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Image Registration with New System for Ensemble of Images of Multi-Sensor Registration

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Abstract: Image registration is an alignment of more than two images. Such images are image-sets or ensemble of images. The registration is done by selecting one image as a template with combination of second image as a registered one, from the ensemble of images. So important is about the selection of image, as a template or registered image. Different sensors form the images of different feature that increases the importance in case of multi-sensor ensemble of images. These two images, template and registered, may use a portion of the data from the available data. This paper is on discussing different techniques for registering ensemble of images with inclusion of some new approaches in these existing techniques. We used multi-sensors to divide an input image in several images and focus on some specific part of the image.

Key words: Joint intensity scatters plot · Registration · Multi-sensor · Magnetic resonance imaging · Computed tomography (CT)

INTRODUCTION

Computer vision and image processing techniques facilitate in visualizing objects inside the human body, so this becomes a point of special interest. Medical diagnosis; treatment planning and medical research are the main areas where advanced image processing techniques are used. For improving image observation, the images are to be geometrically aligned. So image registration is the way of mapping points from an image to relevant points in another image [3]. The role of image registration is to transforms different data sets to a single coordinate system. Such data can be collected from multiple photographs with different sensors, or at different times, or from different viewpoints [1, 2]. The image registration uses are in computer vision, image processing, medical imaginary, military research as automatic target recognition and satellites. Registration is for comparison or integration of the data obtained from different measurements.

The application areas of image registration are geographic information systems, remote sensing, environmental monitoring and remote observation of a patient, monitoring of tumor growth in cancer, weather forecasting, creating high-resolution images, computer tomography (CT), magnetic resonance imaging (MRI), target localization and automatic quality control.

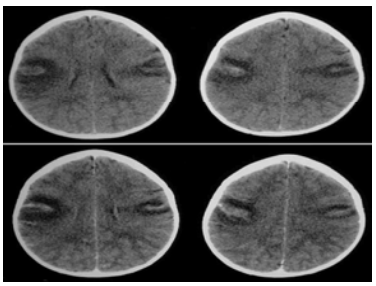

Fig. 1: The CT scan images. (Thanks to University of Hawaii, John A. Burns School of Medicine)

Figure 1 is about problem of registration in CT scan images. The multi-sensor registration techniques are to reduce the dispersion in the joint intensity scatter plot (JISP). The basic idea to link different images of the same object by the intensity is assigned to be components in the image. In CT and MRI images, the bones come as white in CT image but same bone will come as black for MRI image. The white matter and gray matter cannot be distinguished virtually in CT whereas this yields a different intensity in T1-weighted MRI. These two images, CT and MRI, are moved out of register so the spatial correspondence of objects in the images gets disturbed and causes coherence of the JISP to be disrupted [4-7]. The objective is to move the images until the JISP is optimally coherent, or minimally disperse.

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Main Challenges in Registering Ensemble of Images Are:

- Ensemble of images registration does exactly that, implicitly coupling the content of all the images into one optimization problem.
- This benefit stems from the fact that the estimate of an entity gets more accurate as you include more observations.

This paper covers different techniques for registering ensemble of images with some new approaches in these existing techniques. Section 2 provides existing techniques for registering ensemble of images. The proposed system for ensemble of images of multi-sensor registration is in Section 3. The test cases are discussed in Section 4.

Existing Techniques for Registering Ensemble of Images: Mutual correlation based image registration is suitable to the case when two images to be aligned are to have the same gray feature. Already a multi-modal image registration technique [8, 9] was developed for realizing the registration operation between a computerized tomography (CT) image and a magnetic resonance imaging (MRI) image. Multi-modal image registration was used to process multi-sensor remote sensing image registration [11-13]. A geometric correction method was there to determine two sets of feature points respectively in two images. These two sets of feature points are correctly corresponding to each other and they are used as reference points for geometric correction of one image to another. Such feature points are also called as crossing points or corner points. Practically, this is found difficult to determine these feature points at pixel level for lack of determinate criterion. In such a case, the correctness of selected feature points is not guaranteed [14].

Finally, the multi-modal registration techniques are most suited for the geometric distribution of the edges of the two images. Such two images are aligned is coincident but the gray attributes of corresponding regions of the images may not be consistent. But for the applications area of multi-sensor registration, it is difficult to achieve and satisfy such conditions [15]. It gives a way for investigating the registration problems for a 3-D image [19]and also for large sized images formed by many gray level images with distortion of geometry [15, 6].

