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A Novel Approach for Partial Shape Matching Using DTW

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Abstract: Scale invariant and deformation tolerant partial shape matching is a novel approach to the problem of establishing the best match between an open contour and a part of a closed contour. Shape descriptors are computed along open or closed contours in a spatially non-uniform manner. The resulting ordered collections of shape descriptors constitute the global shape representation. A variant of an existing Dynamic Time Warping (DTW) matching technique is use to handle the matching of shape representations. The problem of matching closed-to-closed contours is naturally treated as a special case. In this method is general and can be built on top of any existing shape matching algorithms. The transform shapes into sequences and utilize an algorithm that determines a subsequence of a target sequence that best matches a query. Extensive experiments on benchmark datasets but also in the context of specific applications, demonstrate that the scheme outperforms existing methods for the problem of partial shape matching and performs comparably to methods for full shape matching.

Keywords: Shape analysis, Dynamic programming, matching, shape descriptor, Dynamic Time Warping.

I. INTRODUCTION

Shape matching is a fundamental problem in computer vision and pattern recognition. Scale invariance is a feature of objects or laws that do not change if scales of length, energy, or other variables, are multiplied by a common factor. Deformation tolerance means tolerating a change in the volume or shape of object. The main idea is to develop a computationally inexpensive and transformation invariant measure of a shape boundary that can be used in shape recognition. Shape matching deals with transforming a shape, and measuring the resemblance with another one, using some similarity measure. So, shape similarity measures are an essential ingredient in shape matching. Shapes are represented as binary images depicting foreground objects over their background and developing a shape descriptor for a sampled boundary point of any shape [6] [9] This project discusses the Partial shape matching for scale invariant and deformation tolerant images.

The matching method is for coding the boundary of two dimensional shapes. I propose the method that operates on 2D images. Shapes are represented as binary images depicting foreground objects over their background. I assume that the shapes have already been extracted from images and are represented by their bounding contours. My primary contribution to this work is to measure the similarity between shapes. A key characteristic of this work is the estimation of shape similarity and correspondences based on shape descriptor. Here, outline of the object is extracted and pre-processed to smoothen some of the noise [1].

A variety of shape matching algorithms are available to address the 2D shape matching problem such as**, Smith Waterman Algorithm,** Dynamic Time Warping algorithm, wedge wave feature extraction algorithm, Dynamic alignment matching algorithm, genetic algorithm etc.

II. LITERATURE SURVEY

Shape matching is a problem that has been the focus of a lot of research. The three different classifications methods are adopted that are. One shape matching methods which are depending on boundary exploit only the outline of image or also the interior of the shapes. A second classification is based on whether the shape matching method computes a similarity measure between the compared shapes or an alignment of the shapes. Third Shape matching methods depending preserving information which can be used for recover the original shape [8].

A number of shape present matching techniques are based on some kind of shape skeletonization. Image skeletons are computed at multiple scales and use them to detect salient points on the contour of the shape [3] [5]. Shapes that possess the same shock graph topology are considered equivalent. This is verified through a polynomial time, global optimization algorithm that performs graph comparison/matching [7] Gorelick et al. propose the characterization of each interior point of the shape by the average distance that a random walker will travel before reaching it, assuming a starting point located on the shape's silhouette [4] [2].

Felzenszwalb represent each silhouette as a tree, the root of the tree represents a properly selected cut on the curve while the left and right children represent cuts on the occurring sub-curves. They propose an iterative matching scheme that can be efficiently solved using dynamic programming. They proceed with the formulation of an algorithm that can locate query shapes in real-world color images [10]. An interesting variant is presented, where the goal is to improve shape matching by exploiting the articulated nature of many common shapes. The authors suggest that the distances and angles between contour points should be measured only inside the closed contour of a figure. The key idea is that the inner distance, in contrast to the classic Euclidean distance, is invariant to articulation which permits the effective treatment of this type of shape deformations [11]. A variety of shape matching algorithms are available to address the 2D shape matching problem such as, **Smith Waterman Algorithm,** Dynamic Time Warping algorithm, wedge wave feature extraction algorithm, Dynamic alignment matching algorithm, Genetic algorithm etc. We will see the overview of all the mentioned algorithm which can be used for partial shape matching in brief.

