Outline-Based Part Segmentation Using Intermediate-Level Symmetries

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Abstract

A new part segmentation approach is presented which works on real 2D images. These images may contain a complex foreground 3D object with textures and shadows on a cluttered background. The proposed approach relies on the outline of the object to guide the grouping of lines using symmetry and colinearity principles. This grouping of lines leads to simple shapes which could be modeled by 3D primitives such as geons or general cylinders. An algorithm implemented on the basis of this approach appears robust to noise and generic conditions. Besides, intermediate-level symmetries employed by the algorithm ensure a good robustness to internal textures and markings. The results obtained demonstrate the validity of the approach as a mean towards 3D generic object recognition from real 2D images.

1 Introduction

Despite many years of research, a great number of problems in computer vision still have no complete solutions. This is the case of generic object recognition. Indeed, many approaches have been proposed for recognition of specific objects in specific conditions, but no system has yet been able to successfully recognize objects in generic conditions. What is meant by generic conditions, is a recognition in an environment with variable lighting conditions, variable and complex backgrounds, variable visibility, a great number of different objects and variabilities in the object itself. In the context of this paper, an object is defined as a complex composition of simple volumetric parts. Variabilities of the object are for instance textures and differences in shape which do not prevent humans to recognize an object as being part of a class of objects. The concept of class of objects was introduced in computer vision to mimic the human ability to label several different objects by the same name because of their common functions or their structural similarities.

A system capable of working in generic conditions is said to be a generic object recognition system. Object recognition systems from single 2D images are usually composed of three main steps. The first step is the extraction of low-level primitives (arcs, segments, junctions and corners) in an image. Then, the second step groups these primitives into parts (the outline of the simple volumes that compose an object in 2D or the simple volumes themselves in 3D) and computes the relationships between the parts. Finally at the last step, the extracted parts and their relationships are compared with a database to identify the object.

To this day, the majority of works on 3D object recognition from single 2D images attempt to recognize objects of specific shape without textures with a single color on a uniform background. The lighting conditions are also controlled and the objects are often very simple or synthetic. Despite the contributions of these works, it remains evident that more general methods are required to install an object recognition system on, say, a robot or on a computer controlled unit. This work addresses a new approach to the part segmentation step of an object recognition system. It is based on the outline and its symmetries and it works on a generalization of the usually processed objects. The implemented part segmentation system deals with textured objects, on nonuniform backgrounds with no need of a high contrast between background and object. The paper has the following structure. In Section 2, the recent works on 3D object part segmentation from 2D images are reviewed. Then, in Section 3, the proposed method is explained and in Section 4 some results obtained by this method are shown.

2 Past works on part segmentation

Let us look at why part segmentation is needed in generic object recognition. There exists two main approaches to object recognition, that is i) top-down