An Automatic Image registration: An Introductory survey

Arpan V. Patel¹, Sandip R. Panchal²

¹PG Student, ²Assistant Professor

1, 2 Department of Electronics & Communication, 1,2Sardar Vallabhbhai Patel Institute of Technology, Vasad, Gujarat, India

Abstract— Image Registration is important operation in image processing system which is the process of aligning two or more images into one coordinate system, are taken at different times, from different sensors, or from different viewpoints. It has a lot of applications especially medical imaging and remote sensing. The main aim of this paper is to provide a comprehensive review of existing literatures available on image registration system. This paper overviews the theoretical aspects of an image registration problem. The purpose of this paper is to present a survey of image registration techniques. Registration is a fundamental task in image processing used to match two or more pictures taken, for example, at different times, from different sensors, or from different viewpoints. It geometrically aligns two images the reference and sensed images. Various applications of image registration are target recognition, monitoring global land usage using satellite images, matching stereo images to recover shape for navigation, and aligning images from different medical modalities for diagnosis.

Keywords: Image registration, Feature detection, Feature matching, medical image

I. INTRODUCTION

Image registration is the process of overlaying two or more images of the same scene taken at different times, from different viewpoints, and/or by different sensors. It geometrically aligns two images—the reference and sensed images.[1] To register two images, the coordinate transformation between two images must be found from class of transformations. The optimal transformation depends on the types of relation between the overlapping images. In Image registration, sometimes called image alignment and it is important step for a variety of applications such as remote sensing, medical imaging and multi-sensor fusion based target recognition. It is a prerequisite step prior to image fusion or image mosaic. Its purpose is to overlay two or more images of the same scene taken at different times, from different viewpoints by different sensors. It is a fundamental image processing technique and is very useful in integrating information from different sensors, finding changes in images taken at different times, inferring three-dimensional information from stereo images, and recognizing model-based objects.

II. IMAGE REGISTRATION METHODOLOGY

Image registration, as it was mentioned above, is widely used in remote sensing, medical imaging, computer vision. In general, its applications can be divided into four groups according to the manner of the image acquisition:

Different viewpoints (multi view analysis): Images of the same scene are acquired from different viewpoints.

The aim is to gain larger a 2D view or a 3D representation of the scanned scene.

Examples of applications:

(1) Remote sensing—mosaicing of images of the surveyed area.

(2) Computer vision—shape recovery (shape from stereo).[1]

Different times (multi temporal analysis): Images of the same scene are acquired at different times, often on regular basis, and possibly under different conditions. The aim is to find and evaluate changes in the scene which appeared between the consecutive image acquisitions.

Examples of applications:

(1) Remote sensing- monitoring of global land usage, landscape planning.

(2) Computer vision -automatic change detection for security monitoring, motion tracking. 3. 3.3 Medical imaging- monitoring of the healing therapy, monitoring of the tumor evolution.

Different sensors (multimodal analysis): Images of the same scene are acquired by different sensors. The aim is to integrate the information obtained from different source streams to gain more complex and detailed scene representation.

Examples of applications:

(1) Remote sensing- fusion of information from sensors with different characteristics like panchromatic images, offering better spatial resolution, colour images with better spectral resolution, or radar images independent of cloud cover and solar illumination.[1]

(2) Medical imaging- combination of sensors recording the anatomical body structure like magnetic resonance image (MRI), ultrasound or CT with sensors monitoring functional and metabolic body activities like positron emission tomography (PET), single photon emission computed tomography (SPECT) or magnetic resonance spectroscopy (MRS). Results can be applied, for instance, in radiotherapy and nuclear medicine. [1]

III. BASIC STEPS FOR IMAGE REGISTRATION

- Feature detection: Salient and distinctive objects (closed-boundary regions, edges, points, line intersections, corners, etc.) are manually or preferably, automatically detected. For further processing, these features can be represented by their point representatives (centres’, line endings, distinctive points), which are called control points in the literature.

- Feature matching: In this the correspondence between the features detected in the sensed image, those detected in the reference image is established. Various
IV. CLASSIFICATIONS OF IMAGE REGISTRATION ALGORITHMS

Image registration algorithms can be classified in various ways like based on modality, intensity or methods used for registration. Classified the image registration techniques as area based methods and feature based methods. Area based methods are preferably applied, when in images prominent details are absent and distinctive information is provided by gray levels or colors rather by local shapes and structure. Feature based matching methods are applied when local structural information carried by image intensities are more. These methods make use of image features derived by feature extraction algorithm. Point of sharp variations such as edges, corners, contours, surfaces, points etc. What carries valuable information about images are used for matching

A. Area-based vs. Feature-based

Image registration algorithms fall within two realms of classification: area based methods and feature-based methods. The original image is often referred as the reference image and the image to be mapped onto the reference image is referred as the target image. For area based image registration methods the algorithm looks at the structure of the image via correlation metrics, Fourier properties & other means of structural analysis. or most feature based methods, instead of looking at the overall structure of images, fine tune their mappings to the correlation of image features like points, lines, edges, line intersections, boundaries.

