed in this work is to extract and establish detected objects as possible landmarks while simultaneously localizing and building a map. Neither the objects or location of the objects are known in advance. Objects can be recognized using a deep neural network toolbox e.g. Tensorflow, Caffe, etc. These deep machine learning methods have moved to the forefront of object detection in recent years. However, they are more tailored towards detection from a single image rather than detection and association in multiple images. Data association for detected objects has already been attempted in several recent SLAM solutions [3]–[5]. We present a novel application of nonparametric statistical method to associate detected objects over consecutive frames. We demonstrate a nonparametric statistical method, Mann-Whitney statistic [6], can successfully associate objects in two consecutive frames using a confidence interval and large sample approximation. We then employ an unsupervised clustering method to find existence of objects in the map. We also present a method to execute clustering intermittently which reduces computational complexity.

Our contribution is summarized as

- We show how a nonparametric statistical method can be used for data association of detected objects in consecutive images.
- We demonstrate an unsupervised clustering process to find the probable location of objects in the mapping of an environment and incorporate nonparametric data association to help the clustering process.
- We have evaluated our proposed method on several public dataset to show the significant results.

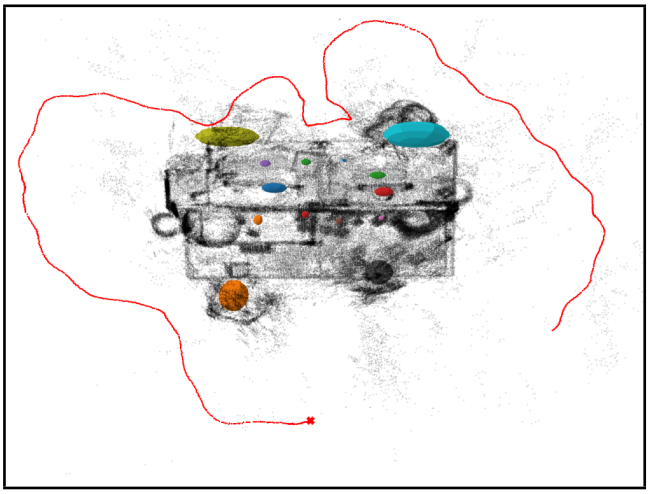

Fig. 1: Object Localization Result on RGB-D Scenes Dataset

Fig.1 shows a result of our process on a RGB-D Dataset. The localized object are represented as ellipsoid representing the location and the size of the object.

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