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FEATURE DESCRIPTOR AND HOMOGRAPHIES

COMPUTER VISION

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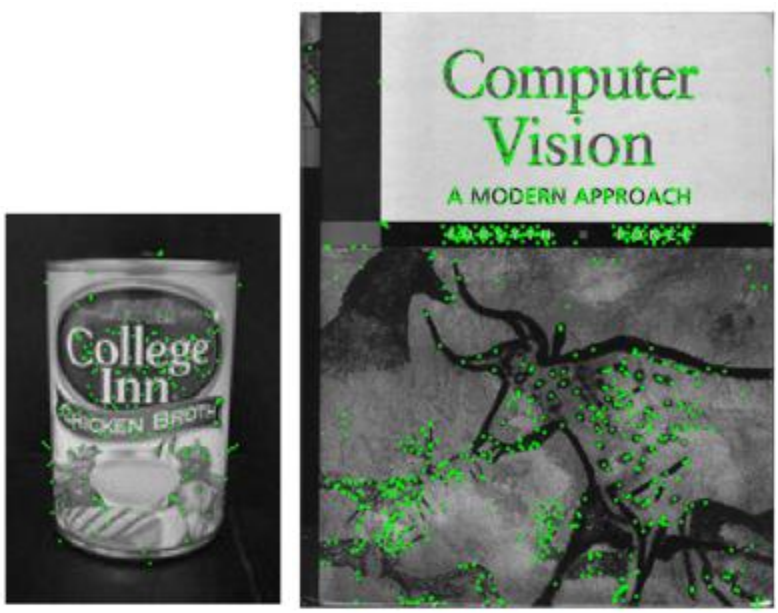
FEATURE DESCRIPTOR AND HOMOGRAPHIES

1.1 GAUSSIAN PYRAMID

1.2 DOG PYRAMID

1.5 DETECTED KEYPOINTS (FOR CHICKEN BOX AND COMPUTER VISION BOOK)

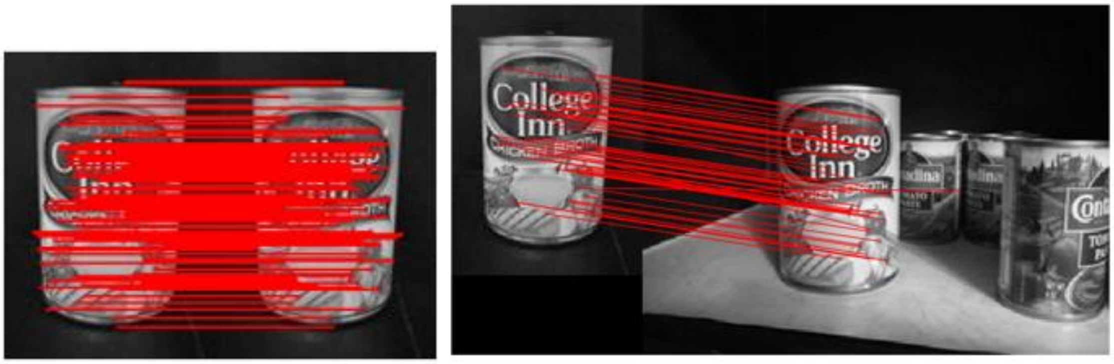


2.1 MAKE TEST PATTERN

Included testPattern.mat in results folder.

2.4 DESCRIPTOR MATCHING

- Chicken



- Computer Vision Book

- Incline

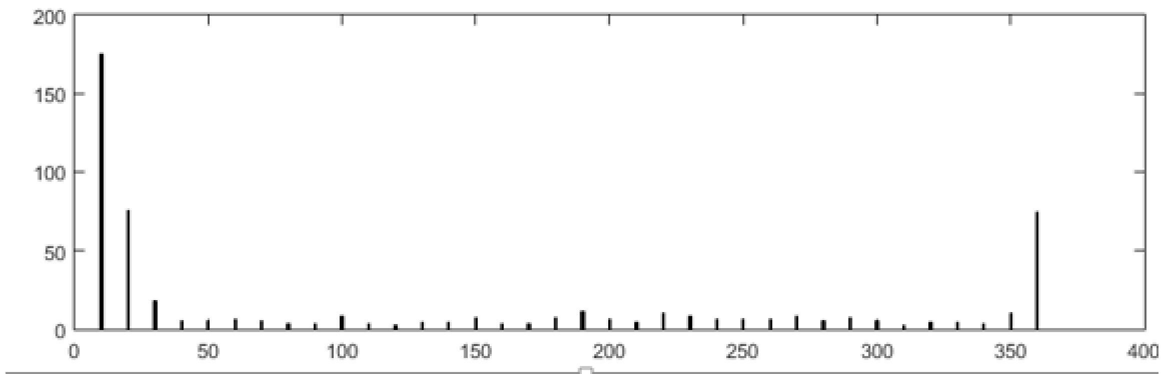
Cases that are performing better:

a. Where we are able to detect corners

Cases that are performing worse

a. In case the images are rotate with respect to each other
b. Some of the edges are still getting detected which are creating problems
c. Cases where there is a lot of texture and is similar (Like in CV textbook)

2.5 BRIEF ROTATIONAL TEST



We see maximum good matches in the case where angle is near to 0 degree and near to 360 degree (0 and 360 are same). Also we can see some with a little better performance when the angles are 90, 180 and 270. But in most of the case where the image is un-rotated the performance is quite bad

The reason for these that the descriptor do not perform in case of rotation. This is because of the way the brief descriptor creates descriptions of patches (in our case 9x9 patched).

