Chapter 8
Object Recognition with a Limited Database Using Shape Space Theory

Yuexing Han
National Institute of Advanced Industrial Science and Technology, Japan

Bing Wang
University of Tokyo, Japan

Hideki Koike
University of Electro-Communications, Japan

Masanori Idesawa
University of Electro-Communications, Japan

ABSTRACT

One of the main goals of image understanding and computer vision applications is to recognize an object from various images. Object recognition has been deeply developed for the last three decades, and a lot of approaches have been proposed. Generally, these methods of object recognition can successfully achieve their goal by relying on a large quantity of data. However, if the observed objects are shown to diverse configurations, it is difficult to recognize them with a limited database. One has to prepare enough data to exactly recognize one object with multi-configurations, and it is hard work to collect enough data only for a single object. In this chapter, the authors will introduce an approach to recognize objects with multi-configurations using the shape space theory. Firstly, two sets of landmarks are obtained from two objects in two-dimensional images. Secondly, the landmarks represented as two points are projected into a pre-shape space. Then, a series of new intermediate data can be obtained from data models in the pre-shape space. Finally, object recognition can be achieved in the shape space with the shape space theory.

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1. INTRODUCTION

In the area of computer vision, object recognition has been considered as the most important research subject. One of the main goals of image understanding and computer vision applications is to recognize objects from various images. The goal of object recognition is to build computer-based vision systems which perform the same functions as the human vision system. Object recognition has been applied in a lot of domains such as industrial machine vision, computer-assisted medical image analysis and treatment, exploiting handwritten digits, information management systems, image processing, process control, multiphase screening and analysis, content-based image retrieval. Many approaches have been proposed for object recognition, and we will describe the basic idea of object recognition and some important approaches in Section 2.

In general terms, a shape of an object can be defined as the total of all information that includes invariance under translations, rotations, and rescaling. If two shapes of two objects are similar in the sense of some geometry, e.g., Euclidean geometry, the two objects can be considered to have the same shape. Not only Euclidean geometry theory, but also some other theories have been used in the area of object recognition, e.g. the shape space theory. The shape space concept has been introduced by Kendall for describing the shape formed by a set of random points, and it has been used subsequently in shape-related statistical problems in archaeology and astronomy (Kendall, 1984) and object recognition (Zhang, 1998; Zhang, 2003; Glover, 2006; Glover, 2008; Han, 2010). Since the approaches of object recognition in this chapter are based on this theory, we will introduce the basic knowledge of the shape space theory and its pre-shape spaces in detail in Section 3.

Current object recognition systems are generally limited to the recognition of objects which are presented in their database and any deviation from these objects renders the object in the scene as unrecognizable and unmatched. Generally, data in the database corresponds to an observed object. But some objects may possess many configurations, e.g., scissors and pliers with various opening degrees. Recognizing the sort of objects with many configurations is defined as *the Recognition of Multiple Configurations of Objects* (RMCO) (Han, 2010). Humans can easily recognize various configurations of an object, since our brain has a highly efficient system for self-learning including object recognition. But for machines or robots, it is very difficult to achieve RMCO. Generally, to recognize objects with many alterable configurations, multiple data are needed in the database. However it is hard to collect a large amount of data to recognize such objects. Since recognition systems ultimately need to be designed for operation in the real world, it is reasonable to require that the system has the ability to learn about new objects that it may encounter and add them to its database. So it is emergent and necessary to be able to build new data based on the original data in the database to match more observed objects. In this chapter, we will describe an approach to augment a database by obtaining new data from a continuous curve between any two pre-shapes in a pre-shape space without calculating any orthogonal geodesics. We will introduce the work in detail in Section 4.

After augmenting database, we can use the new data to match the observed objects. We will describe a series of algorithms of object recognition based on the shape space theory, and give some examples in Section 5, where the objects are differentiated in static state and in dynamic state. We will also extend the works in the future in Section 6 and give a brief conclusion in Section 7.

2. BACKGROUND

The problem in object recognition is to determine what the observed objects are, if a given set of data objects includes analogues of the observed