International Journal of Electronic and Electrical Engineering.
ISSN 0974-2174 Volume 7, Number 2 (2014), pp. 125-132
© International Research Publication House
http://www.irphouse.com

Rotation Invariant Image Registration using Robust Shape Matching

M.D. Divate[1] and S.R. Baji[2]*

[1]Department of Electronics and Telecommunication Engineering (PG Student) KCT's Late G. N. Sapkal College of Engineering, Anjaneri, Nashik, India
*[2]*Department of Electronics and Telecommunication Engineering (Faculty of Engineering) KCT's Late G. N. Sapkal College of Engineering, Anjaneri, Nashik, India*
E-mail: [1]mdivate2002@gmail.com, [2]bajiseema1@gmail.com

Abstract

Image registration enables the geometric alignment of two images and is widely used in various applications in the fields of remote sensing, medical imaging and computer vision. The performance of image registration may degrade due to image quality. As a digital image may undergo any arbitrary translational, rotational changes because of which the object shape may change. Several algorithms have been proposed earlier involving feature matching. All these algorithms involve correspondence and transformation making the shape matching complex. It also increases the computational complexity.
In this work, a novel approach for shape and feature matching using putative point matching has been proposed. The images considered in this thesis are views of a scene taken by a rotating camera. The approach is based on three basis steps of image acquisition, finding the feature points and matching.
It involves detecting the feature points using feature descriptors irrespective of its color, shape, brightness, intenstity.etc. After which the feature points are matched in the images. The experiment shows robustness to various types of disturbances including outliers detecting our object of interest. The algorithm works effectively in detecting the desired shapes in complex and highly cluttered scenes irrespective of quality and type of image.

Keywords: Point matching, feature extraction, feature descriptors, putative point matching.

Paper Code: 14388-IJEEE

1. Introduction

Digital image processing is the use of computer algorithms to create, process, communicate, and display digital images Image registration is an image processing technique used to align multiple scenes into a single integrated image. It helps overcome issues such as image rotation, scale, and skew those are common when overlaying images. It is the process of transforming different set of data into a common coordinate system. It is used in computer vision, medical imaging, military automatic target recognition, and compiling and analyzing images and data from satellites. In practice, the picture may undergo several rotations; translation due to which the point set matching becomes difficult [1] [2]. The image may be damaged while taking the clips from camera or it may be contaminated by noise. The geometry of the object may also change making it an intricate task in object detection. In remote sensing, mosaicing of images of the surveyed area, the images of the same scene are acquired from different viewpoints. In automatic change detection for security monitoring and motion tracking images of the same scene are acquired at different times, often on regular basis, and possibly under different conditions. In medical imaging, images of the same scene are acquired by different sensors. In some cases comparison of the patient's image with digital anatomical atlases is needed in which the images of a scene and a model of the scene need to be registered. Therefore, in all these methods either the viewpoint changes or the images are taken at different times or may be from different sensors. Due to all these the shape detection with point set matching becomes difficult approach for feature detection.

Mainly the feature based method consists of the following image acquisition, feature detection, feature matching, resampling of image, and transformation [11].

Feature point matching [11] establishes the correspondence between the points from two extracted images.

2. Related Work

The transformation and the correspondence are normally regarded as the two unknown variables in a point matching problem. They share an intimate relationship. Once one variable is known, the solution for the other is actually mostly trivial. Given the set of correspondences [2][3] (including the set of outliers), finding a good transformation is often a straightforward least-squares problem. On the other hand, given a transformation, we can apply it to one point-set and determine the set of correspondences using some proximity criteria. Consequently, if either variable is deemed known, the point matching problem is considered solved. This is the main reason why the point matching problem can represented as a problem using either variable (transformation or correspondence)[5], or both. While it may seem simpler to define the problem using a single variable, we will see that it is not necessarily the case for non-rigid point matching. Thus all point matching algorithms can be characterized by examining the way they handle the two variables. Insofar as a method attempts to solve either the correspondence or the transformation alone, it can be regarded as an independent estimation approach.