Solution 3

3.1 we have

$$p^i = \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} \qquad q^i = \begin{bmatrix} u_i \\ v_i \\ 1 \end{bmatrix}$$

$$p^i = Hq^i$$

We need to derive 2N equations of the form $Ah = 0$

$$\begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} u_i \\ v_i \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = \begin{bmatrix} h_{11} u_i + h_{12} v_i + h_{13} \\ h_{21} u_i + h_{22} v_i + h_{23} \\ h_{31} u_i + h_{32} v_i + h_{33} \end{bmatrix}$$

$$\Rightarrow \quad x_i = h_{11} u_i + h_{12} v_i + h_{13} \rightarrow (1)$$

$$y_i = h_{21} u_i + h_{22} v_i + h_{23} \rightarrow (2)$$

$$1 = h_{31} u_i + h_{32} v_i + h_{33} \rightarrow (3)$$

Dividing (1) by (3) we get

$$x_i = \frac{h_{11} u_i + h_{12} v_i + h_{13}}{h_{31} u_i + h_{32} v_i + h_{33}}$$

$$x_i (h_{31} u_i + h_{32} v_i + h_{33}) - (h_{11} u_i + h_{12} v_i + h_{13}) = 0 \rightarrow (4)$$

Similary from (2) & (3) we get

$$y_i (h_{31} u_i + h_{32} v_i + h_{33}) - (h_{21} u_i + h_{12} v_i + h_{23}) = 0 \rightarrow (5)$$

By rearranging (4) & (5) we get equation of the form

$$a_x^T h = 0$$

$$\& \quad a_y^T h = 0$$

here $h = [H_{11}, H_{12}, H_{13}, H_{21}, H_{22}, H_{23}, H_{31}, H_{32}, H_{32}]'$

we get

$$a_x = (-u_i^o, -v_i^o, -1, 0, 0, 0, x u_i^o, x v_i^o, x_i^o]_{1\times 9} \rightarrow (6)$$

$$a_y = (0, 0, 0, -u_i^o, -v_i^o, -1, y_i^o v_i^o, y_i^o v_i^o, y_i^o)_{1\times 9} \rightarrow (7)$$

$$Ah = 0$$

$$\Rightarrow \quad A = \begin{bmatrix} a_x^T \\ a_y^T{}_1 \\ \vdots \\ A_{x4}^T \\ a_{y4} \end{bmatrix}$$

$Ah = 0$ can be solved using least squares.

b) we can see from eq (6) & (7) that there are 9 elements

c) Degree of freedom or point pair $= 8$

$$\begin{bmatrix} c\theta & -s\theta & t_x \\ s\theta & c\theta & t_y \\ 0 & 0 & s \end{bmatrix} \rightarrow \text{4 degree of freedom for 1}$$

$$4 \times 2_{\text{pairs}} = 8$$

d) Estimate H

taken ~~reference~~ from.

cseweb.ucsd.edu/Classes/wi07/cs252a/homography-estimation/homography-estimation.pdf

we have $Ah=0$

~~to~~

~~function w.r.t for~~

Error function which represents sum squared error can be represented as:

$$f(h) = \frac{1}{2}(Ah-0)^T(Ah-0)$$

$$f(h) = \frac{1}{2}(Ah)^T(Ah)$$

$$f(h) = \frac{1}{2}h^T A^T Ah$$

In order to minimise the error function, we need to set it derivative as zero.

$$\frac{df}{dh} = 0 = \frac{d}{dh}\left(\frac{1}{2}h^T A^T A h\right)$$

$$\frac{df}{dh} = \frac{1}{2}(A^TA + A^TA^T)h = 0$$

$$\Rightarrow A^TAh=0$$

~~For $(A^TA)h=0$ to be in nul~~

For $A^TAh=0$ h should be in null space of AA^T

$\Rightarrow$ h should be equal to eigen vector of A^TA that has 0 eigvalue.

