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Review and Application of Different Digital Image Registration

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Abstract **-** Digital Image Processing is a digital signal processing that deals with digital images by using various algorithms. With time, this field of study has see some immense development in terms of research and the development of new and improved algorithms, not to mention some of the new and advanced methodologies capable of performing some special tasks.

Such is the foundry of Digital Image Registration, Digital Image Registration is a part of Digital Image Processing, which deals with the process of transforming a set of data (here image) into a coordinated system, once registered, the data (here image) can be fused in a way that improves information extraction. This is done by using some special algorithms. The purpose of this paper is to present a theoretical/literature review of the existing Digital Image Registration methods and, theoretically compare them on sets of certain parameters and provide useful documentation for researchers and non-experts to select a specific algorithm that delivers the finest information extraction of all.

I. INTRODUCTION

Digital Image Processing is a branch of digital signal processing and systems that deal with manipulating digital images by using various algorithms. It mainly focuses on developing systems which are to perform the processing of images. Started in the late ’60s, this field has seen tremendous growth in the field of research and application, and hence the process of Digital Image Registration was introduced.

Digital Image Registration is a process which is performed before what is a much broader field i.e, Digital Image Fusion. Digital Image Registration is a process of overlaying multiple images of the same subject taken at different intervals of time, from different points of view, and from the same or different sensors. It is a method to superimpose pixels from multiple geometrically aligned image sources.

The application of Digital Image Registration is not limited to Image Fusion. Registration is required for some other models of Digital Image Processing such as Multi-Camera Object Tracking, Image Stitching, Panoramic Imaging, Image Stabilization etc. To perform such tasks we high quality and well registered images.

In this paper we reviewed following methods of the Digital Image Registration from different research papers and then have provided the fitting use of these methods in the observation section below.

II. DIGITAL IMAGE REGISTRATION

Digital Image Registration is a process of overlaying multiple images of the same subject taken at different intervals of time, from different points of view, and from the same or different sensors and then map them on to another image by using perfect transformation. It is a method to superimpose pixels from multiple geometrically aligned image sources. It aims to combine the data from multiple images. [1] When images are taken one of them is referred as a reference image or the original image which is kept untouched and the image other is called as a sensed image and is employed to register the reference image. The flow diagram below shows the exact steps of how Image Registration works.

Global Transformation	Parametrisation	Transformation Description
Affine	$u = a_0 + a_1 x + a_2 y$ $v = b_0 + b_1 x + b_2 y$	The affine transformation can describe translations, enlargements, rotations and shearing of the image.
Polynomial	$u = \sum_{i=0}^{N} \sum_{j=1}^{i} a_{ij} x^{i-j} y^{j}$ $v = \sum_{i=0}^{N} \sum_{j=1}^{i} b_{ij} x^{i-j} y^{j}$	The polynomial transformation can describe the same image changes as the affine transformation and non-linear warps of the image plane.
Projective	$u = \frac{a_0 + a_1 x + a_2 y}{1 + a_6 x + a_7 y}$ $v = \frac{a_3 + a_4 x + a_5 y}{1 + a_6 x + a_7 y}$	The projective transformation describes the registration of one co-located sensor to another.

Number of models have been proposed to describe the mapping between the reference image and the input image. They may be divided into global transforms which are typically parameterized by a few coefficients and local transforms which are able to represent more complex local behaviors.

III. DIFERENT METHODS FOR IMAGE REGISTRATION

1. PIXEL BASED METHOD

[2] Pixel based suggests that to vary the label of the intensity of the pixel. we have a tendency to calculate the relation between the normalized cross-correlation and therefore the angle of rotation supported pixel value. during this methodology cross-correlation applied mathematics approachis used for registration. it's typically used for template matching or pattern recognition within which the placement and orientation of a template or pattern is found in image. Cross correlation is a similarity measure or match metric. Since native image intensity would influence the measure therefore the cross correlation ought to be normalized.

Also, by comparing intensity patterns in pictures via correlation metrics. Intensity-based strategies register entire pictures or sub-images. If sub-images area unit registered, centers of corresponding sub pictures area unit treated as corresponding feature points Knowing the correspondence between variety of points in pictures, a geometrical transformation is then determined to map the target image to the reference pictures, thereby establishing point-by-point correspondence between the reference and target pictures.

The flatness of the similarity measure maxima (due to the self-similarity of the images) and high machine quality area unit the most important drawbacks of correlation strategies. By pre-processing or by using the edge or vector correlation the maximum can be sharpened effectively

2. EXTRINSIC IMAGE REGISTRATION METHOD

[3] Extrinsic methods rely on artificial objects attached to the patient, objects which are designed to be well visible and

accurately detectable in all of the pertinent modalities. As such, the registration of the acquired images is comparatively easy, fast, can usually be automated, and, since the registration parameters can often be computed explicitly, has no need for complex optimization algorithms. Image guided surgery has advanced with time and developments in image processing techniques. These types of surgeries greatly depend upon the accurate registration of medical images. In extrinsic registration method, external objects are more visible therefore more distinguishable from any other part in the image. The computation speed of extrinsic registration method is also fast as it doesn't need any complex algorithms for implementation. The registration of complex 3D and 4D shapes is easily performed with extrinsic registration methods.