These methods are designed only for rigid point matching problem. A more refined technique is the Hough Transform [2] [3] in which the transformation parameter space is divided into small bins, where each bin represents a certain configuration of transformation parameters. There are numerous other methods such as tree searches, the Hausdauff Distance [2] [3], Geometric Hashing and the alignment method as well.

In these there are two major types of methods [11] designed for determining the shape matching between the images.

The first method groups the feature points into higher level structures such as lines, curves or surfaces.

The second type of method is based on brightness (appearance) [11] making direct use of pixel brightness. In this instead of focusing on the shape or other extracted features, these approaches make direct use of gray values within the visible portion of object.

There are many algorithms for rigid and non-rigid point set registration. This involves a two-step iteration involving correspondence and transformation. We will briefly review the algorithms used for these two methods.

2.1 Rigid Point set registration

Iterative closest point, one of the most popular algorithms for its simplicity and low computational complexity. Assuming two shapes are roughly aligned, for each point in one shape, the closest point in other shape as taken as a current estimate of correspondence. In ICP [1] [2] [3] neighboring points in one shape may be matched to two points far apart in other shape. To overcome the drawbacks of ICP, soft assignment of correspondence between all combinations of points to some probability is done. Robust Point matching [1] [2] [3] algorithm introduced by Gold is among those methods. It is equivalent to Expectation Maximization (EM) algorithm for GMM where one point is treated as GMM centroid and other point is treated as data points. Another method of rigid registration is spectral methods. Scott and Longuet-Higgins introduced a no iterative algorithm to associate points of two arbitrary patterns to associate points of two arbitrary patterns. The algorithms work good rigid transformation involving translation, shearing and scaling.

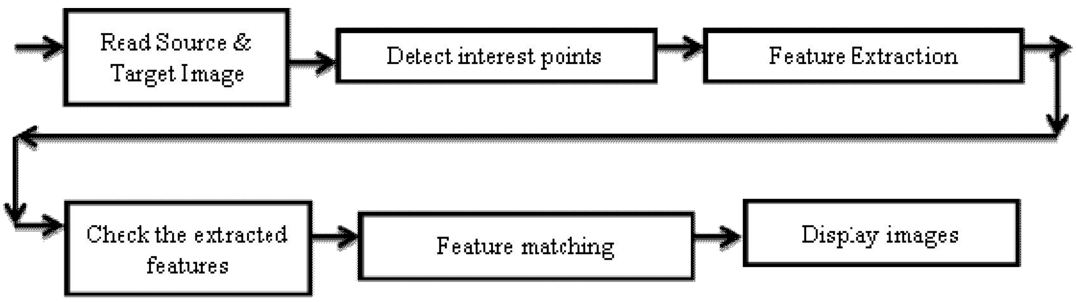
2.2 Non rigid point set registration

One of the most popular method designed by Chui and Rangarajan [2] using Thin Plate spline of transformation following RPM resulting in TPS-RPM [1] [2] [3] method. In this method a thin plate spline is adopted as the spline can be decomposed into affine and non-affine subspaces minimizing the energy functions. It is unaffected by the deformation and the amount of noise. However its performance degrades presence of occlusions. The algorithm is likely to work if the dimensions of points are less than two. A new probabilistic method for non-rigid registration of two point sets is Coherent Point drift [4] [9]. The Gaussian mixture model centroids of first point set are fitted to the data of the second point set by maximizing the likelihood. The GMM centroids are forced to move coherently as a group to preserve the topological structure of point sets. It is robust in the areas of missing points and corrupted data. However it does not work well for large in plane rotations.

3. Our Approach

The goal of proposed method is to detect object in an image. In this there will two images. One will be called as Source image (Image in which we are interested) and second is the target image containing cluttered scenes. These images will be read and its feature points will be detected. Feature points of the image are its shape information, thresh holding, edge detection, line drawing, corner detection, blob detection etc. After these, the feature descriptors are extracted at the interest point in both images. Feature descriptors [11] are the descriptions of the visual features of the contents in images, videos, algorithms, or applications that produce such descriptions. They describe elementary characteristics such as the shape, the color, the texture or the motion, among others. These features are matched in both the images using their descriptors. Display the matched features and locate the object with outliers removed.