A. Dynamic Time Warping:

Dynamic time warping (DTW) is an algorithm for measuring similarity between two sequences which may vary in time or speed. For instance, similarities in walking patterns would be detected, even if in one video the person was walking slowly and if in another he or she were walking more quickly, or even if there were accelerations and decelerations during the course of one observation. DTW has been applied to video, audio, and graphics — indeed, any data which can be turned into a linear representation can be analyzed with DTW.

A feature of DTW that is useful for the field of handwriting recognition is it being able to handle curves of unequal length i.e., curves that consist of a different number of points. This allows comparison without re-sampling. Because re-sampling usually deletes information or adds \false" information, it is better not to use it [1] [10].

The goal of the matching step is to estimate the similarity of two given contours based on the descriptors already computed on them.

This is achieved by establishing correspondences between contour points. Closed contours correspond to cyclic strings. Correspondences between symbols are established through string alignment with a method that is based on Dynamic Time Warping (DTW) [12].

B. Pattern Recognition:

Shape matching is a fundamental problem in computer vision and pattern recognition. A pattern is an entity, vaguely defined, that could be given a name, e.g., fingerprint mage, handwritten word, human face, speech signal, DNA sequence etc.

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest, make sound and reasonable decisions about the categories of the patterns. Pattern recognition techniques find applications in many areas: machine learning, statistics, mathematics, computer science, biology, etc.

Pattern recognition is the scientific discipline whose goal is the classification of objects into a number of categories or classes. Depending on the application, these objects can be images or signal waveforms or any type of measurements that need to be classified.

C. Partial Shape Matching:

Shape matching is an important ingredient in shape retrieval, recognition and classification, alignment and registration, and approximation and simplification. Partial shape matching is an essential process for image retrieval and computer vision. Its basic requirements are location-free, size-free, orientation-free, and noise-tolerance. I often treat image as shape. For example, image retrieval is a process searching similar shape from large amount of image data. Many shape matching methods have been proposed, but most of them can recognize only whole shape's similarity. For smarter search in image retrieval and recognizing occluded shape, partial similarity is quite important [9] Shape matching is of central importance in a number of computer vision problems such as shape classification, retrieval, recognition, and simplification. Shape matching also deals with transforming a shape, and measuring the resemblance with another one. The quality of the shape matching process depends on whether its final outcome agrees with human judgment [1].

The Fig 2 shows some of the example of 2D shape matching and the process of shape matching is shown as Fig. 3.

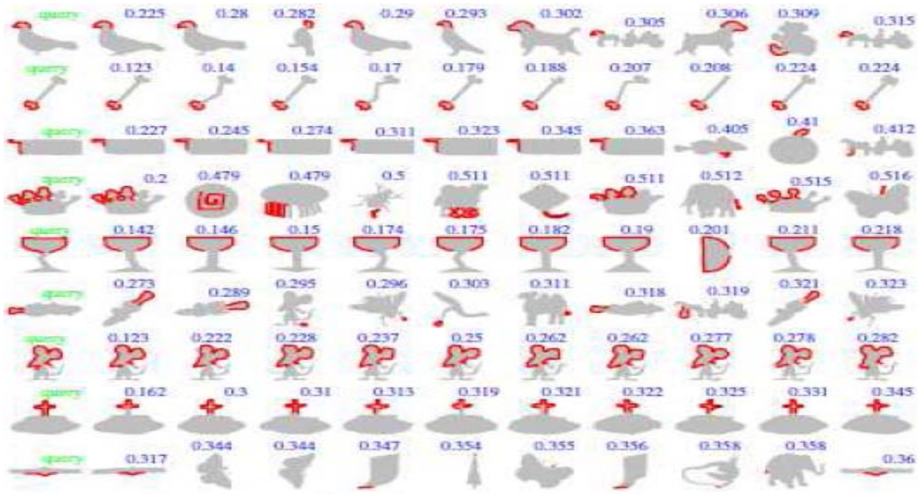
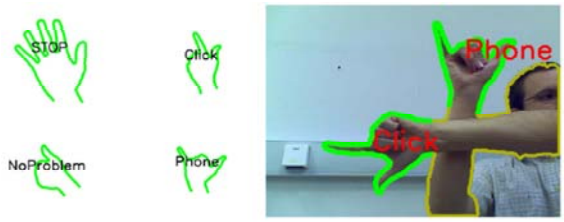


Fig. 1. Examples of 2D shape matching

The primary problem with matching is lack of knowledge on how to deal with geometric distortion i.e. noise. Almost all forms of shape representation are sensitive to geometrical distortions. With the earlier investigation, the problem is two folds. There is a representation (coding) problem and matching (recognition) problem. The representation problem is largely geometrical in nature whereas matching is primarily an algorithm problem. However, the means of representation determines the complexity of the matching algorithm. Finally, The quality of the shape matching process depends on whether its final outcome agrees with human judgment.



