CSE344: Computer Vision - Assignment 3

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Q1.

(1)

1. (i) Given $E = [t_x] R$

We know that $x'^T E x = 0$ — ①

As x lies on the epipolar line,

$x^T l = 0$ — ②

$x'^T l' = 0$ — ③

So $l' = Ex$ (from ① & ③)

And, $(x'^T E x)^T = 0$

$\Rightarrow x^T E^T x' = 0$

& $x^T l = 0$

So, $l = E^T x'$

Since e lies on l & e' lies on l',

$e^T l = 0$ & $e'^T l' = 0$

$e^T E^T x' = 0$ and $e'^T E x = 0$

$\Rightarrow x'^T E x = 0$ and $e'^T E x = 0$

Now, since e' & e lies on all epipolar lines,

$Ee = 0$ and $e'^T E = 0$

And, $E = [t_x] R$

So $[t_x] R e = 0$

and $\Rightarrow e'^T [t_x] R = 0$

So, $[t_x] R e = 0 \Rightarrow (t) \times (Re) = 0$

$(t) \times (t \times Re) = 0$

$((t.R)e)t - (t.t)Re = 0$

So t & Re are vectors such that their linear combination is 0

So $Re = \lambda t$, where ~~$\lambda \in R$~~ $\lambda \in \mathbb{R}$

Now, $e = R^{-1}\lambda t = \lambda R^{-1} t$

$R^{-1} = R^T$ (orthogonal)

$\boxed{e = \lambda R^T t}$

Also, $e' [t_x] R = 0$

$[[t_x] R]^T e' = 0$

$R^T [t_x]^T e' = 0$

$\Rightarrow R^{-1} [t_x]^T e' = 0$

$I [t_x]^T e' = 0$

$[t_x]^T e' = 0$

$-[t_x] e' = 0 \rightarrow [t_x] e' = 0$

$(t) \times (e') = 0$

$\Rightarrow e' \parallel t \Rightarrow \boxed{e' = \lambda t}$

(2)

2. Given,

$$t = [t_x, 0, 0]^T$$

$$R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$E = [t_x]R = \begin{bmatrix} 0 & -t_z & t_y \\ t_z & 0 & -t_x \\ -t_y & t_x & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$E = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -t_x \\ 0 & t_x & 0 \end{bmatrix}$$

We know, $\boxed{x'^T E x = 0}$ — (1)

let, $x' = \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$ and $x = \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$

By eqn,

$$\begin{bmatrix} x' & y' & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -t_x \\ 0 & t_x & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = 0$$

$$\begin{bmatrix} 0 & t_x & -y't_x \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = 0$$

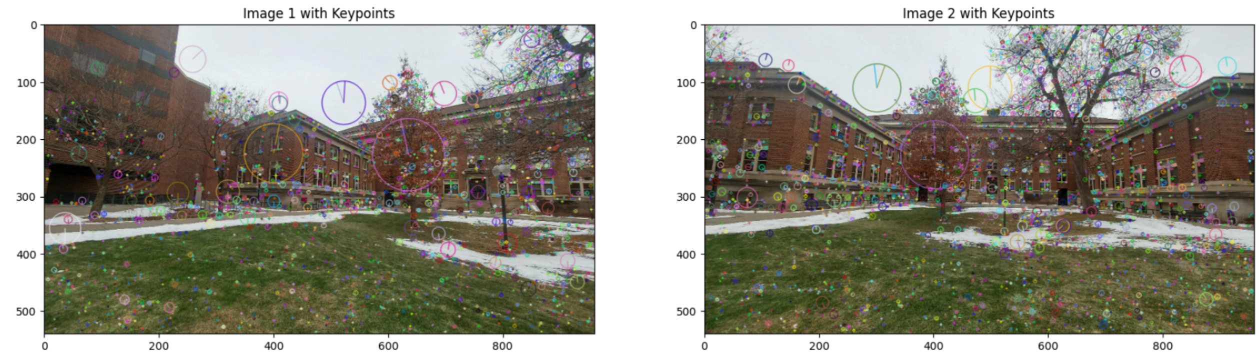
$$y t_x - y' t_x = 0$$

$\boxed{y = y'}$ ⇒ The y-coordinate will always be same.

