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Image Registration in Medical Image Processing -An Overview

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Abstract :Image registration the process is very difficult problem facing in medical field . The process of image registration is an automatic or manual procedure. It tries to find similar points between two images and align themto minimize the "error", i.e. distance measure between twoimages.The dataset can be multiple photographs like MRI,spect,CT scan images from different times ,depths or viewpoints.The purpose of this paper is to provide a overall information about the existing registration techniques and a detailed approach about non rigid registration which is in advanced mode .

Keywords : CT scan images, MRI, medical field

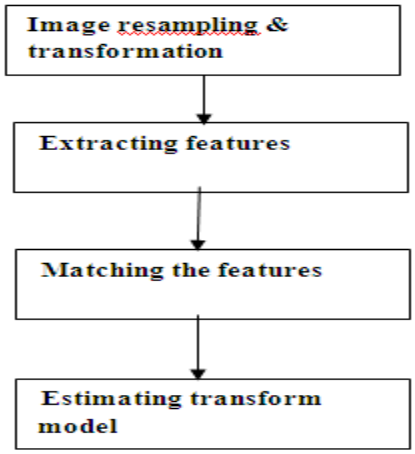
1.Introduction : Image processing methods are used to visualize objects inside the human body in region of interest.Two images can be taken, one is target image and other is reference image .The images should be aligned spatially for good performance or observation. Applications of image registration in medical fields are diagnosis in renal,brain,abdomen,pelvis or other parts disorders and alsorecognizing the target, using satellite images monitor the global land usage.aw This procedure of mapping points from one image to corresponding points in another image is called registration.

2. STEPS INVOLVED IN IMAGE REGISTRATION

The steps involved in image registration are

2.1Feature Detection

Feature-based methods establish a correspondence between a number of similar points in both reference and target images .Features like closed boundary regions, contours, line intersections, corners are detected.



.Fig 1 Steps in Image Registration

2.2. Feature matching

The matches between the features in the reference and Target image is found out

2.3. Transform model estimation

The type and parameters of the mapping Functions and the aligning of the target image with the reference image, are found out.

2.4. Image resampling and transformation

The target image is resampled and then transformations are carried out to make the image better by the mapping functions and then transformations like rotation ,resizing scaling and then extractions are carried out. Hence the target image

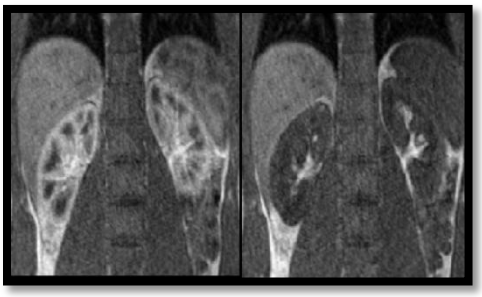


Fig 2 Input Images

This is the sample input image that is to be process

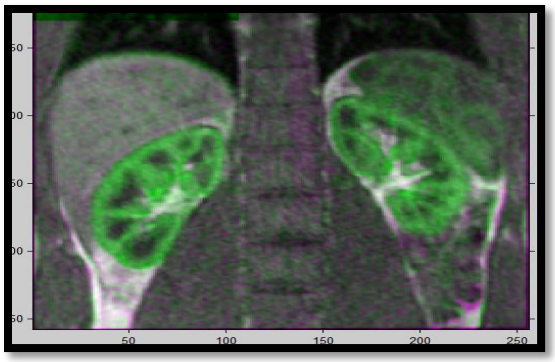


Fig 3 registration result

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3.TYPES OF REGISTRATION

3.1.DIMENSIONALITY

It is of two types

3.1.1 Spatial dimensions are

1. 2-D/2-D

2. 2-D/3-D

3. 3-D/3-D4

.3-D/4-D

5.4-D/4-D

Nowadays current papers focus mostly on 4D-4D image registration of two images. Time is involved in this2-D/2-D registration involves in the slice images of some tomographic data.