(a) (b)

Fig. 2. The four prototype parts in (a), need to be matched with the yellow, closed contour in (b). In (b), it is shown which of the four prototypes matched with parts of the closed contour and at which positions the best matches were achieved, based on the proposed partial shape matching method.

III. PROPOSED WORK

The proposed system will be implemented to provide a solution to the problem of partial shape matching. The method that operates on 2D images. Shapes are represented as binary images depicting foreground objects over their background. I assume that the shapes have already been extracted from images and are represented by their bounding contours. My primary contribution to this work is to measure the similarity between shapes. The outline of the object will be extracted and pre-processed to smoothen some of the noise.

Objective of the proposed system is to implement such a system that, provide a solution to the problem of partial shape matching. The proposed work will be confined to two dimensional shapes. The implemented system should be user friendly enough for anyone to use. System should be able to get static image through the webcam and match it with the existing one by performing some sort of classification. It will be able to match shapes of arbitrary scales and orientation. The given shape may have open and closed boundary or even have portion of it obstructed from a view. A matching approach should be invariant under scaling and translation and robust under small geometric distortion, occlusion and outliers. The proposed system will be simple and easy to use.

D. System Development Plan:

The input for the proposed system will be a binary image. For measuring the similarity of the input image and source image, first we will have to extract the edges of the test image. Then the matching will be carried out by using some efficient algorithm or any technique. Even if the image is deformed, the proposed system will try to match it with the source image.

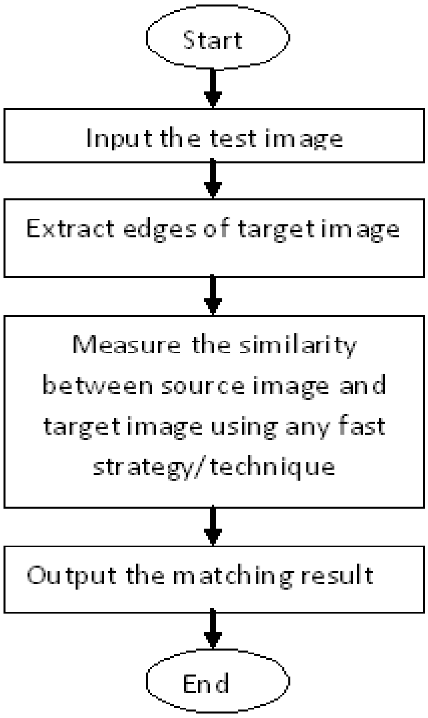


Fig 3. The process of shape matching.

The following figure shows the block diagram of proposed system.

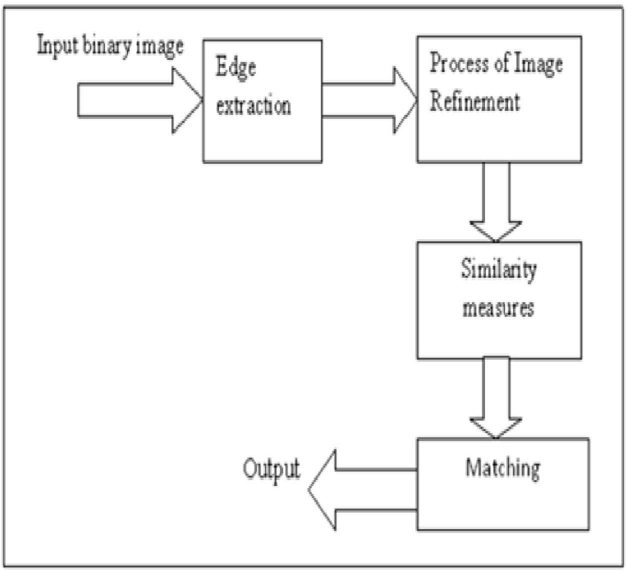


Fig 4. Block diagram of proposed system.

- **Shape representation:**

At a first step, the input to the system will be a binary image. Input image have to be matched with the source image. For this purpose, the outer edge of the test image is extracted. Then a given edge of image is uniformly sampled and one descriptor is computed on each point sample.