B. Transformation model

Image registration algorithms can also be classified into to the transformation model used to relate the reference image space with the target image space. The first broad category of transformation models includes linear transformations, which are a combination of translation, rotation, global scaling, and shear and perspective components. Linear transformations are global in nature, thus not being able to model local deformations. Perspective components are not needed for registration, so that in this case the linear transformation is an affine one. The second category includes elastic and non-rigid transformations. These transformations allow local warping of image features, thus providing support for local deformations. Non-rigid transformation approaches include polynomial wrapping, interpolation of smooth basis functions (thin-plate splines and wavelets).

C. Search-based vs direct methods

Image registration methods can also be classified in manner of the type of search that is needed to compute the transformation between two image domains. In search-based methods, the effect of different image deformations is evaluated and compared. In direct methods, use the Lucas Kanade method and phase-based methods, an estimate of the image deformation is computed from local image statistics and is then used for updating the estimated image deformation between the two domains.

D. Spatial-domain methods

Many image registration methods, operated in the spatial domain, using structures, features and textures as matching area. In the spatial domain, images found normal as the human eye might perceive them. Some feature matching algorithms are traditional techniques for performing manual image registration, in which operators choose matching sets of control points between two or more images. When the numbers of control points are more than the minimum required to define the appropriate transformation model, iterative algorithms like RANSAC are used to robustly estimate the best way solution.

E. Frequency-domain methods

Frequency-domain to directly determine shifts between images. Applying the phase correlation method to overlapping images produces a third image which contains a single peak. The area of this peak corresponds to the relative translation, between the two images. In many spatial-domain algorithms, the phase correlation method is resilient to occlusions, noise and other defects of bio-medical or satellite images. Moreover, the phase correlation uses the fast Fourier transform to compute the cross-correlation between the two images, resulting in large performance gains. This method can be extended to determine affine scaling and rotation between two images by converting the images in to log-polar coordinates. Because of properties of the Fourier transform, the scaling and rotation parameters can be determined in a manner invariant to translation. This single feature makes phase-correlation methods more useful than typical spatial methods. It must determine, translation scaling, and rotation simultaneously and often at the cost of reduced precision in all three.

F. Single-modality vs Multi-modality

Another attractive classification is between single-modality and multi-modality registration algorithms. Single-modality is the registration algorithms are those intended to register images of the same modality (i.e. acquired using imaging devices like camera, handy cam etc), while multi-modality registration algorithms are those intended to register images acquired using two or more different imaging devices. There are some specific examples of multi-modality registration algorithms in the medical or bio medical imaging. Examples include registration of brain tumour CT/MRI images or whole body PET/CT images for tumour localization, registration of contrast-enhanced CT images vs. non-contrast-enhanced CT images for segmentation of some specific parts of the anatomy and registration of ultrasound images and CT images for prostate localization in field radiotherapy.
G. Image similarity-based methods

Image similarity-based methods are widely used in medical field. A basic image similarity-in this based method, consists of a transformation model, which is applied to reference image coordinates to compute their corresponding coordinates in the target image space, an image similarity metric, that quantifies the degree of correspondence between features in two image spaces achieved by a given transformation and an optimization level algorithm, which tries to make maximize image similarity by changing the transformation parameters. The choice of an image similarity measure depends on the nature of the images its way to be registered. Examples of image similarity measures include mutual information, cross-correlation, sum of square differences and ratio image uniformity. Mutual information and its variant, normalized mutual information are the most popular image similarity measures for registration of multimodality images. Sum of absolute difference sum of square differences, Cross-correlation and ratio image uniformity are mostly used for registration of images of the same modality.

V. APPLICATIONS

- Diagnosis: Combining information from different multiple imaging modalities
- Studying disease progression: Monitoring changes in size, shape, position or image intensity over time
- Medical image: Image guided surgery or radiotherapy: Relating pre-operative images and surgical plans to the physical reality of the patient Brain tumor, registration (for data of the same patient taken at different points in time such as change detection or tumor monitoring) often additionally involves elastic (also known as non-rigid) registration to cope with deformation of the subject (due to breathing, anatomical changes, and so forth). Non-rigid registration of medical images can also be used to register a patient’s data to an anatomical atlas, for neuroimaging.[9]
- Patient comparison or atlas construction: Relating one individual’s anatomy to a standardized atlas

VI. CONCLUSIONS:

Various methods are studied in this paper to register images. Feature based method filter out the redundant information. Accuracy of this method is more but the limitation of this method, it is manual and slow compare to other methods and it is very useful in medical imaging. In the frequency based method, accuracy is more than correlation method but it is less as compared to other registration methods. But if we extract features of image and then apply Fourier method, accuracy will be increased. In frequency domain it should be found that some form of interpolation and implementation must be used. These are some of the conclusions about methods, used for image registration.

REFERENCES


[3] Anna Brook and Eyal Ben-Dor, “Automatic Registration of Airborne and Space borne Images by Topology Map Matching with SURF Processor Algorithm”, Remote Sensing Laboratory, Department of Geography and Human Environment, Tel-Aviv University, Ramat Aviv, P.O. Box 39040, Tel Aviv 69978, Israel, Remote Sensing, ISSN 2072-4244, 2011, 4292, Published: 6 January 2011


