Question:

Consider the following motion models: translation, rigid (translation + rotation), rigid and equal scaling in X,Y directions, rigid and unequal scaling in X,Y directions, affine, non-rigid. Consider each of the following applications separately. In each case, identify what is the optimal motion model and justify. Do not needlessly pick a more complex motion model if it is not needed. For example, in some cases, a rotation is enough, in which case please do not choose affine as it has additional degrees of freedom. [15 points]

1. Consider that you have scanned a document twice with the same scanner, when the document was potentially in slightly different positions. You now want to align these two images. Which motion model is needed here? Assume there is no stretching or bending of the paper.

Ans:

Rigid Motion-

When we have scanned a document twice with the same scanner, when the document was potentially in slightly different positions, and there is no stretching or bending of the paper **rigid** is most suitable.

Reason:-

A rigid transformation consists of translation and rotation. Since there is no stretching, bending, or scaling involved and only slight positional variations are present.

translation model couldn't be sufficient because the image not only underwent translational shifts but might have gone through rotational shifts.

Hence, a rigid transformation, which will provide the necessary adjustments for both translational and rotational differences between the two scans.

Optimal motion model for aligning is **rigid transformation.**

2. In the earlier example, consider that the two images were respectively acquired from two different scanners with different resolutions. Assume that for both scanners, the X and Y resolutions were the same. Which motion model is needed here? Assume there is no stretching or bending of the paper.

Ans:

Equal scaling in x,y direction-

When we have two images acquired from two different scanners with different resolutions, but the X and Y resolutions are the same, and there is no stretching or bending of the paper, most suitable is **equal scaling**.

Reason:-

Since the X and Y resolutions are the same for both scanners and there is no stretching or bending of the paper, any differences in the images' sizes can be attributed to scaling factors. Significant amount of scaling in both X and Y directions is sufficient to account for the differences in image size without introducing any distortion or other unnecessary adjustments.

Hence, **Equal scaling** is the **optimal motion** model for aligning the images.

3. Consider a document with words written on both sides with ink. When you scan such a document from one side, some portions from the other side are visible. This is called ‘ink bleeding’. To remove bleeding artifacts, you need to acquire images of both sides of the document and first align them. Which motion model is needed here? Assume there is no stretching or bending of the paper.

Ans:

Non-rigid Transformation:-

When we have a document with words written on both sides and ink bleeding occurs when you scan the document from one side, to remove bleeding artifacts, the most suitable is non-rigid transformation.

Reason:-

Ink bleeding can result in location deformations where portions of the text from one side of the document are visible on the other side. These deformations are not uniform and can vary across the document. A non-rigid transformation allows for local deformations and adjustments, which are necessary for aligning images in these cases, all other transformation works when uniform transformation is to be applied but non-rigid works for non-uniform too.

Hence, the **optimal motion** model needed here is a **non-rigid transformation**.