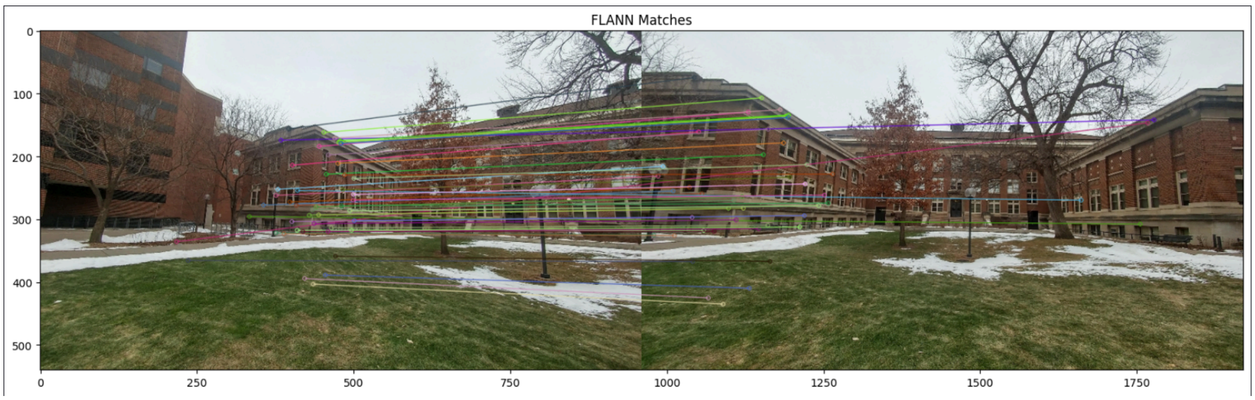
Q2.

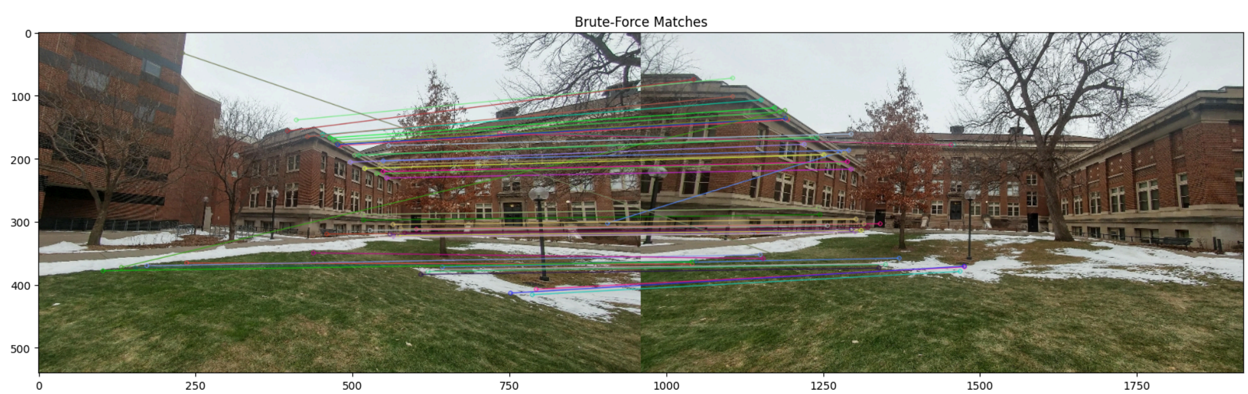
(1)

Keypoint detection was performed using the SIFT algorithm on the first two images. Keypoints and descriptors were extracted and overlaid on the original images to visualise them.



(2) Feature matching was conducted using two distinct algorithms: BruteForce and FlannBased. Following the matching process, the matched features were visualised by drawing lines between them.



