Comparative analysis in satellite image Registration

Conference Paper · December 2012

DOI: 10.1109/ICCIC.2012.6510182

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Comparative Analysis in Satellite Image Registration

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Abstract: **This paper proposes a comparative study and analysis in satellite image Registration. Image registration techniques are aimed to improve the geometrical consistency of satellite images. This technique can be employed for the detection of changes in images .we are analyzing Point based, Edge based and Contour based image registration techniques. In the first method control points are selected manually and registration is performed using cross correlation. Edge based image registration emphasized on corner features. Two pairs of optimal matching corners were selected from matched corners as control points and transformation is applied. In contour based approach contour points are extracted from image and based on the contour points image registration is performed .Finally localization error and matching error is calculated and analyzed.**

Index Terms— **Image registration, feature detection, corner detection, contour matching**

I. INTRODUCTION

Satellite images are used for the detection of natural sources and monitoring of Geo environment. To acquire better coverage the area spanned by the satellite should be small.
Image registration is an important process in image-processing applications whenever two or more images of the same scene have to be compared pixel by pixel[1]. Important applications of satellite images are for land use or land cover monitoring. Through Image registration techniques we are finding a proper geometric transform between two images that can align corresponding points in them[2]. It is the foundation of applications, such as image fusion, medical image processing, remote sensing and three dimensional (3D) image reconstructions. The increased volume of satellite images reinforces the need for automatic image registration techniques. In this paper we are analyzing and comparing the various image registration techniques. Our method works well for image pairs in which the contour information is well preserved. Optical images from Landsat and Spot satellites can be used.
The images used are captured by different sensors at variable view point and times .image Registration is based on the assumption that there are sufficient overlaps between the captured images. Once the images are registered, they can be mosaicked .Mosaicking is the technique of stitching two images together [3]. The mosaicked image is geometrically and photometrically consistent with the scene.
Typically, we are having one image called the base image or reference image and is compared with the sensed image.
Our objective of image registration is to bring the sensed image into alignment with the base image by applying a spatial transformation to the sensed image. The differences between the sensed image and the base image might have occurred as a result of terrain relief and other changes in perspective when imaging the same scene from different viewpoints.
The overall performance of registration methodology depends on the following aspects such as specific applications, sensor characteristics and the imaged areas nature and composition [5]. It is unlikely that a single registration scheme will work satisfactorily for all different application. From this we can infer that a different registration scheme can be applied for different applications. The main goal of this work is to analyze the image registration technique. We are proposing an improved contour based image registration technique and is also compared with other techniques.

II. POINT BASED IMAGE REGISTRATION

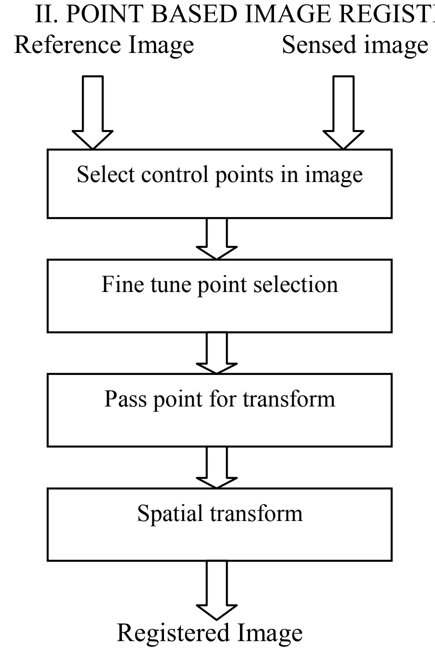

Fig 2.1 Block Diagram for point based image registration

The different steps involved in registering two images, named reference image and sensed images are shown in figure 2.1. Initially the feature points in the images are extracted, and then establish functions of geometric transformation between two images by finding common conjugate feature points in an overlapping region. Finally the slave image (sensed image) is resampled to match the orientation and pixel spacing of the master image (reference image).