3.1.2. Registration of time series

For example the registration can be done to detect tumor growth in some parts and also arrival of bolus in blood vessels and from that the registration can be done after image capturing. To compare two images then registration is compulsorily needed.

3.2.NATURE OF REGISTRATION BASIS

The nature of registration are

3.2.1. Extrinsic registration methods

In Extrinsic registration methods, artificial objects,are attached to the patient's body. It should be detectable and this method doesn't need complexity algorithms and computation speed will be good and it can be achieved. 2The objects used in this are Stereo tactic frame (invasive)screwed tightly to the patient's outer skull table they are used for localization and guidance purposes in neurosurgery .

Limitations of extrinsic

Provisionsmust be made in the pre capturing phase, and the oftenthe characters of the marker objects.Non invasive(mound frame) can also be taken but rules are not very accurate. Patient related information is not there in this method so that it's a failure one.

3.2.2.Intrinsic registration methods

- Landmark based
- ` Registration methods on basis of segmentation

These methods are discussed below

Registration can be based on a limited binary structures segmentation alignment. It is used to find rigid or affine transformations. Theoretically it can be used for complex structures when the set of points are large .The drawback is user interaction is needed for the landmark identification.

- registration methods on basis of segmentation

Registration methods on basis of segmentation can be rigid-method. A drawback ofsegmentation-based methods is that the registration accuracyis limited. In segmentation-based registration is applicable to images ofmany areas of the body, yet in practice the application areashave largely been limited to neuroimaging and orthopedicimaging.

3.2.3Non-image-based registration

It is possible if the imagingcoordinate systems of the two scanners are coordinated to each other.This usually necessitates the scannersto be brought into the same location, and that the patient remains motionless between bothacquisitions.

3.3. NATURE OF TRANSFORMATION

3.3.1. Rigid registration or transformation

Normally transformation is a function and thatfunction creates images which are similar to the original images.The original image is called the pre-image or reference image and the resulting image is called post- image. This transformation is known as rigid transformations.

The Rigid transformations include

- Rotations
- Translations
- Reflections, Or Their Combination

Rigid transformation has 3 DOF for 2D (Degrees Of Freedom) and also 6 DOF for 3D. RigidTranslations and rotations registers images of objects. The rigid transformations are used mostly in medical neuroimaging and registration applications.This transformations are also used to align images of two images and it shows the small changes and object intensity which will be most useful in medical analysis

3.3.2. Affine Transformations and registration

It consists of 4 properties

- Translation
- Rotation
- Shearing
- Scaling

Affine transformation has 12DOF (Degrees Of Freedom).It will only look after parallelism of lines it won't look ahead their length nor their angles. It has two extra factors compared to rigid transformation i.e scaling factor for each dimension and also a shearing dimension.

3.3.6. Projective transformation

Projective transformation is used and it will be tilted .The difference is straight lines be as same as straight but the parallel lines will be converged to the end points. Straight lines should be in reference image and it will remain straight in sensed image. The projective transformation is not always used in *2D/3D* applications, even though projections will always be in the problem, the transformation is not necessarily or truly projective but rigid, if it applies to the 3D image similar to its projection to the 2D image.

3.3.4 Curved transformation

A 2D-to-3D non-rigid intensity-based planar-to-curved-surface image alignment algorithm was proposed by Smarder Gefan. This matches the two images on a curved surface with volumetric image..It allows inter modality matching of data

3.3.5 Non rigid transformationCrum

Earlier techniques like affine or rigid registration has main disadvantages so non rigid registration has come up with varying applications in modelling,tissue deformations in anatomical structures, It is a challenging phenomenon for their requirement of smoothness and high degree of freedom. Many algorithm are there to register images to one another but many has the disadvantage like time consumption it is a major drawback in medical field,

3.3.7 Spline

Family of splines have been used in different forms for more than 15 years and it is one of importantnonlinear transformation. Mostly all the registration techniques using this spline match corresponding points in both source and destination. But spline based registration techniques uses control points to define the similar points using spline function.

