Medical Image Analysis
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Lecture 13
Registration Introduction

Hello, and welcome back. This week, we are going to look at Images Session, will have brief introduction to the Images Registration followed by some description of the rigid registration model or rigid transformation registration model.

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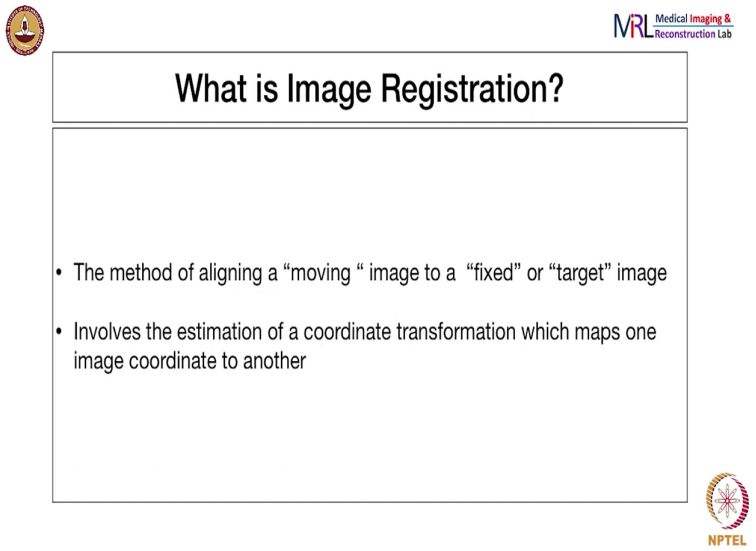

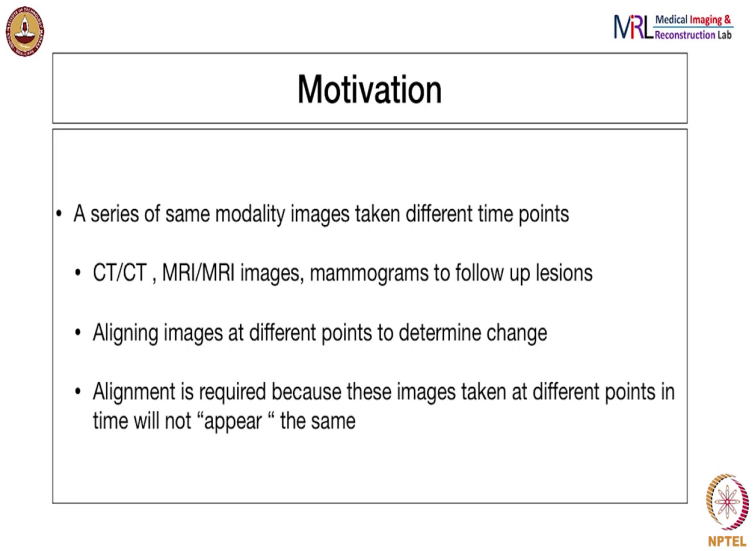

So, what is Image Registration? So, typically, this involves aligning a moving image, moving in the sense the image that is being transformed aligning it to a fixed or a target image. So,

and in this process, this involves the estimation of a coordinate transformation or a transformation matrix or a bunch of parameters, which maps one image coordinate system to another.

So, this process is actually an important step in a lot of research studies as well as clinical studies before any diagnosis is made. So, we will look at briefly look at the motivation for estimating such a transform. So, where are these two images coming from fixate and this moving image? Why we doing this?

So, in a lot of these, research and clinical studies specially, clinical studies, a series of images are taken. So, for instance, a patient walks in maybe with some complaints in some products, anatomy let us say, just deliver etcetera. So, they would do a preliminary imaging scan, the radiologists would then recommend maybe a CT image or an MRI image.

So, this is registration typically applies to a lot of the Tomographic Imaging Techniques, we saw, the image techniques state produced cross section of the body. So, now the same patient might work in a few months later, and then you want to image the same anatomy and compare them. But then before comparing them, you would like to make sure that they are aligned.

In the sense you are looking at the same scene, in both the or a same slice are the same locations in both time points. So, the before you overlay one time point or the other, it is important that these two time points be registered. So, that is where the process of registration comes from. This helps not only, just for diagnosis, in the sense you also want to see whether any changes are there in the anatomy over time.

The alignment is required. So, you might say, well, it is a same patient. In this case, we are talking about the same patient and then why would we need alignment, because, the problem is that even though, you would these images are of the same patient, they are taken at different time points and they would not appear the same primarily.

Because, the orientation of the patient the way he lives in the scanner bed, where the, the bodies oriented etcetera might be different. In addition, the anatomy is not strictly rigid. So, there will be some, deformation of the anatomy says the patient lies down and it will be a different deformation, every time a patient lies down so, that change is always then so, some example where, where you can expect the cross section to look exactly the same was basically when you are looking at the skull, skull is a very rigid object. So, you should be

able to match the, same locations in the skull, same cross sections in the skull, taken at two different time points, but these are premium primarily from a diagnosis point of view, wherein you are Engineering Map, monitoring the patient over time. So, and then you would like to see whether there is some disease progression or cessation of the disease.

