Model-Based Recognition of 3D Objects using Intersecting Lines

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Abstract Exploiting geometric features, such as points, straight or curved lines and corners, plays an important role in object recognition. In this paper, we present a model-based recognition of 3D objects using intersecting lines. We concentrate on using perpendicular line pairs to test recognition of a parallelepiped model and represent the visible face of the object. From 2D images and point clouds, first, 3D line segments are extracted, and then intersecting lines are selected from them. By estimating the coverage ratio, we find the most accurate matching between detected perpendicular line pairs and the model database. Finally, the position and the pose of the object are determined. The experimental results show the performance of the proposed algorithm.

Keywords Line matching · Model-based recognition · Intersecting line

1 Introduction

Object recognition has been studied extensively in computer vision, and model-based object recognition is a well regarded method. Most approaches use the correspondence between model features and image features to estimate the pose of the object. With these approaches, the challenging problem is the selection of the most useful geometric features for matching.

Some researchers have exploited methods to recognize and estimate the shape of a 3D object using color features [1]; these algorithms may not be robust when objects lack texture or discriminating characteristics. Zhang and Faugeras [2] proposed a method to present line matching problems, but the resulting points are often not the midpoints of the corresponding line segments pairs. Guerra and Pasucci [3] presented an algorithm to match between two sets of 3D line segments
with unknown line correspondences. Some other matching methods [4–6] were issued which did not completely solve the general matching problem. Košcká and Zhang approached more complicated features such as rectangular structures [7] and Kamgar-Parsi [8], Polygonal Arc Matching. Many researchers are mentioned in the feature of 2D model line [9] as well as multiple features [10]. However, these methods have limitations with a large number of models. Lowe [11] determined the algorithm for SIFT features but this method seems to be ineffective when the object lacks texture or is occluded. Some approaches have focused on parallel line features and used that as an independent method to recognize and match up with the object. Here we have approached model-based recognition of 3D objects using intersecting lines with more advantages, for instance, almost the shape of the objects generally store the corners which are constructed by two or more intersecting line segments while parallel line segments do not appear popularly.

The main contribution of this paper is to demonstrate detection of the intersecting line segments in the scene, and then select the highest probability pairs which can fit the shape of one face of object. One proposed method is to represent one object’s face using the selected intersecting line pairs and calculate the coverage ratios for each matching case. By comparison, we find the highest coverage probability to indicate the most accurate pose of the object in the scenario. In our algorithm, we assume the shape of the object which needs to be recognized contains perpendicular corners as a box in Fig. 1. Consequently, we extract perpendicular line segments and represent them as a rectangle for one face of the box.

The paper is organized as follows: Sect. 1 explains 3D line segments’ representation from model and 3D line extraction from the scene. An algorithm which detects coplanar line segments and intersecting lines is described in Sect. 2. Interpretation and matching method between the model and the perpendicular line segment are explained in Sect. 3. Section 4 demonstrates that our experimental result can be implemented in the real environment. Finally, Sect. 5 summarizes our results and states our conclusions.

![Fig. 1 The scene and box model](image.png)