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A Representation and Matching Algorithm for Planar Curve Based on Distance Ratio and Concentric Circles

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Abstract

Curve Matching plays a significant role in object recognition, target tracking and fragment reassembling. This paper presents a representation and matching algorithm for planar curve based on sub-matrix and concentric circles. The algorithm includes two steps, namely rough matching and exact matching. The rough matching uses a sub-matrix matching method. As for exact matching, first, the representation of curve uses concentric circles and then measures their similarity through two curve representation sets of concentric circles. Our algorithm which is robust to the translation, rotation and scaling, can be used to match block objects and SAR image registration. The experiment results show us the effectiveness and feasibility of algorithm.

*Keywords:*Target tracking; Matching algorithms; Concentric division; Robustness;

1. Introduction

Contour information (edge) is the most basic and intuitive features of the object, and the curve is the important part of the object contours (edge). How to match curve fast and accurately has been an important research topic in pattern recognition, machine vision and image understanding. Curve matching in target recognition and tracking, archaeological research in cultural mosaic fragments and retrieval, graphics stitching, automatic assembly and other fields have a wide range of applications. Therefore, improving the matching speed and accuracy of the contour curves has important practical value and theoretical significance.

In the curve matching, describing the curve directly affects the curve matching performance. A good curve description method should have translation, rotation, scaling in-variance, and has a certain robustness. There are ways to describe the curve, which can be divided into methods based on global feature and local characteristics in general. In the curve description method based on global features, the most common one is the chain code.The

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traditional method of linear chain code can not guarantee rotation and stretching in-variance. Later, there was improved chain code, such as the angle chain code[1], beam-let angle chain code, etc. However, using these improved chain code curve description methods, it is so high to determine the length of the line of the time complexity. The advantage of such matching method based on the key point is without extracting the full profile of the object, which can greatly improve the efficiency of the matching curve. But when we only use the key point to describe the curve, we may lose some the useful information of the curve smoothing.

There are lots of methods to match the curve. The common whole matching methods of the curve are: Literature[2] proposes a rough curve matching method, although improves operational efficiency, it only applies to the opening matching between the curves, and has higher false matching rate; Literature[3] uses a coarse-to-fine curve matching method. The purpose is to ensure the accuracy of the matching, at the same time, reduce the amount of calculation. And it does not consider the noise problem in the description of some key points, which affects the matching robustness; Literature[4] proposes a curve tree to describe a matching curve, and its essence is from different scale to describe the curve. However, when determining the starting point of the curve is and the curve of the tree structure, the time complexity is high. Common curve partial matching algorithms are: Literature proposes a part matching algorithm of the flat curve, the algorithm uses the sub-matrix matching method to determine the matching area, while having higher false matching rate. Literature[5] uses the longest common sub-sequence method to achieve automatic mosaic of the fragments, but under the control, there's a greater probability of false matches. Literature[6] uses the probability distribution of the transform space to complete the partial matching of the curves. However, the amount of calculation has exponent relation to the precision. And for high precision, the calculation is too large; Literature uses a coarse-to-fine curve matching method , and the algorithm does not have scaling in-variance. For all types of curves using the same rough matching method, it increases the time complexity of the algorithm; Literature proposes a curve description method based on a concentric circle. But it is only applicable to simple opening matching between the curves, and it does not have a scaling in-variance.

This article shows a representation and matching algorithm for planar curve based on distance ratio and concentric circles. The description of the method not only has the translation, rotation, scaling in-variance, but also has good robustness, which can be used for SAR image registration and block matching objects[1].

2. Contour extraction and P.re-treatment

In order to accurately extract the contour of the curve of the target object, we use canny operator to make edge extraction to obtain a single pixel profile curve of the target object. But it is often discontinuous pixels in this way. In this article, a geometric method is used to locate, measure discontinuous point on the contour, and to fill the profile, resulting in contour curve of seamless break-point.

2.1. The judgment of curves opening and closing and the defined distance ratio

The outline curve of the target object is generally a closed curve, but as the need to the contour matching of the target object, the contour of the target object is usually divided into open curves and closed curves. In order of the needs of the curve matching, we need to judge the opening and closing of the contour curves. Assuming curve for single-pixel, if there is such a pixel point on the curve, whose pixel gray value in the eight-neighborhood is the only one that is same as the current pixel gray value, so the curve exists the end-to-end point, and determine this curve for open at this time. Point M and point N shown in Fig1 (a) are both breakpoints, and it is an open curve. If there is no break point, a closed curve instead.

Definition 1 The end-to-end points of the open curve of the Euclidean distance is defined as the end-to-end distance of the open curve. If using open curve d represents the end-to-end distance, (x_i, y_i), (x_j, y_j) are start and end points of the open curves. Then

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