Medical Image Analysis
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Lecture 18

NonRigid Registration

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MRL Medical Imaging & Reconstruction Lab

Medical Image Analysis

Nonrigid Registration

NPTEL

Hello and welcome to the week 4 of medical image analysis course, in this week we will talk about nonrigid registration techniques, specifically a quick look at two algorithms, very highly cited and popular algorithms for nonrigid image registration. And there are several free implementations of these available we will talk about them in the following minutes week 5.

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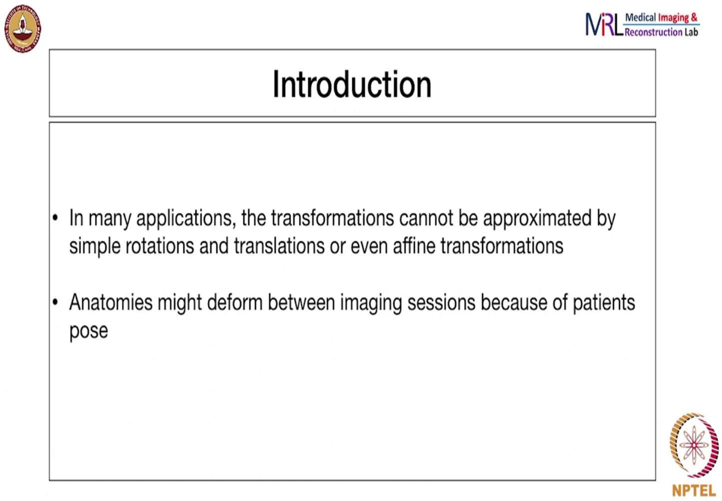

So, in many applications, the transformations that we use for registering two images from the same patient even they cannot be approximated by rigid transformation. So, not even affine transformations. This is because the anatomies might deform.

And between imaging sessions and that might also be because the patient's post so, for instance, in some applications, the patient's lies in the bed for a prolonged period of time and images are acquired for a particular anatomical location. But even in that, in that situation, because of the respiratory motion, or there could be some deformations which cannot be approximated by rigid body transformations.

And there are other applications where in, the patient is followed over a long longer period of time, he has multiple imaging sessions and even those sessions he might not have he or she might not have the same pose there is of course going to be deformation of our various organs.

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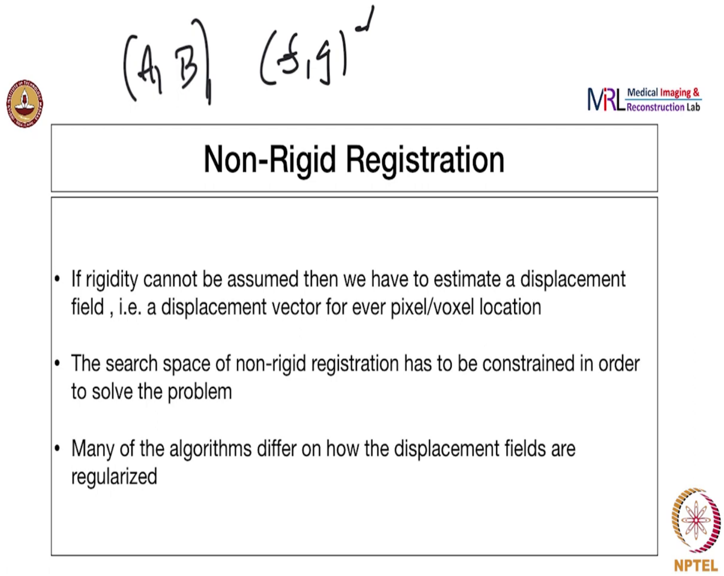

So, if rigidity cannot be assumed, then the most what you called general, nonrigid registration transformation is basically the estimation of a deformation field or a displacement field. So this is nothing but the estimation of a displacement, which is a vector, because you need to have components in the XY and Z directions, a small displacement for every pixel in the image, or in some cases, a control points of the, a bunch of pixels, you chose those control points estimate at least, the displacement for those pixels.

The problem with this approach is that, if we consider any grid, let us say on a 2D grid, and you are trying to estimate displacement vector for every pixel in that grid, for every pixel can move almost any direction. So, there is no constraint there.

And so, that means that the problem becomes that much harder to do. So, they tend to limit the search space make it to make it doable, then you typically have a constraint or a regularization that is imposed on the deformation field or on the displacement field.

So, a lot of algorithms different how the displacement fields are regularized and in some cases, even how the displacement fields are estimated. So, we are actually going to look at two different algorithms with the estimate the deformation field slightly differently. So, this is where I know this is the general approach to nonrigid registration.

So, there has to be an estimation step of the deformation fields and followed by regularization over this, over the estimated field, because then, so that you can actually limit the search space. So, once again, when in many problems, the loss function is regularized so as to obtain, displacement field which is which is already smooth and constrained and all that.

In some cases, because the algorithm itself the way it is done, that once you estimate the displacement fields, you can regularize. So, we are going to look at two different methods whether to do that with what I what I just described in this week. But just to reiterate, notice potentially a very difficult problem and there are lots of issues here still. And in general, you would do not registration following a rigid registration.

So, you would actually do rigid registration to bring two images close enough and then you would do the nonrigid registration following that. So that, these displacement fields that you estimate as part of the nonrigid registration algorithm, they basically the special fields are the transformation vectors.

And they can only be very small, so you cannot, so, if you do very large deformations per pixel, you would end up doing something unphysical. And, for instance, breaking the image into two etc, those are not allowed transformation. So, typically, these displacement fill estimates, they only work for very small displacements, when they are small in comparison to the organ of interest, and in general, what could be feasible displacements that problem allows.

So, in the next few videos, we will look at two different algorithms to talk about how to estimate them. So, in these two papers, typically there is also usually a moving image. And a fixed image notations might differ slightly, but typically they are either denoted by A or A or B, for instance, something like this, A,B used a very large so, it is either A, B or in some cases f and g, f and g is more commonly used I think.

But anyway, so, these are pairs of images, one you would consider as the moving image typically g. And the other one you would consider as the fixed image. And all of them can be treated as either 2d or 3d images. But, both techniques we are going to see work on 3d images as well.

We will look at the results and demos of these algorithms in the next week. So, this is where I promise the files where you look at some of these case studies. So, we look at these case studies, where you get a demo I will try to provide you some freeware that is available to actually try out these algorithms. So, we will now look at the 2 or the 3 ends, demons algorithms and the freeform deformations, algorithms. The next couple of videos. Thank you.