- **Process Refinement and preprocessing:**

After extracting the edges of given image, it is then traversed in some predefined order. Both shape description and matching require consistency with respect to this order. We proceed by performing a fixed sub-sampling of the extracted edge.

- **The proposed local shape descriptor:**

The fundamental idea behind the proposed descriptor lies on measuring the distance of a certain open contour from the closest contour of the same image, along properly defined directions. An important issue is related to how the "inner" part of a shape is defined for an open contour. In practice, this is handled by defining open contours as parts of some closed contour, for which the inner part is unambiguously defined.

- **Shape matching:**

Matching open contours against parts of closed contours i.e., the extracted edge of source image is then matched with that of the target image. And the matching is carried out by applying some sort of effective algorithm. Matching must be done in the presence of noise i.e. geometrical distortion.

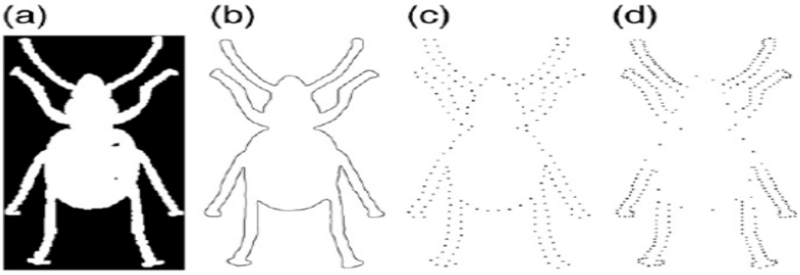


Fig 5. Shape preprocessing steps. An example input binary image is shown in (a) and the smoothed contour in (b). The fixed-rate and non-uniformly sub-sampled contour are shown in (c) and (d), respectively.

IV. EXPERIMENTAL RESULTS

The experimental results are presented to show that the proposed approach for 2D shape matching has been validated by several experiments. The experiments can be grouped into two categories, one that assesses the performance of the proposed method in matching open to closed contours and another one that concerns the matching of closed contours.

For performing a partial shape matching, first of all we have to insert a set of images. We have to calculate the shape descriptor of the each image. Along with shape descriptor, edges of all images are extracted by using filter. Then from the set of images, a query image is selected. Then the matching is carried out between query image and the answer images by using dynamic time warping technique. After matching is done, matching percentage is displayed. As we uses the boundary based representation, the outer boundary of the shape only is considered. This is done by describing the considered region using external characteristics i.e. edges of the image. For the extraction of the shape of the shape of the image, first we identify the object of the shape, second detecting edges and extracting the feature of the object, later applying the sampling.

Finally, shape of query image is compared with the shapes of answer images by using Dynamic time warping.

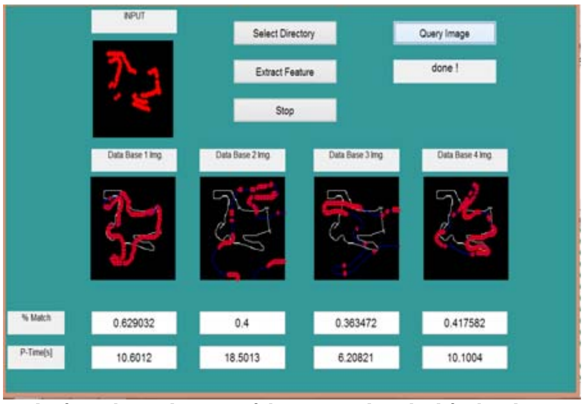


Fig 6. Sample results from the application of the proposed method for hand postures recognition.

V. CONCLUSION AND DISCUSSION

In this paper, we proposed using work presented a solution to the problem of partial shape matching. The key idea and main contributions of this work lie in the proposed shape descriptor, the scale dependent sampling, and the cost assignment for descriptor matching. The shape descriptor is robust under significant deformations due to articulation, efficient to compute and captures sufficient information to enable high performance. The problem of matching closed-to-closed contours is naturally treated as a special case. This work will prove to be most efficient for the problem of establishing the best match between an open contour and a part of a closed contour. As compared with other similar matching methods, this model can be used for image recognition and matching in practice.

We have future plans as follows for more sophisticated shape matching:

1. Applying other matching technique
2. Utilizing scale space (for roughly matching)
3. Developing other applications
4. Shape with multiple contour

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