3.3.8 Elastic

Elastic model is a non-rigid registration method and it is introduced by Broit and later it is extended by bajcy and Kovacic to find the low contrast brain structures and other physical structures in pet, CT and MRINavier equation for estimated deformation field

$$\mu\nabla^2 u + (\lambda + \mu)\nabla(div(u)) + F = 0$$

Where u deformation field to estimate,
λ and μ Lame coefficients
F sum of forces

For perfect registration forces F should be specified. Thesource image should be treated as elastic solid and forces should be applied for deformation.Deformation occurs till equilibrium state is reached.

3.3.9 Fluid Registration

Elastic registration has the limitation of large displacement because the energy of deformation increases well with the strength of deformations but in fluid registration the disadvantages are overcomed i.e. the conditions are relaxed over time so that the deformations are applicableIt is really useful in atlas matching which has large deformations.

3.3.10 Diffeomorphic Registration

It protects the topology and also folding which is not possible normally. It is a good registration when the object doesn't have spatial information. The early diffeomorphic registration approaches were based on the "viscous fluid" registration method of Christensen et al .Differential equations can be solved using finite difference methods it shows one image as it "flows" to match the shape of the other.

3.3.11 Finite Element Method

FFM is used in many tissues like bone, myocardium, pelvis and brain.Other parameters can be guessed by geometrical transformation. It is mainly used in clinical and research applications. Displacements can be used to find the inter relation of tissue types.

3.4. DOMAIN OF TRANSFORMATION:

I) Globalii) Local

Global is nothing but the whole image is considered
Local is nothing but only some part is considered

3.5. INTERACTION

Three types of interaction are there

3.5.1 Automatic

The data of image can be given by the user to the algorithm of registration and also the information regarding image capturing.

3.5.2 Interactive

The registration can be done by the user by his own and also using the software .the unction of software is to supply the visual data to algorithm or else the numerical data of their transformed result and sometimes initial transformation is needed

3.5.3 Semi-automatic

The I interaction occurred can be in two different levels .Firstly the algorithm should be initialized for ex steering the algorithm and segmenting tithe recent research is based on automatic because it provides very high usefulness in clinical field. But the area to be keenly watched is robustness and speed.

3.6 OPTIMIZATION PROCEDURE

3.6.1. Parameters computed

The parameters can be computed directly taken from the available data or else it can be searched by finding the function .the computation can be determined directly but finding some global transformations is difficult on sparse information's.If local transformations are there then local displacement can be computed directly from all the available data.

3.6.2. Parameters searched for

In searching of parameters they can be searched through mathematical functions that can be set as standard.it will detect the similarity between two images. Many well documents optimization techniques are used. But these functions are less complex in monomodal registrations but in multimodal it is bit difficult

3.7. MODALITIES INVOLVED IN THE REGISTRATION

3.7.1. Monomodal

1. Auto-radiographic
2. CT or CTA

3.7.2. Multimodal

1. CT–MR
2. CT–PET
3. DSA–MR
4. PET–US
5. SPECT–MR
6. X-ray–CT
7. Video–MR

3.7.3. Modality to model

1. CT
2. MR
3. SPECT
4. X-ray

3.7.4.. Patient to modality

1. CT
2. MR
3. PET
4. Portal

Based on the modalities four types of registration can be achieved.. In monomodal applications, the.

3.8. SUBJECT

a. Intrasubject b. Intersubject c. Atlas

An example of modality to model is the registration of anMRkidney image to a mathematically defined compartmentalmodel of gross kidney structures.It is used very frequently in medical diagnosis and mostly used in 3D DCE MRI and 3D CT. the properties are

Conclusion

Many papers reviewed on brain registration.I'm viewing about kidney registration we will break down this section according to the areas mentioned in the list. Hopefully this will give anidea of the specific approaches and trends associated with each .Note that many papers may have more than one application area, even though they only demonstrate a registration methodin one area.

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