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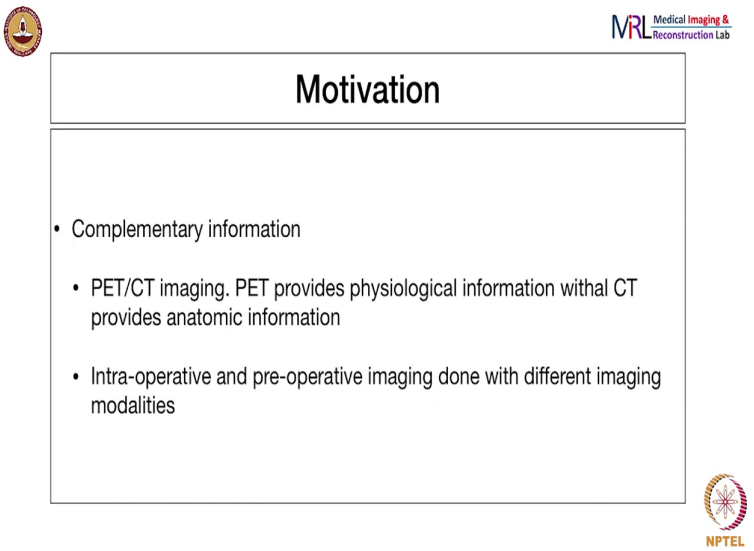

The other motivation would be complementary information. For instance, PET CT, or PET, MRI or MRI and CT, where the patient has undergone both CT and MRI scans. And we have seen before introductory lectures, that they provide kind of different kinds of information. So, you would like to merge them and see but before you merge, or fuse those images, there, you would have to align them so that the anatomy is lined up exactly.

But there is another application. So, PET CT imaging, for instance, it is pretty much a solved problem in the sense that now there is a PET CT scanner where the patient lives in the same bed, and the scanner itself has both the CT and the pet component. So, the registration problem slightly less problematic in the sense it is easier to do the registration in this case, there are other situations wherein you need for instance, high quality or high resolution information. But then when you for instance, if you are doing surgery.

In the, during the surgery, image guided surgery, for instance, there is usually very high resolution pre-operative image. And during the operation, they might do something like an ultrasound, which might not have such a high resolution as compared let us say MRI, and it would be good to align the intra-operative and pre-operative images. So, here two again image registration, the processes this comes into play.

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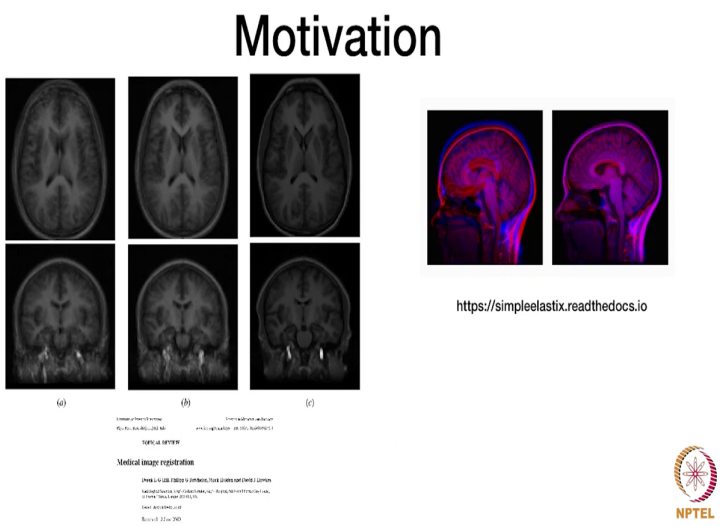

So, here are some examples so this is from the review paper, by hills and others. So, here, if you see what is shown here are three columns, a b c, each one of them are basically an average of seven patient brains after alignment? So, the leftmost column is basically the rigid transformation based alignment. The middle column is affine transformation based alignment.

And the rightmost column was basically the alignment after non rigid registration. So, why do we do so basically a lot of research studies in stuff, comparing a single patient to a single patient was comparing, one patient at a time, for instance, scientists might have multiple cohorts. And then maybe they would skew one cohort as probably a goes standard for comparison, instead of choosing one image from that cohort.

You would like to have an average image of that cohort, but then you would not randomly average you have to align them on average. So on hand, this process is shown on the right when you see this two different colors, red, blue, and that other color, the show, the, what he called the outline of the brain, as well as the components of the brain.

These are two different images, this is before alignment. So, you just take those images and then and overlay them on top of each other. After that, after alignment or after registration, you would, see that both of them align perfectly, there are some blue streaks here and there, which shows regions of misalignment but in general, they have been well aligned.

So, this is again taken from simple elastics it is over, it is a tool box for image registration. So, there is a wide variety of applications for image registration. So, the important application being that you would want to align the same patient's image taken at different time points or would different scanners or you would like to align a bunch of patients scans as in order to produce an average scan that you can compare other patients with.

So, in all these all these applications, of course, like I said, registration plays an important role. And there are broadly speaking you can based on the type of transformation that you use, they can be divided into rigid registration techniques or rigid transformation based registration techniques and non rigid registration techniques. So in this week, we will look at rigid registration techniques.