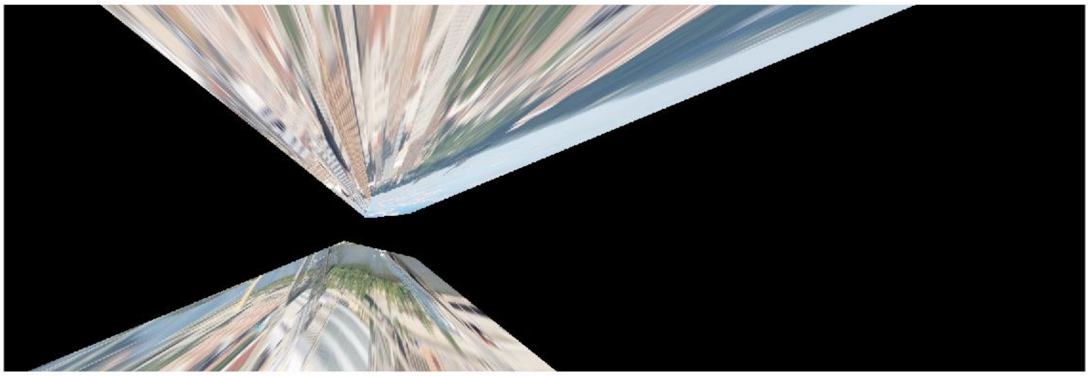
The decomposition in SVD is identical.

& SVD(A) gives U,S,V (last column of V gives required eigen vector)

5.1 IMAGE STICHING

Q5_1.mat is attached

Image 2 warped to image 1 is below (without ransac)



(with ransac)

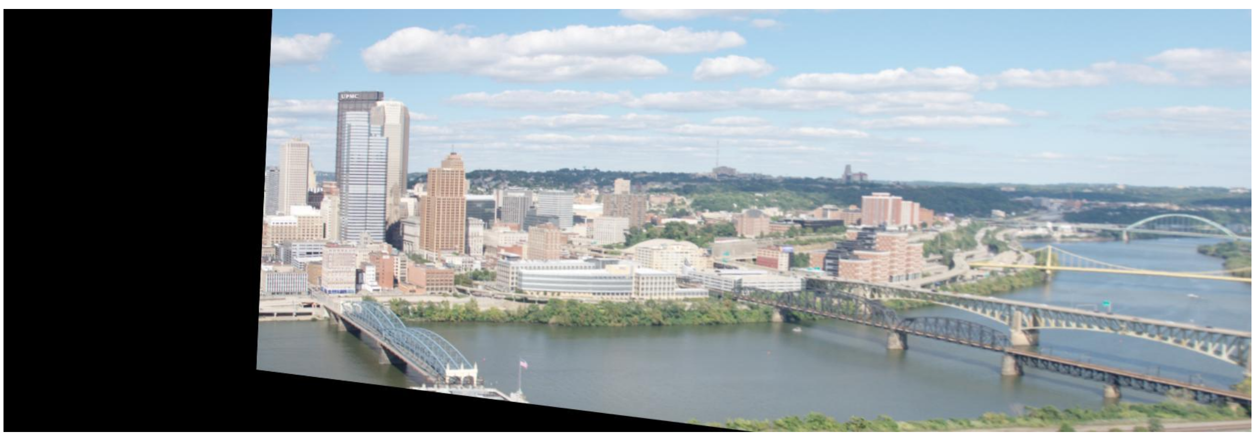
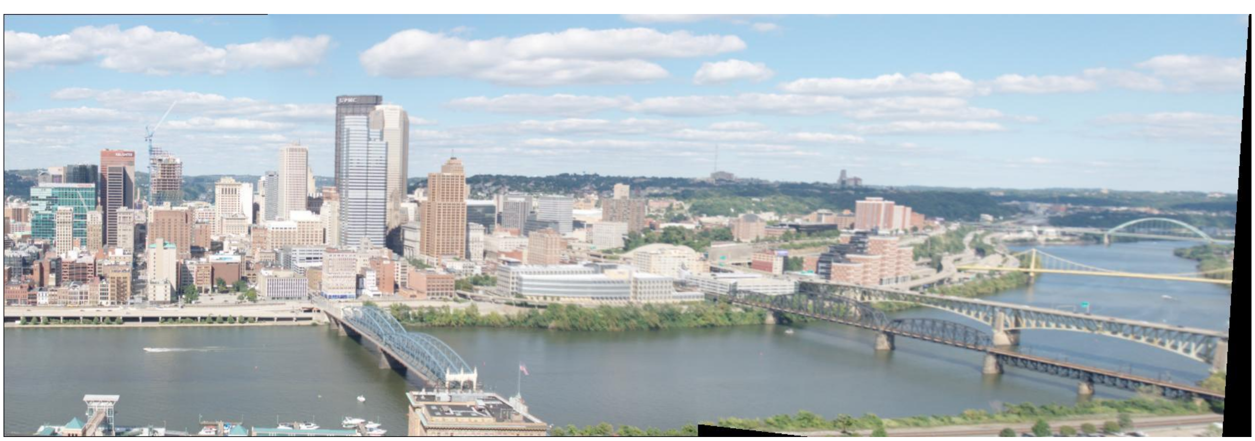


Image 2 added to image 1 (We can that the top and bottom portions have been clipped)



5.2 IMAGE STICHING WITH NO CLIPPING

Without RANSAC

With RANSAC but without maintaining aspect ration

6.2 IMAGE STICHING WITH RANSAC AND NO CLIPPING (MAINTAINING ASPECT RATIO)