3.1 Framework of proposed methodology



Description of proposed methodology

1) Read the source and target Image:-The image containing the source and the cluttered image are readied.
2) Detect the interest points:-Detect the points of interest in both images and select the strongest features from both images. Display both the images.
3) Feature Extraction:-Extract [11] the features in both images using descriptor methods which may be used for corner detection, blob detection or for whole image by selecting the threshold value.
4) Check the extracted features:-Check if the extracted features in both images are same using sum of absolute difference. Make sure the features are of compatible classes and size.
5) Feature Matching:-The detected features [11] are matched in both images. The correspondence is shown between the two images by padding. Draw the line style between the two images.

4. Experimental Results

The algorithm is implemented using MATLAB R2013a using various real time and standard images. The real time images are captured from Olympus 3 mega pixel camera as well as on 2 mega pixel Nokia phone camera.

The experimental results show the robustness of algorithm in both real time and standard images even in case of rotation. The main motive of this work is to detect the object which has some degree of rotation.

4.1 Experimental Results on real time images when object is rotated by 180 degrees

Image 1: Left Image1- Object to be detected, Right Image 2- Cluttered Image

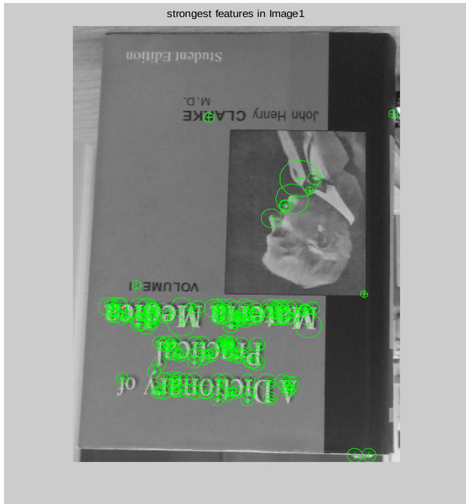


Image 2: Strongest Features in Image 1(rotated by 180 degrees)

Image 3: Strongest Features in Image 2

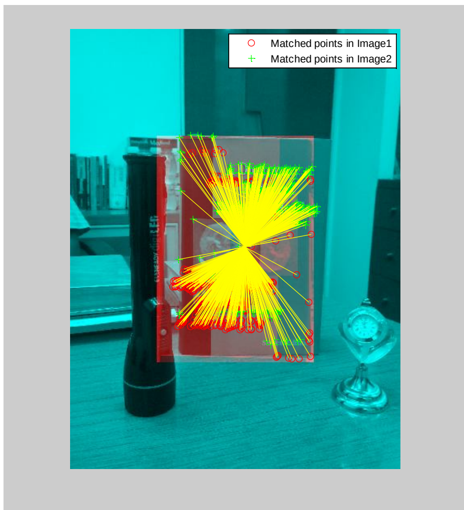


Image 4: Final matched points in both images detecting object of interest

4.2 Experimental Results on standard images when object is rotated by 180 degrees

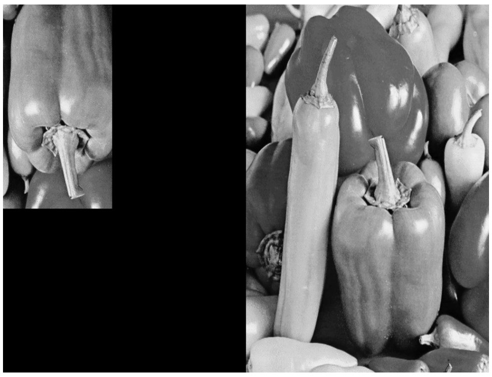


Image 1: Left Image1- Object to be detected, Right Image 2- Cluttered Image

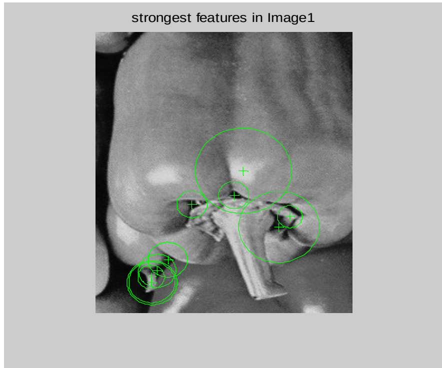


Image 2: Strongest Features in Image 1(rotated by 180 degrees)