If some set of corresponding point pairs can be identified a priori for a given pair of views, then registration can be affected by selecting a transformation that aligns the points. Such points can be taken for the purpose of registration. They are called control points. To be reliable, they must lie in clearly discernible features, which we will call control point features. The determination of a precise point within a feature is called control point localization. The transformation that aligns the corresponding control points will then interpolate the mapping from these points to other points in the views. Geometric transform between images is the foundation in our image registration[7]. To describe the transform, we introduce projective geometry. Unlike traditional Cartesian coordinate, a point in projective coordinate is defined as a vector of three elements: the first two are x and y, and the third coordinate is introduced to deal with the situation of infinite point. The third element is 1 when the point is not infinite and 0 when the point is infinite. Because when divided by 0, any small value becomes infinite, using projective coordinate makes an infinite point homogeneous with any other point in the space. A geometric transform can be written in matrix form as

$$\begin{pmatrix} X_1' \\ X_2' \\ X_3' \end{pmatrix} = \begin{bmatrix} H_{11} H_{12} H_{13} \\ H_{21} H_{22} H_{23} \\ H_{31} H_{32} H_{33} \end{bmatrix} \begin{pmatrix} X_1 \\ X_2 \\ X_3 \end{pmatrix} \quad (1)$$

In many practical applications control points are manually selected. Obtaining a reliable number of control points is very tedious. Sometimes inconsistency problem, limited accuracy and partial or total occlusions results in lack of availability of control points. Automated techniques play a key role in overcoming these problems and handling georeferencing multi temporal and multi sensory images[8]. These images require higher accuracy and precision.

III.IMAGE REGISTRATION BASED ON CORNER DETECTION

A corner is defined as points for which there are two dominant and different edge directions in a local neighbourhood of the point. Well defined positions that can be robustly detected can be considered as interest points or control points [13].In this case the interest points may be a corner or an isolated point of local intensity having maximum or minimum values[12]. We can consider a point on a curve as interest point, but the curvature should be locally maximized. In practice, most of the corner detection techniques identify interest points in general. Because of this if only corners are to be detected then we have to do some local analysis to determine the real corners.

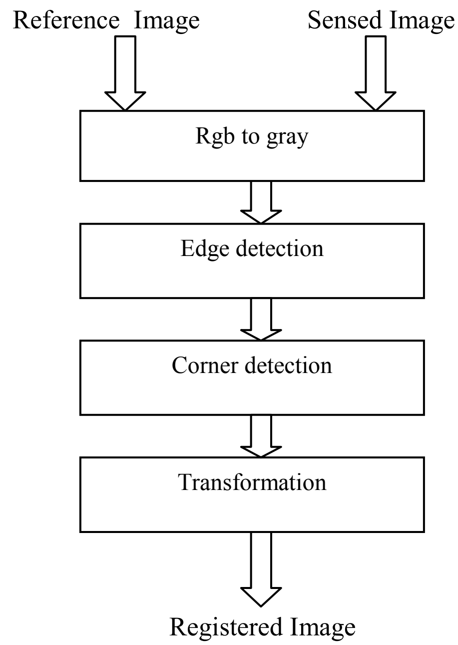

Fig 3.1 Block Diagram for corner detection based image registration

Corner detection in images plays an important role in tracking, registration, detection of change and identification of camera position and pose[13]. In order to detect corners we need a very fine image boundary. Our edge detector whose output is edge extracted one pixel thick binary image. In the binary image each image segment is M connected[9]. The input to the edge detector should be gray level image. If the input is coloured it is converted to gray level images. The block diagram is shown in figure 3.1.

IV.IMAGE REGISTRATION BASED ON CONTOUR MATCHING

Contour Matching aims at establishing the correspondence between image contours observed at different positions by one or more cameras. Contour in an image can be defined by two representations such as contour points and contour chains. Contours are general descriptions in an image and if provide more geometric information about the image For linking edge points we are having mainly two approaches , such as general purpose approach and perceptual based approach[4][6] .

Perceptual based approach is based on finding salient closed boundaries .These approaches are designed to solve a specific grouping problem..Acceptable results are obtained on images for which their assumptions hold .No prior knowledge about the number of objects contained in the scene is required. The main target of general purpose approach is to compute closed contour representation by connecting edge points, which could be useful for a further high level processing. The block diagram for contour based image registration is shown in figure 4.1.

Since only edge-point positions are used, computed boundaries do not necessarily correspond to a boundary between two regions. Matching is then usually achieved as follows[10]:

First, contour segments are extracted from two images by identifying edge maps, connect them and determining a set of points. Then, correspondence between two sets of contours is sought.

