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ect 4: Stitching Photo Mosaics

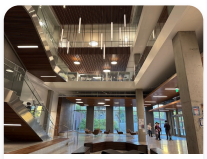
By Ethan Jagoda

Introduction

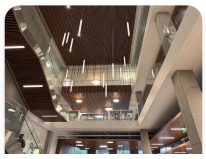
This project explores how to use homographic transformations to stitch together a photo mosaic. As well, we use homographic transformations to warp images to rectify shapes to seem like they are from a different point of view.

Raw Images Used

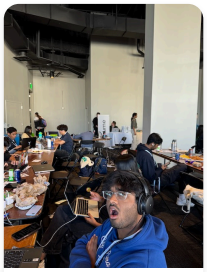
These are some of the raw images I used in this project.



Berkeley Way West Bottom



Berkeley Way West Top



Pranav Left

Pranav Right

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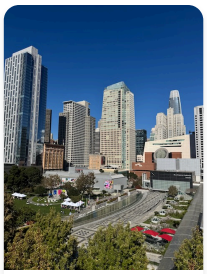
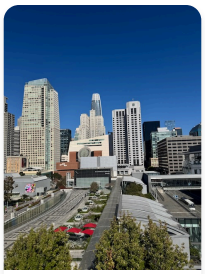


SF Skyline Left



SF Skyline Right

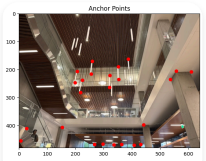
Recovering Correspondences

I used a GUI to manually select correspondences between the two images. This was done by clicking on a point in one image and then clicking on the corresponding point in the other image.

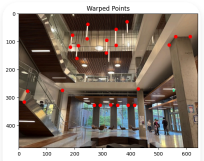
This is an example of one of the images with the correspondences marked.

Pranav Left Points

Pranav Right Points



Berkeley Way West Bottom Points



Berkeley Way West Top Points

Computing the homographic transformation

The homographic transformation is computed using the following equation:

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$$Hp = p'$$

Where H is the homography matrix, p is a point in the source image, and p' is the corresponding point in the destination image.

Expanding this out, we get the following equation:

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = w \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

Expanding this out further, we get the following equations:

$$wx' = ax + by + c$$

$$wy' = dx + ey + f$$

$$w = gx + hy + 1$$

Reframing this so that we can use the new points and old points to solve for the homography matrix, we get the following equations:

$$\begin{bmatrix} x & y & 1 & 0 & 0 & 0 & -xx' & -yx' \\ 0 & 0 & 0 & x & y & 1 & -xy' & -yy' \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \\ e \\ f \\ g \\ h \end{bmatrix} = \begin{bmatrix} x' \\ y' \end{bmatrix}$$

To reduce the chance of overfitting, we can use more than 4 points and then solve this system of equations using least squares to get the homography matrix.

Warped Images

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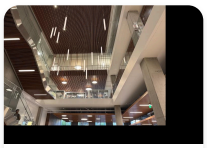
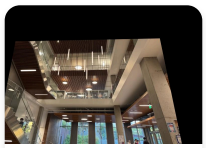
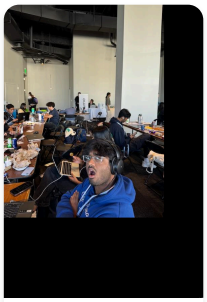
Here are some of the warped images I got from this technique.



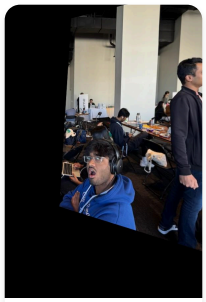
Berkeley Way West Top



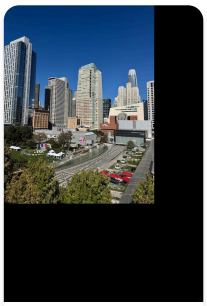
Berkeley Way West Bottom Warped into Top



