MS5125/MS5145

ENGINEERING MATHS 1A

PBL SET 2

IMAGE MOSAICKING

INTRODUCTION

Image mosaicking is a method to stitch together overlapping images of a scene into a single large image. This is the basis for panoramic software used for various cameras. Below is an example of a panoramic photo that uses image mosaicking.

Mini Venice in Hamburg, Germany. Photo by Shidrati Ali, 2006.

The photo above is stitched from three different photos to form the panoramic view. In order to stitch the photos together, it is necessary to find a global transformation that relates the coordinate systems of these set of different photos into a common coordinate system. This global transformation is actually a composite transformation of different types of transformation such as translation, rotation, and scaling.

QUESTIONS

The main problem in image mosaicking is then to find a global transformation that spatially aligns all the images. To do this, we ask the following questions:

1. How do we transform from a local coordinate system to a global coordinate system? Give an example of the transformation matrix necessary to relate the local coordinate system to the global coordinate system.

2. In order to align the images, it is necessary to find the common points between them. In the panoramic photo above, try identifying some of the common points used to align the three images together.

3. What types of transformation are likely used to align the images? How do these transformations and the transformation from local to global coordinate system form the global transformation?

Please provide references for any quotes or ideas you have obtained from the various sources.

PROBLEM

In order to give us a better understanding of how image mosaicking is done, we try to solve the following problem. Given three images below denoted by the boxes, we need to align them together on a new canvas to form the mosaic image.

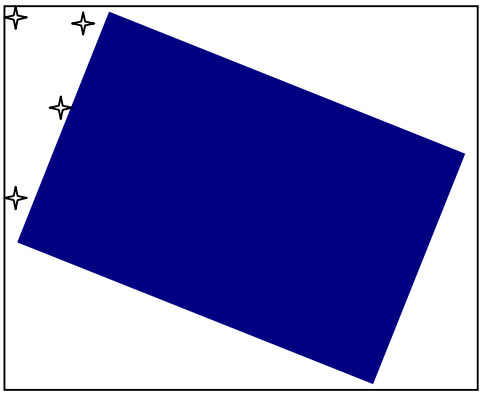
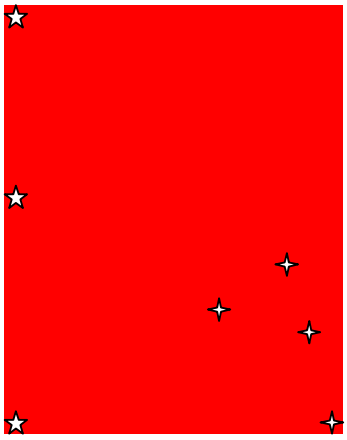


Image 1

Image 2



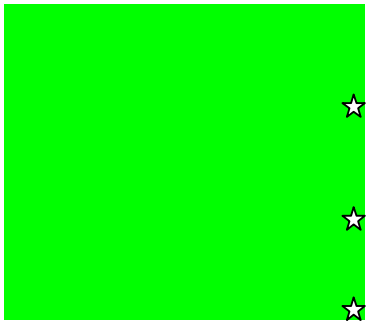


Image 3

The dimensions of the images are given as follows. Image 1 is 100 by 100 pixels, image 2 is 90 by 150 pixels, and image 3 is 30 by 30 pixels. The new canvas has 400 by 400 pixels. The stars found within the images denote the points of alignment.

In image 1, the four points are given as $x_1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$, $x_2 = \begin{pmatrix} 20 \\ 0 \end{pmatrix}$, $x_3 = \begin{pmatrix} 15 \\ 20 \end{pmatrix}$, $x_4 = \begin{pmatrix} 0 \\ 50 \end{pmatrix}$.

The corresponding points in image 2 are given as $y_1 = \begin{pmatrix} 65 \\ 107 \end{pmatrix}$, $y_2 = \begin{pmatrix} 82 \\ 97 \end{pmatrix}$,

$y_3 = \begin{pmatrix} 88 \\ 117 \end{pmatrix}$, $y_4 = \begin{pmatrix} 90 \\ 150 \end{pmatrix}$.

In image 3, the three points are given as $z_1 = \begin{pmatrix} 30 \\ 30 \end{pmatrix}$, $z_2 = \begin{pmatrix} 30 \\ 20 \end{pmatrix}$, $z_3 = \begin{pmatrix} 30 \\ 10 \end{pmatrix}$, while the corresponding points in image 2 are $y_1 = \begin{pmatrix} 0 \\ 150 \end{pmatrix}$, $y_2 = \begin{pmatrix} 0 \\ 75 \end{pmatrix}$, $y_3 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$.

When image 2 is transferred to the new canvas, its four corners are located at $X_1 = \begin{pmatrix} 100 \\ 100 \end{pmatrix}$, $X_2 = \begin{pmatrix} 100 \\ 250 \end{pmatrix}$, $X_3 = \begin{pmatrix} 190 \\ 100 \end{pmatrix}$, $X_4 = \begin{pmatrix} 190 \\ 250 \end{pmatrix}$.

Questions:

4. Find the transformation matrix that relates the four corners of image 2, given by the points, $I_1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$, $I_2 = \begin{pmatrix} 0 \\ 150 \end{pmatrix}$, $I_3 = \begin{pmatrix} 90 \\ 0 \end{pmatrix}$, $I_4 = \begin{pmatrix} 90 \\ 150 \end{pmatrix}$, to the corresponding points in the new canvas given by $X_1 = \begin{pmatrix} 100 \\ 100 \end{pmatrix}$, $X_2 = \begin{pmatrix} 100 \\ 250 \end{pmatrix}$, $X_3 = \begin{pmatrix} 190 \\ 100 \end{pmatrix}$, $X_4 = \begin{pmatrix} 190 \\ 250 \end{pmatrix}$.

5. What geometric transformations are needed to align images 2 and 3? Find the composite geometric transformation matrix that aligns images and 3. Find the new image points of image 3 due to the transformation matrix.

6. Using the transformation matrix found in Question 4 and the new image points of image 3 in Question 5, find the corresponding points of image 3 on the new canvas.

7. What geometric transformation, besides rotation, is needed to align images 1 and 2? If the rotation angle is given as 30 degrees anticlockwise, find the rotation matrix needed to align the two images. Using the homogeneous coordinates, find the composite transformation matrix for the alignment.

8. Again, as using the transformation matrix in Question 4 and the composite matrix in Question 7, find the global transformation matrix to transfer image 1 to the new coordinates in the new canvas.

Draw the composite image on the new canvas.

APPLICATION

9. What other applications besides panoramic photography uses image mosaicking techniques?

References:

A. Ardeshir Goshtasby, "2-D and 3-D Image Registration: for medical, remote sensing and industrial applications," Wiley-Interscience Publications, 2005.

Prabhakara Rao G.V., Mahidhar A., "A novel still image mosaicing system using featureless registration, binary check stitching and minimal blending," http://ww1.ucmss.com/books/LFS/CSREA2006/IPC4575.pdf