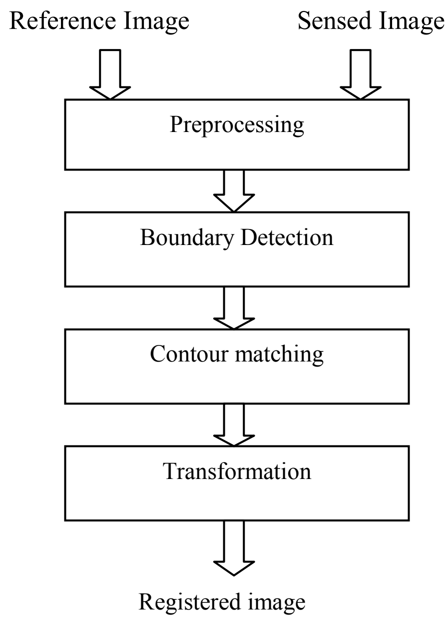

Fig 4.1 Block Diagram for contour matching based image Registration

Preprocessing involves the following steps. Both the input images are converted to gray level, then binarize the image by applying a simple thresholding. Normally the shape images are often corrupted with noise around the shape boundary, so smoothing or denoising is required. The denoising process eliminates those isolated pixels and those isolated small regions or segments. In the image structures, the boundary is not always connected; therefore, a m-connectivity connection technique is used to fill the gaps between boundary points. The shape is then traced using an eight connectivity contour tracing technique to obtain the shape boundary coordinates. After the closed contours are detected from two images, a correspondence mechanism between the regions must be established to match these two images. Region similarity is obtained by comparing the shapes of the segmented regions [11]. Since the images may have transformational differences, the shape measures should be invariant with respect to this.

The steps involved in contour matching are:

a) The matching of contour points: This establishes correspondence between contour points.

b) The initial matching of contours: This process makes use of the results of the first matching process. Pairs of contour points are traced and selected from the reference image and the sensed image.

c) Final matching of contours: The matching process aims at establishing the final correspondences using the initial contour correspondences obtained from the previous step. We use the matching process of contour points by using similarity criterion to get contour point correspondences.

Control points are obtained from the contour matching process. It is a measure of comparison between the reference and sensed image. Once the set of control points is identified, by using least square methods the transformation function to be used is estimated .Three types of transformations can be selected in the system: affine[14], translation and RST .The registration precision and the control points can be evaluated. For this evaluation three independent tests are used. This test provides a statistical procedure to characterize good and bad registrations.

V. ANALYSIS

1. Localization Error

The movement of the control point coordinates due to the in accurate detection is called localization error. This is an intrinsic error and it cannot be measured directly. Meanwhile the mean precision of control point detection procedures are known . Point based, edge based and contour based image registration technique are analyzed. Our contour based image registration algorithm is an optimal feature detection algorithm and hence the localization error is reduced.

2. Matching Error

Measure of the false match when establishing correspondence between control point candidates is known as matching error. False match can be identified by applying different matching methods to the same set of control points. Those control points which are detected by most of the methods are considered as valid control points.

3. Alignment Error

Alignment errors in image registration techniques are due to different reasons. It always depends on the mapping model selected. We can evaluate it by measuring the mean square error at the control points. Alignment accuracy can be checked by multiple cues. The image registration methods are compared and the contour based image registration is having good registration accuracy