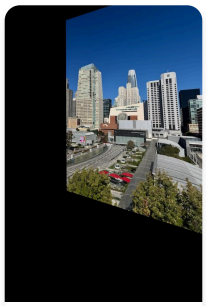
Pranav Left



Pranav Right Warped into Left



SF Skyline Left



SF Skyline Right Warped into Left

Blending Images

To blend the images, we create a mask that is the same size and shape as the warped images. Then, to ensure a smooth transition, we use a dissolve factor that changes linearly with the distance from an images edge from 0 to 1. We then use this mask to blend the pixels of the two warped

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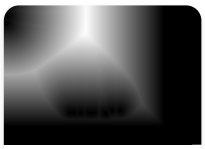
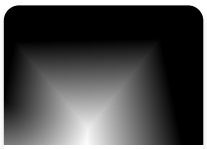
images together, normalizing the pixels by the mask so that the brightnesses are correct.

Here are some of the blended images and the corresponding masks I got from this technique.

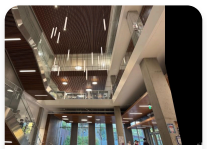
Berkeley Way West



Anchor Alpha Mask

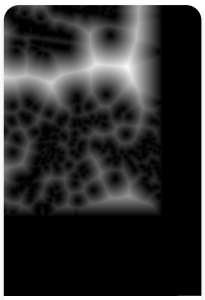


Warped Alpha Mask

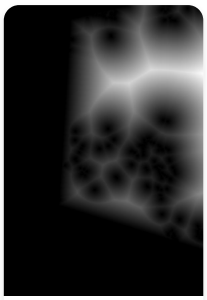


Blended Images

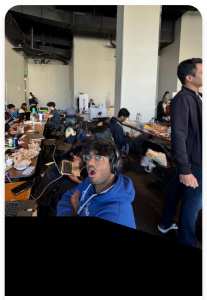
Pranav



Anchor Alpha Mask



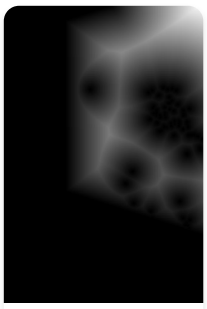
Warped Alpha Mask



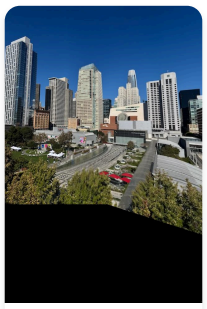
Blended Images

SF Skyline

Anchor Alpha Mask



Warped Alpha Mask



Blended Images

Rectifying Images

To rectify images, we can use the homography matrix to warp the image to a new point of view. This is useful for things like correcting perspective shift in photos.

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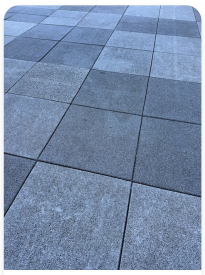
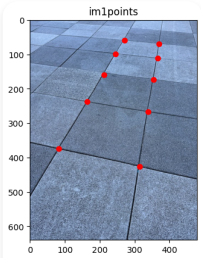
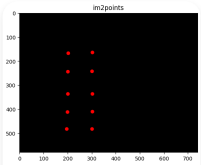
Here are some of the rectified images I got from this technique.



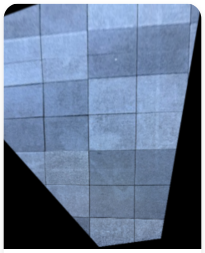
Original Tiles



Original Tile Points

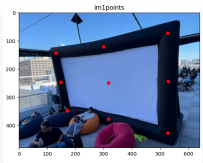


Target Tile Points

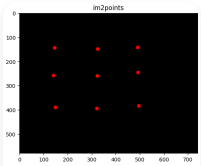


Rectified Tiles

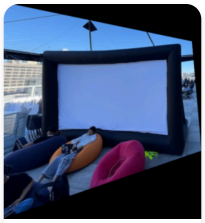
Original Presentation Screen



Original Presentation Screen Points



Target Presentation Screen Points



Rectified Presentation Screen