JISP covers the coherent collection of points of the each object in an image. An example can be given for bone in CT and MRI, as a collection of points for distribution around a single focal point. The gradation of shades in one image corresponds to a different and this gradation of shades in the other image is creating a curve of points in the JISP. The spatial correspondence of objects in the two images disturbed and result in cause of coherence of the JISP to be disrupted. Some pixels of bone are now paired with muscle pixels and few with fat pixels, the clusters of scatter points spread out and moved. The main aim was to move the images till the JISP is optimally coherent, or minimally disperse. The entropy [18] of the joint histogram to quantify dispersion is used in such applications. The JISP between two images forms a joint histogram that reflects the density of the points in the scattered plot. The histogram entropy can be computed. The lower the entropy results in the more compact and tight-clustered scattered plot that will give more closely registered the two images. The normalized mutual information and mutual information used the idea of histogram entropy [6, 7, 16, 17]. Some of the existing techniques for registering ensemble of images are:

Segmentation: Segmentation is needed for commonly close region in the pre-processing for image registration. Such work is application-based. Feature homogeneity based segmentation technique deal with segmentation problems in a limit. Image fusion needs some other regional assignment techniques. So, for image processing, the segmentation region is defined for lacks of proper standard as the architecture usually forms irregular image patterns [15, 16].

Feature Extraction: Extraction of features from an image is an operation in image processing. Usually, a segmentation technique is required for extracting features contained in an image. Typically, the profiles of features are extracted. But this is not always feasible, when the boundary of the object is not distinguishable with the background. Some artificial objects like airports, roads, large buckets and bridges, are highly concerned in military image fusion [15]. Usually, these features cannot be extracted directly from a large size image. The grid searching scheme has the similar difficulty. At the first step, assign a particular object region that contains the objects. This can be done on the basis of history knowledge obtained from remote sensing for most objects. For emerged unknown objects and moving objects, such as airplanes, vehicles, tanks, warships, etc, a seeking algorithm would be needed. In any case, if a compact region that contains objects can be assigned before seeking, the computational burden of extraction operation will decrease drastically.

In the development of the multimedia content description standard, MPEG7, researchers have proposed a series of technical techniques for extracting and

describing the content in images [31]. For describing regular artificial objects there exist a number of techniques that can be utilized singly or compositely. The mathematic transform techniques were used for extracting the numerical features of objects in common. Complex moments are a kind of numerical features with invariability. These features have been used successfully for pattern identification [15].

Outer Part Registration Technique: On outer part of a human body an artificial object is attached. By using this approach a good computational speed can be achieved and which should be detectable without a need of complicated algorithms [20].

Atlas Techniques: In atlas registration, one image to be acquired from the patient and the other image is from an image information database. K.K. Bhatia *et al*. [21] discussed registration algorithm in a group. This algorithm simultaneously registers all images to a common reference space. Other researchers Wan Rui and Li Minglu [22] explained that standardized brain coordinate system. This brain coordinate system was mainly used in automatic segmentation of individual cerebral structures in brain image volumes and stereotactic neurosurgical planning.

Curve Techniques: A curve matching method is used to register 2-D projection images [23]. In this technique it is sampled to generate sequences of corresponding points to be registered. Corresponding "open" curves are searched manually and they are registered 2-dimensional projection radiographies. These corresponding open curves were matched by searching for the optimal fit of the local curvatures in the two curves. Medical image registration was also used points, contour and curves [24], which were having accurate registration based-on points.

Moment and Principal Axes Techniques: The rigid bodies were characterized by the spatial distribution of their mass used moments. Next, the orthogonal axes about which the moments of inertia are minimized were called the principal axes. Any two objects are identical (not for a translation and a rotation) then these two objects were registered exactly by bringing their principal axes into coincidence [9].

Correlation Techniques: Fourier transform was used with best-search method for finding the translation between two input images. [25] The Fourier-based technique was used to estimate the candidate translations to decrease

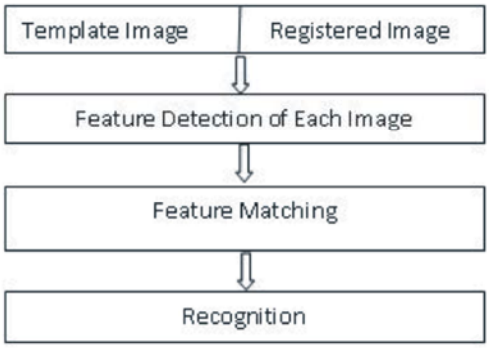

Fig. 2: Multiple sensor ensembles of images registration

searching space while best-first search algorithm was used to further search for the correct translation. Translations, scaling and rotations in images were estimated by an extension of phase correlation technique.

Mutual Information-based Techniques: Mutual information-based registration technique means that it started with the estimation of the joint probability of the intensities of corresponding voxels in the two images. The mutual information-based technique was also called as voxel-based registration. Registration of multimodal images was mainly used in medical imaging. [26]

Multi-Sensor: In multi-sensor image registration, registration /alignment of the related images was showing different attributes of different images. So for some areas of images there were different patterns from one image to another. Such different patterns cannot be registered with each other. Here, such a registration technique was used and that has the ability of distinguishing the object's regions with non-object's regions of images. For the aim of geometric correction, it is needed to determine three or more pairs of GFD located in the non-object's regions. This is not a difficult task in usual case. However, detection of different patterns in different images by computer will be by no means an easy task for multi-model images.