Image 3: Strongest Features in Image 2

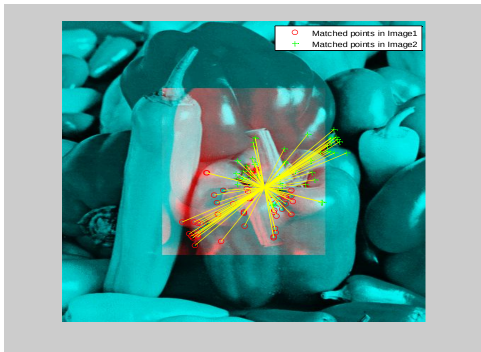


Image 4: Final Matched points in both images detecting object of interest

5. Conclusion

The feature-based methods for image registration frequently encounter the correspondence problem, regardless of whether points, lines, curves or surface parameterizations are used. Feature-based image matching requires, to automatically solving for correspondences between two sets of features. In addition, there could be many features in either set that have no counterparts in the other. This outlier rejection problem further complicates an already difficult correspondence problem. Hence a novel method has been formulated for feature-based non- rigid registration in cluttered images.

An algorithm called as Putative Feature Point Matching (PFPM) algorithm has been designated which concentrate not only on similar features of images but also on its shape, non-rigid points, and its degree of rotation. This is the big advantage of this algorithm. This method of object detection works best for objects that exhibit non-repeating texture patterns, which give rise to unique feature matches. The proposed algorithm is used for detecting a specific object based on finding point correspondences between the reference and the target image using shape and feature matching. It can detect objects despite a scale change or in-plane rotation.

References

[1] Wei lian ,Lei Zhang and David Zhang, "Rotation Invariant Nonrigid point set matching in cluttered scenes" IEEE Trans.Pattern Analysis and Machine Intelligence, 2012

[2] S. Belongie, J. Malik, and J. Puzicha. "Shape Matching and Object Recognition Using Shape Contexts". TPAMI, 24(24):509–522, 2002

[3] H. Chui and A. Rangarajan. "A new point matching algorithm for non-rigid registration." Eng CVIU, 89:114–141, 2003

[4] Barbara Z, Jan F, "Image registration methods: A survey", Image and vision computing 21 977-1000,2003

[5] A. Myronenko and X. Song. "Point Set Registration: Coherent Point Drift." TPAMI, 32(12):2262–2275, 2010

[6] H.Jiang and S.X.Yu, "Linear solution to scale and rotation invariant object matching", IEEE conf.Computer Vision and Pattern recognition, pp.2474-2481, 2009

[7] Y.Zhang and D. Doermann, "Robust point matching for non rigid shapes by preserving local neighbourhood structures," IEEE Trans.Pattern Analysis and Machine Intelligence, vol.28, no.4, pp.643-649, 2006

[8] Csaba D, Jozsef N and Zoltan Kato, "Non linear Shape Registration without correspondences" IEEE Trans Pattern Analysis and machine Intelligence, vol. 34 No.5, May 2012

[9] D.Zhang, G.Lu, "Review of shape representation and description techniques", Pattern Recognition 37(1-19),2009

[10] Andriy M, Xubo S,Miguel, "Point set registration : Coherent Point drift", IEEE Trans Pattern Analysis and machine Intelligence, vol. 32 No.12, Dec 2010

[11] H Zhang,Xiao B,Jun Zhou, "Object detection via Structural Feature Selection and shape model" IEEE Trans on image processing, vol22,No12,Dec 2013.