VI RESULTS

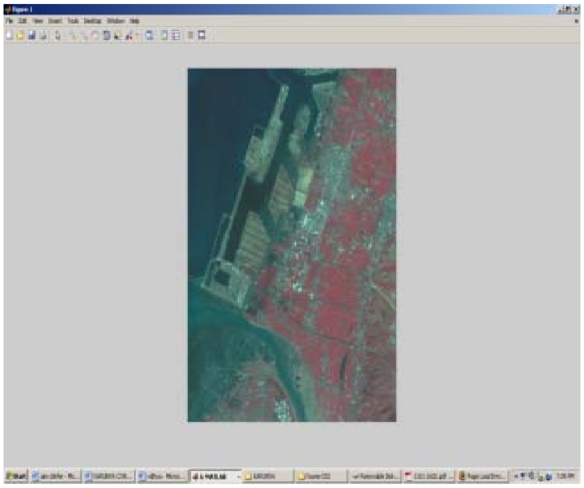

Fig 6.1(a)Reference image

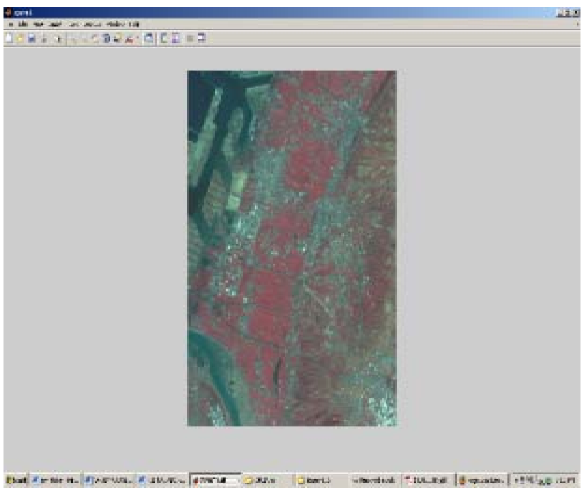

Fig6.1(b) Sensed image

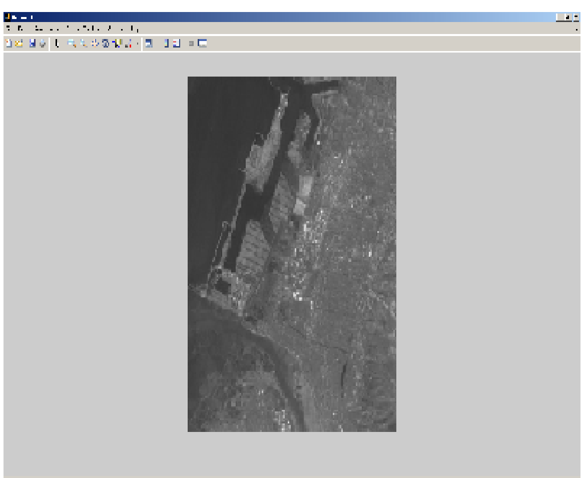

Fig 6.2 (a) Gray image for Reference image

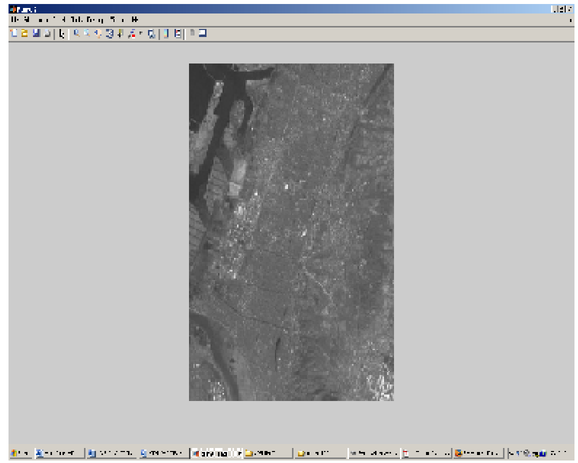

Fig 6.2 (b) Gray image for Sensed image

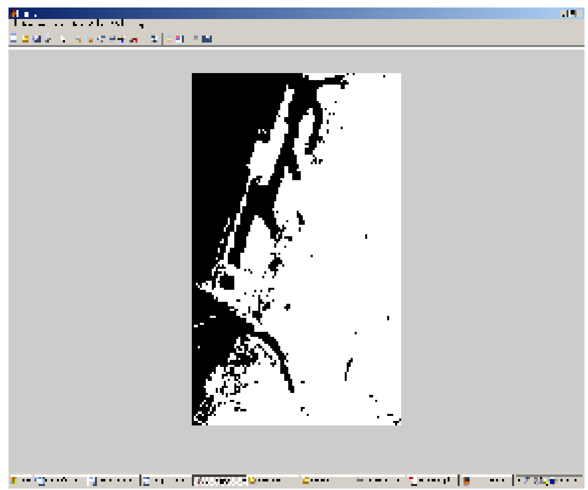

Fig 6.3 (a) Binary image for Reference image

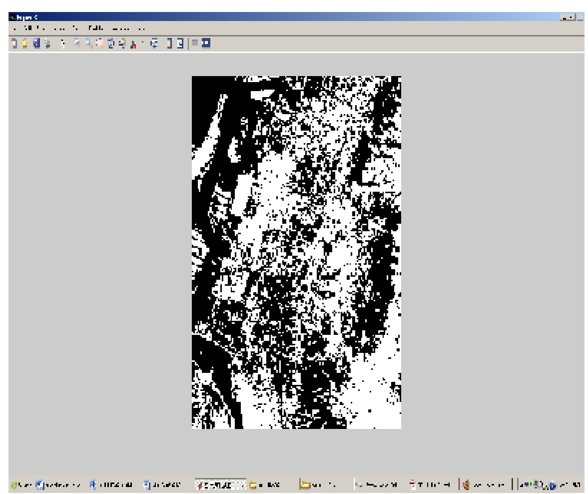

Fig 6.3 (b) Binary image for Sensed image

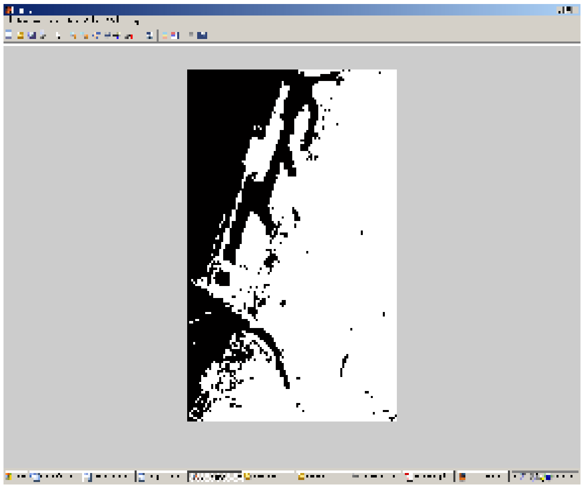

Fig 6.4 (a) Denoised Image for Reference image

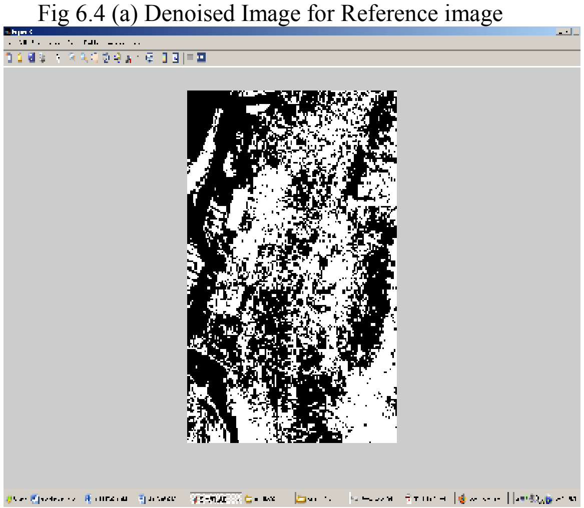