Proposed System for Ensemble of Images of Multisensor Registration: Ensemble of image registration is registering multiple images simultaneously in a single optimization. We use a Gaussian mixture model (GMM) to perform density estimation of the content in the joint intensity space. The implicit assumption linking different images of the same object is that they are recognizable as the same object because of some consistency by which intensities are assigned to components in the image. Fig. 2 it shows steps of the proposed system, initially

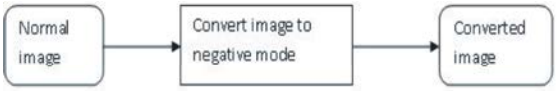

Fig. 3: Formation of template image (negative image/ outlined image/ lighted image/ gray scale image)

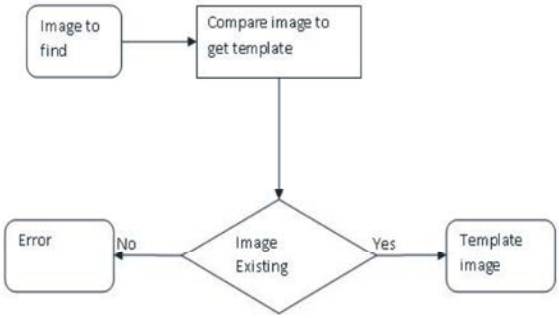

Fig. 4: Image matching.

both template image and registered image are taken, second step to extract the features, third step will cover the feature matching and at last it will go for recognition.

The high-dimensional joint histogram is too large to store in memory. Previously we cannot able to register more than two images at a time. Here Gaussian mixture model (GMM) is used to perform density estimation for the content in the joint intensity space. This GMM model also helps for the cost function based on likelihood. Our challenge is to formulate an optimization problem with development of solutions for the density estimation and motion parameters. The proposed system for ensemble of images of multi-sensor registration can be implemented by description of following modules:

- Multi-pose image: For availability of more than a single image of the same object, it is assumed that the relative pose of the same object in two different images is known or can be estimated. One other condition, when the pair of templates and a pair of candidates have a signal in common, the joint distribution is assumed to follow Gaussian distribution with mean zero and covariance matrix composed of four block matrices.
- Effects: This module effects like dark, shadow, illumination or glossy to the given input image and then the affected image will be given as input for the reorganization process.
- Recognition: Recognition can be performed by the information collection from extracting features by the images of the objects. These features are needed to be combined with vectors i.e. templates. Such templates are stored in library of objects. So here the recognition channel is defined as the environment that transforms reference templates of objects in a library into templates submitted for recognition.

Formation of template image is shown in Fig. 3. All type of images, like negative images, outline images, lighted images or gray scale images, are taken initially and converted to negative mode.

Fig. 4 is for the image matching process. A new image is found and compared with the formed template image. If new image is matching with template image than template image of that is formed.

RESULTS AND DISCUSSION

As this paper s based on registering a multisensor ensemble of images, so when an image (Fig. 5) was taken as input image, it generates a cluster (Fig. 6). Multisensor is used to divide a input image in several images and this focus on specific part of the image. As the image need to be searched, the part of the image was taken by using the value that can easily recognize. Both the values are matched and according to the value a joint intensity plot (Fig. 7) graph is generated. Now, that part of image can easily recognized.

From results it is clear that this method of ensemble of images is more powerful then the method used earlier for image registration like pairwise clustering method. This method can be viewed as a parametric regression method, with the number of parameters dictated by the number of Gaussian components. Gaussian modeling method is strong method to calculate the density of the joint, based on this calculation the density graph can be easily plotted.

Conclusion and Future Work: Ensemble of images registration of images is the process of registering images simultaneously in a given problem. Multi-sensor registration of image is previously not possible because intensity plotting method takes more memory space to store. In this paper, we used a method known as Gaussian mixture model to plot the intensity graph which is efficient method.

In this paper, we divide the image in several components by using sensors and which help us to recognize the desire component which is asked by the user. User can easily give effect on that part or he can register some another image on that part of image. Our method of ensemble of images registration is robust and more accurate compare to the pair wise registration method. This method can easily be extended for non-rigid body registration.

Fig. 5: Testing Image

Fig. 6: Cluster Images

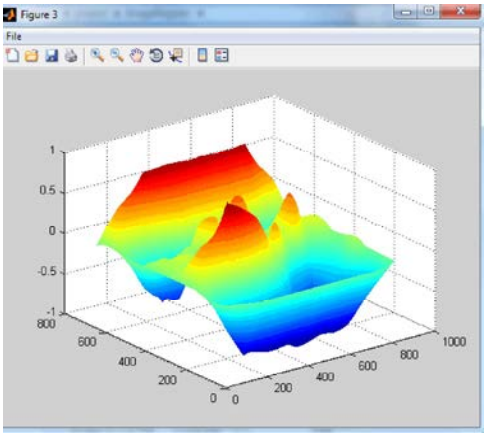

Fig.7: Intensity Plot

This proposed paper is mainly helpful in medical sciences it helps to locate the problem very fast. A doctor can easily compare to different images of same problem using this technique. In future we can improve the optimization search process for clustering registration. We can also use some other technique to estimate the density.

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