3. REGISTRATION BASED ON HIGH LEVEL FEATURES (CONTOUR BASED IMAGE REGISTRATION)

[4] For matching image feature point's high statistical/mathematical features are utilized in this method. For extracting regions of interest from the image, color image segmentation is used. for instance, for a given set of color mean is calculated. For segmentation method every RGB Pixel in a picture is classed as having a color in such that vary or not. additionally, the geometer distance is needed to measure similarity. Noise is removed once segmentation method victimization Gaussian filter. Thresholds blurred the image then acquire the contour of a picture.it is observed that these strategies don't use the grey values for matching and therefore overcomes the constraints of abstraction strategies. Feature based mostly method filtrate the redundant data. Accuracy of this methodology is a lot of however the limitation is that it's manual and slow.

4. SURFACE METHODS

[7] Boundaries or surfaces, in medical images are many times more distinct than landmarks and hence can be used for segmentation by locating high contrast surfaces. Surface matching algorithms are mainly used for rigid body registration. The representation of surface methods is a surface-based approach for registering multimodality brain image. They fit a set of points extracted from contours in one image to a surface model and extracted from contours in the other image. The image that covers the larger volume of the patient, or the image that has a higher resolution if volume coverage is comparable, is used to generate the surface model. Another version of surface matching is to provide user with an interactive transformation package that allows the user to translate and rotate one image with respect to the other.

5. GENETIC ALGORITHM

A genetic algorithm (GA) is a search technique utilized in computing to seek out precise or approximate solutions to optimization and search issues [8] Image Segmentation is the toughest task in image processing. The original image is partitioned off into totally different items for higher analysis. The foremost tough task in image segmentation is parameter selection. The image segmentation using genetic algorithm can be done by Parameter selection and pixel-level segmentation, wherever parameter selection includes the genetic algorithms that are used to modify the parameters of existing image segmentation methodology to enhance its output. and Pixel-level segmentation includes genetic algorithms which are used to perform region labeling.

6. IMAGE REGISTRATION IN FREQUENCY DOMAIN

[9] The correlation theorem states that "the Fourier transform of the correlation of two pictures is that the product of Fourier transform of one image and the complex conjugate of Fourier transform of other". The Fourier transform of an image f(x,y) is a complex function, every function value has real part R(ωx,ωy) and the imaginary part I(ωx,ωy) at every frequency (ωx,ωy) of the frequency spectrum. Shift theorem guarantees that part of the cross power spectrum is equivalent to the phase distinction between the photographs. If we tend to represent the part of the cross power spectrum in its partial form, i.e. by taking the inverse Fourier to transform the illustration within the frequency domain, then we'll have a function that is an impulse, that's roughly Zero everyplace except at displacement that is required to optimally register two images. The above methodology is used to register images having only translation.

7. CROSS CORRELATION IMAGE REGISTRATION METHOD

[10] Image correspondence and registration techniques have gained quality in recent times because of the advancement of utilization in digital media and its storage. the most downside related to image processing is when it's applied to fields like robotic vision and machine vision. the matter is because of clutter, i.e. identical frame with completely different objects has got to be matched. hence there has been a need for efficient techniques of Image Registration. This lead to the development of feature extraction techniques and model matching techniques. The normalized cross-correlation technique is one among them. A classical resolution for matching 2 image patches is to use the cross-correlation coefficient. This works well if there's plenty of structure inside the patches, however not therefore well if the patches are about to uniform. this suggests that some patches are matched with additional confidence than others. By estimating this unsurty additional weight is placed on the assured matches than those who are additional uncertain. All the simulations are performed using the MATLAB tool.

Criteria / Application	**Image Registration Method**	**Description**
Image guided surgery	Extrinsic registration methods	Extrinsic methods are based on external artificial objects attached to patient's body. Extrinsic registration methods always remain a best option in Image Guided Surgery.
Monitoring the Progression of Surface Fatigue Failures in Geared Transmission Systems	Surface methods	Surface-based image registration methods involving determining corresponding surfaces in different images (and/or physical space) and computing the transformation the best aligns these surfaces.
Image segmentation	Genetic Algorithm	The difficult task in image segmentation is parameter selection, which can be done using Genetic Algorithms.
Image translation	Image Registration using frequency domain	frequency based method accuracy is more than correlation method and after applying Fourier method accuracy increases.
Registration of Multispectral/multisensory images	Contour Based Image Registration	Multisensory images have different gray level characteristics, and simple methods cannot be applied directly. Contour based approach can overcome this issue.
Template Matching	Pixel based method	This method is often used in template matching in pattern recognition in which small part of an image matches a template

		image.
Machine Vision/ Robotic Vision	Cross Correlation method	This method for Machine vision is quite simple and efficient as matching the same frame with different objects can be done efficiently by this method.
Remote sensing	Mutual Information based Image registration	MI based Image Registration method can efficiently register large volumes of Remote Sensing Data.

8. MUTUAL INFORMATION-BASED METHODS

[7]Mutual information-based registration begins with the estimation of the chance of the intensities of corresponding voxels within the two pictures. The utilization of data-theoretic measures like mutual information has benefited voxel-based registration. the current papers have indicated that mutual data will be used to parameterize and solve the correspondence drawback in feature-based registration.

CONCLUSION

Remote sensing is that the method of detecting and observation the physical characteristics of it by measuring it is reflected and emitted radiation (usually from a satellite or aircraft). Mutual Information-Based techniques are currently changing into a preferred selection for Remote Sensing knowledge.

OBSERVATION

Using above Image Registration method we have deduced the following table, these methods are used in various fields and processes, since more than one method can be used for a particular process we analyzed and compared methods and provided current most fitting methods for certain applications

The table is the theoretical analysis of various image registration method and represents/depicts the current most fitting available Image Registration methods for mentioned applications.

NOTE: All the methods from various research papers were considered to be factually correct and true.

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