# Question 1

## CS663 (Digital Image Processing) Assignment 1

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PART

I

# *Question 1*

**Problem 1**

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.

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.

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.

Section 1

## Part (a)

**Motion Model 1**

Rigid (Translation + Rotation)

Since the document is scanned twice with the same scanner and we are assuming there are no bending or stretching of paper, the only difference between the images would be in their position. If the images are slightly shifted from each other, then a translation would suffice. But there are chances that they might be slightly tilted as well, so the Rigid model consisting of both translation and rotation would be an optimal choice.

Section 2

# Part (b)

**Motion Model 2**
Rigid and equal scaling in X,Y directions

Since the images are acquired from different scanners with different resolutions, the main difference between the images is the translation due to the difference in scanning positions and orientations. Since the X and Y resolutions are the same for both scanners, this means that the aspect ratio is preserved, and there is no need to consider scaling in either direction and the translation model can effectively correct for the positional difference between the images. Therefore, Rigid model with equal scaling in X,Y directions would be an optimal choice.

Section 3

# Part (c)

**Motion Model 3**
Non-rigid Motion Models

Due to Ink bleeding, parts of the writing from one side of the document appear on the scanned image of the other side. This implies that there are deformations or warping happening due to the interaction of the ink and the paper. These deformations are not rigid (rigid includes translation, rotation, scaling) and can vary across the document. Therefore here Non-rigid motion models allow more flexible transformations that can account for local distortions and warping that occur due to ink bleeding.