1 ...

2 Theory Questions (Homographies)

2.1 Q2.1 Correspondences

$A_i h = 0$

- How many degrees of freedom does h have?
  - h has 8 degrees of freedom.
- How many point pairs are required to solve h?
  - Because there are 8 degrees of freedom, 4 point pairs are required to solve h.
- Derive Ai.
  - $x_i^1 \equiv H x_i^2$
  - $x_i^1 h_{31} x_i^2 + y_i^1 h_{32} x_i^2 + h_{33} x_i^2 = x_i^2 h_{11} + y_i^2 h_{12} + h_{13}$
  - $x_i^1 h_{31} y_i^2 + y_i^1 h_{32} y_i^2 + h_{33} y_i^2 = x_i^2 h_{21} + y_i^2 h_{22} + h_{23}$
  - $A_i = \begin{bmatrix} -x_i^2 & -y_i^2 & -1 & 0 & 0 & 0 & x_i^1 x_i^2 & x_i^1 y_i^2 & x_i^1 \\ 0 & 0 & 0 & -x_i^2 & -y_i^2 & -1 & y_i^1 x_i^2 & y_i^1 y_i^2 & y_i^1 \end{bmatrix}$
- When solving Ah = 0, in essence you're trying to find the h that exists in the null space of A. What that means is that there would be some non-trivial solution for h such that that product Ah turns out to be 0. What will be a trivial solution for h? Is the matrix A full rank? Why/Why not? What impact will it have on the singular values? What impact will it have on the singular vectors?
  - A trivial solution for h is when h = 0, because it does not say anything about the transformation from one image to a different one.
  - Matrix A is not full rank because it doesn't span the entire space because there isn't enough different point configurations.
  - This means that at least one of its singular values will be too small or zero.
  - This means h is in the null space of A.

3 Computing Planar Homographies

3.1 Q3.1 FAST Detector

FAST works by checking circles around a possible corner, and determines if its a corner based on if those other pixels are bright or darker than those at the center, while the Harris corner detector checks the gradient at every point in the image. Because of this, the FAST detector is less computationally expensive and has better performance, but it might miss some points that the Harris detector would catch.

3.2 Q3.2 BRIEF Descriptor

The BRIEF Descriptor makes binary strings by comparing image patches and their intensities. Filter banks use a set of filters to get edge information, getting big feature vectors. Filter banks could be used as descriptors but it would be very computationally expensive.

3.3 Q3.3 Matching Methods

Hamming distance measure the distance between two binary strings as the number of bits where they are different. It's used with binary descriptors by using nearest neighbor search to look for the descriptor in the second image with the smallest Hamming distance from that in the first. Hamming distance is computationally faster and more efficient compared to Euclidean distance.

3.4 Q3.4

Feature Matching

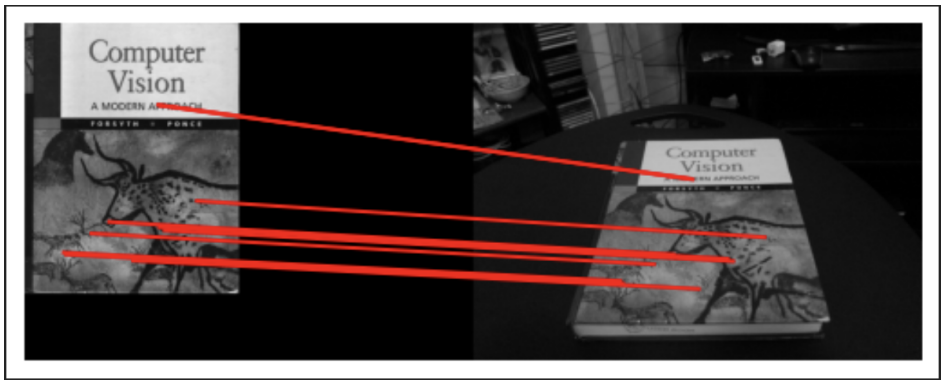

Figure 1: Matching

3.5 Q3.5

BRIEF and Rotations

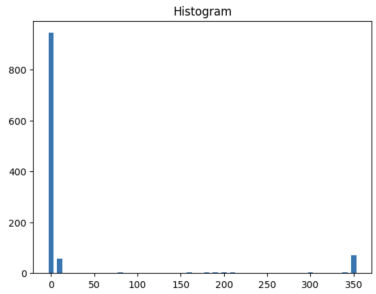

Figure 2: Histogram

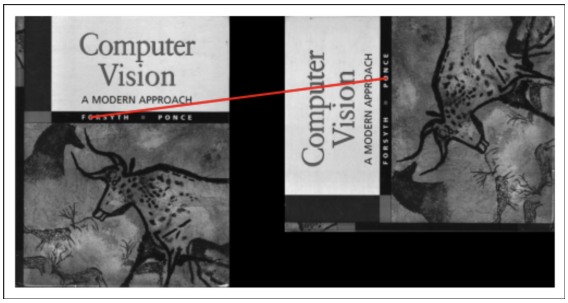

Figure 3: 90 Degrees

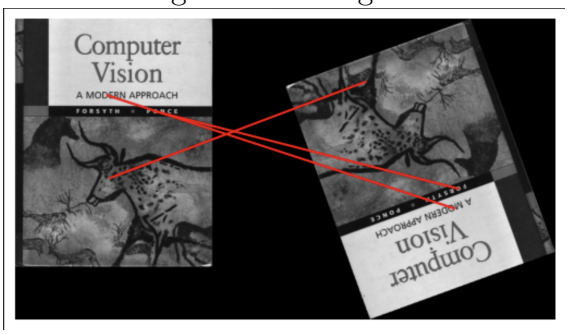

Figure 4: 200 Degrees

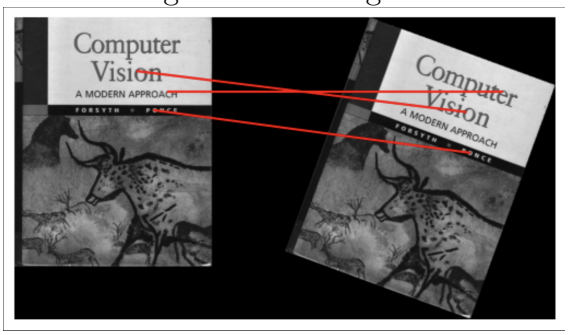

Figure 5: 340 Degrees

I think the Brief descriptor behaves in this way because it isn't very good with rotations, I picked 3 angles where the matching lined up pretty nicely, but for most angels BRIEF had a hard time actual matching the points.

3.6 Q3.9

Putting it Together

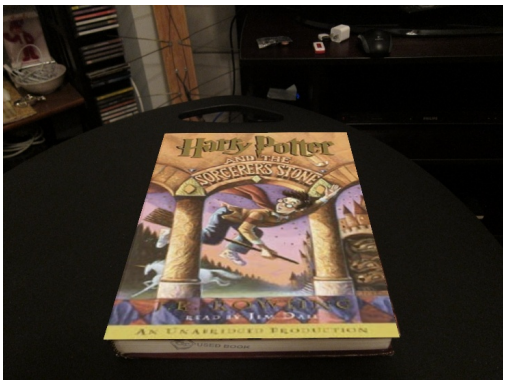

Figure 6: Harry Potterize result

At First the image was being warped to the right spot, but not the right size. This is because the harry potter cover image is smaller than the cv cover image. To fix this issue I resized the harry potter cover to fit the textbook cover.

4 Creating an Augmented Reality Application

I did complete the AR portion of this assignment, the output is in my results folder.