Fig 6.4 (b) Denoised Image for Sensed image

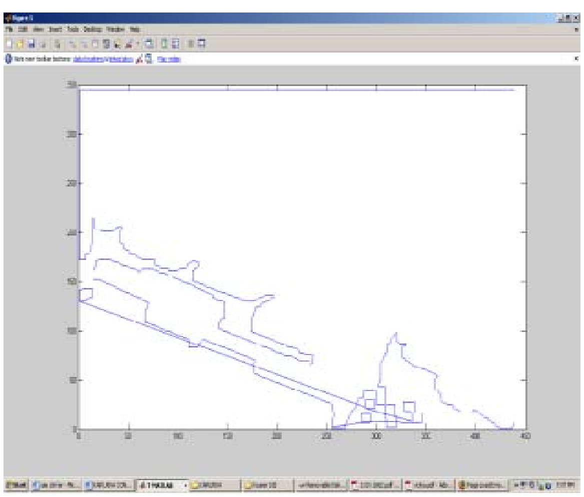

Fig 6.5(a) Contour detection for Reference Image

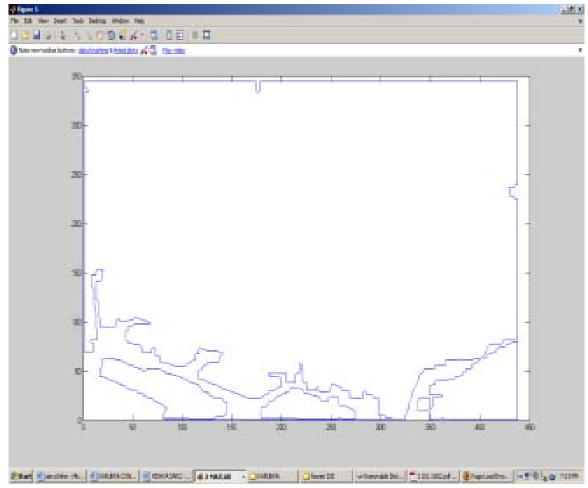

Fig 6.5(b) Contour detection for Sensed Image

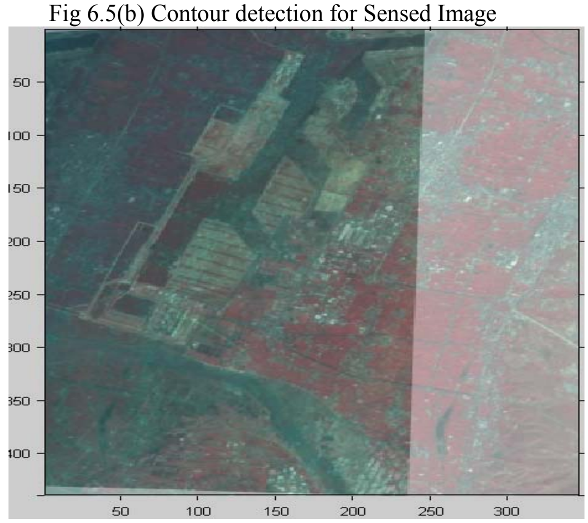

Fig 6.6. Registered Image for point based IR

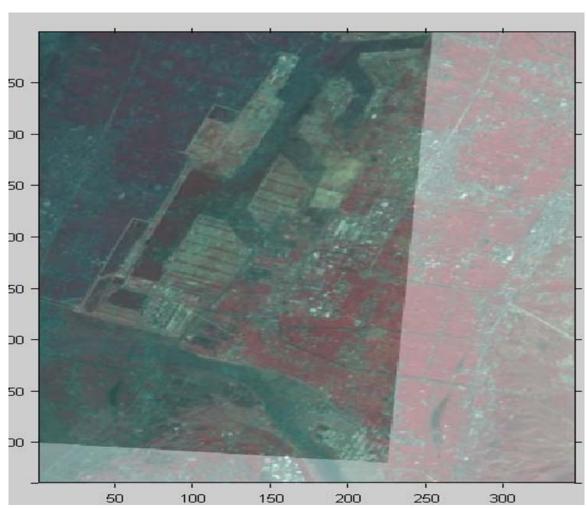

Fig 6.7. Registered Image for Corner based IR

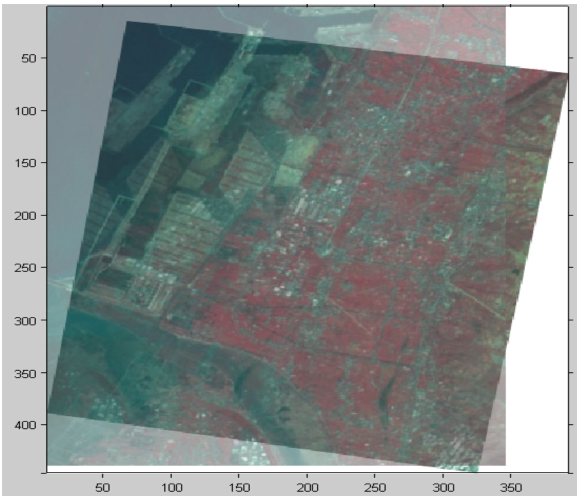

Fig 6.8. Registered Image for Contour based IR

VII .CONCLUSION

Image registration based on point based, corner based and contour based techniques are analyzed. In our contour based matching algorithm the contour are detected separately from two images and are matched at a later stage. For single-sensor and multisensory optical image registration, this algorithm is quite robust and reliable when the corresponding contours are available. It can handle images with large rotation and translation, and images with scale difference if there exist sufficient numbers of closed regions. The method is simple and does not need to set up a large number of parameters. The algorithm is performed at progressively higher resolution, which allows for faster implementation and higher registering precision

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