Matching 2D Image Segments with Genetic Algorithms and Approximation Spaces

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Abstract. [1]This article introduces an approach to matching 2D image segments using approximation spaces. The rough set approach introduced by Zdzisław Pawlak provides a ground for concluding to what degree a particular set of similar image segments is a part of a set of image segments representing a norm or standard. The number of features (color difference and overlap between segments) typically used to solve the image segment matching problem is small. This means that there is not enough information to permit image segment matching with high accuracy. By contrast, many more features can be used in solving the image segment matching problem using a combination of evolutionary and rough set methods. Several different uses of a Darwinian form of a genetic algorithm (GA) are introduced as a means to partition large collections of image segments into blocks of similar image segments. After filtering, the output of a GA provides a basis for finding matching segments in the context of an approximation space. A coverage form of approximation space is presented in this article. Such an approximation space makes it possible to measure the the extent that a set of image segments representing a standard covers GA-produced blocks. The contribution of this article is the introduction of an approach to matching image segments in the context of an approximation space.

Keywords: Approximation space, coverage, genetic algorithm, image, 2D matching, rough sets, image segment.

1 Introduction

Considerable work on the application of rough set methods in image processing has been reported (see, e.g., [37,2,18,51,52]). This paper introduces an approach to matching image segments in the context of approximation spaces. The basic model for an approximation space was introduced by Pawlak in 1981 [30], elaborated in [28,32], generalized in [46,47,50], and applied in a number of ways (see, e.g., [36,38,39,48,11]). An approximation space serves as a formal counterpart of perception or observation [28], and provides a framework for approximate reasoning about vague concepts. Image segmentation (see,

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e.g.,[43,4,8,13,14,23,29,56,54]), and the image segment matching problem (see, e.g.,[12,55,42,53]) have been widely studied . The goal of an image-matching system is to match the segments from the two given images. Color and overlap are the two features of image segments that are commonly used to solve the matching problem. To achieve more accuracy in matching image segments, a combination of an evolutionary approach to finding sets of similar segments and approximation spaces are used. The evolutionar approach is realized with a genetic algorithm (GA) that partitions collections of image segments into sets of similar image segments. Filtering out GA-produced sets of image segments with the best match is carried out in the context of an approximation space. This approach makes it possible to solve the image segment matching problem with larger sets of features that yield more information about segments. This approach also results in more accurate matching of image segments. An overview of the 2D image segment matching method presented in this article is shown in Fig. 1.

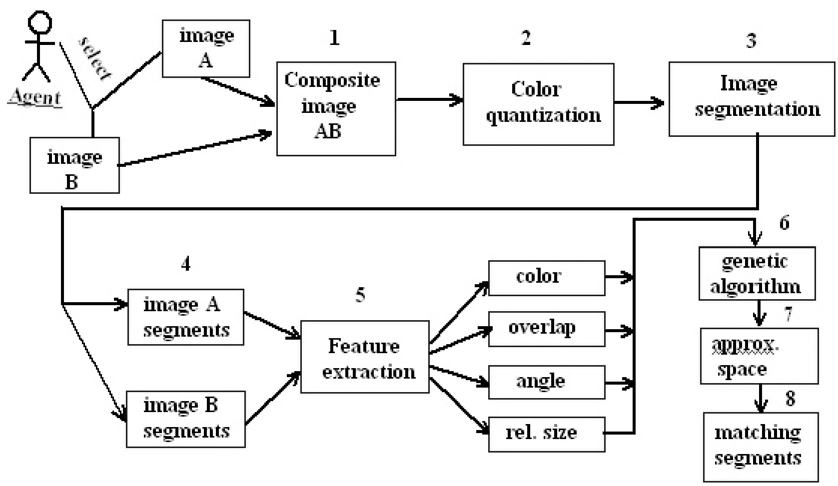

Fig. 1. 2D Image Segment Matching Steps

The matching process begins by forming a composite of a pair of images, then carrying out color quantization (step 2 in Fig. 1). After that, the quantized image is segmented, which results in a pair of segmented images. Next, feature values of image segment pairs are obtained in step 5 in Fig. 1. Then a GA is applied to a collection of image segment pairs, which are partitioned into sets. After eliminating non-disjoint sets of segment pairs, the coverage of the remaining sets of segment pairs is measured relative to a standard (norm), which is a set of image segment pairs that represent certain knowledge. The end result in step 8 of Fig. 1 is a collection of best matching pairs of image segments. This is in keeping with the original view of approximation spaces as counterparts of perception (in this case, approximations provide a framework for visual perception). The