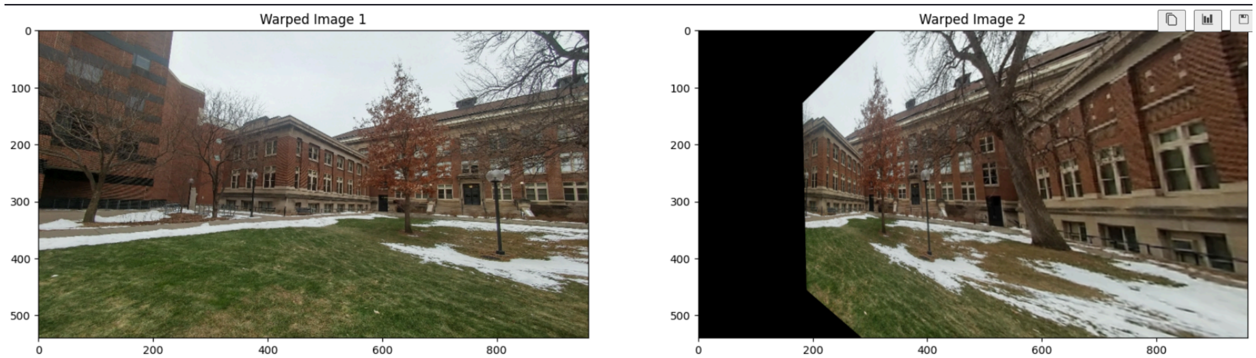


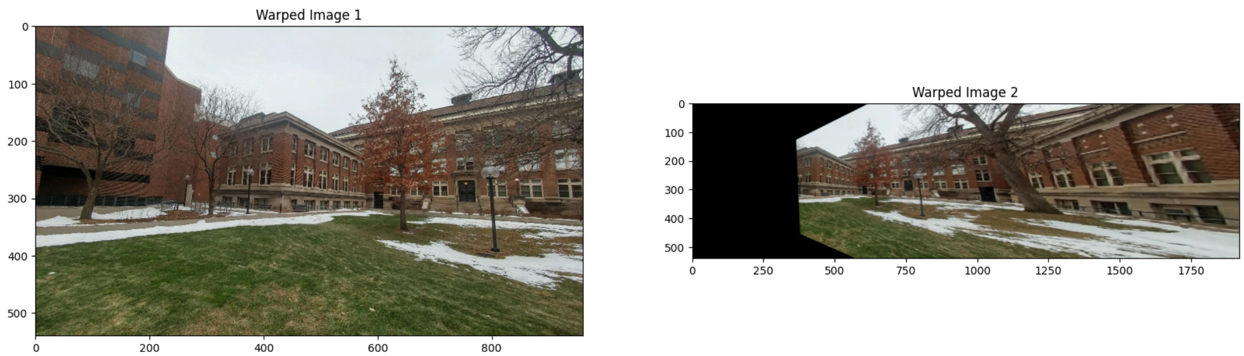
(3) Obtained homography matrix for image 2 with respect to image 1-

Homography Matrix:

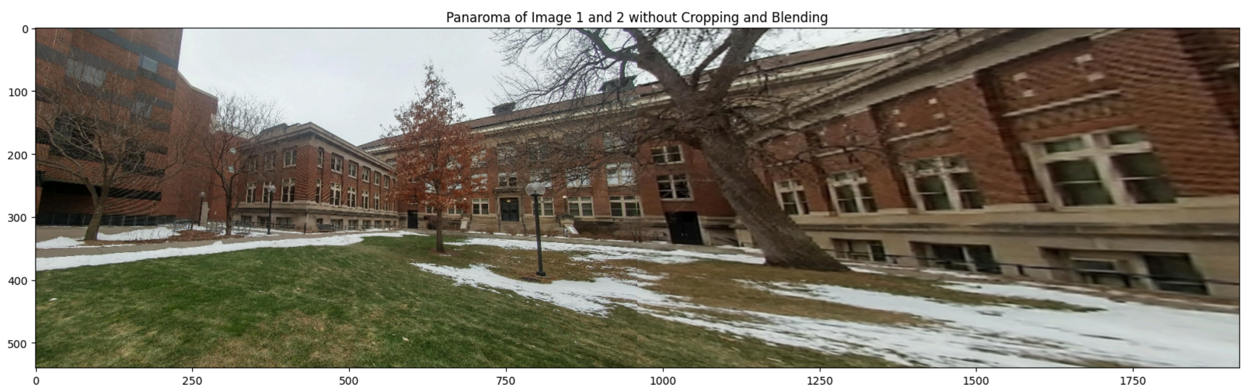
[[-0.01801127 -0.02168112 363.35437656]
 [-0.30106695   0.5486864 128.70740944]
 [-0.00100491 -0.00012691   1.   ]]

(4) Perspective warped image 2 with respect to image 1, where the homography matrix computed as above was used -

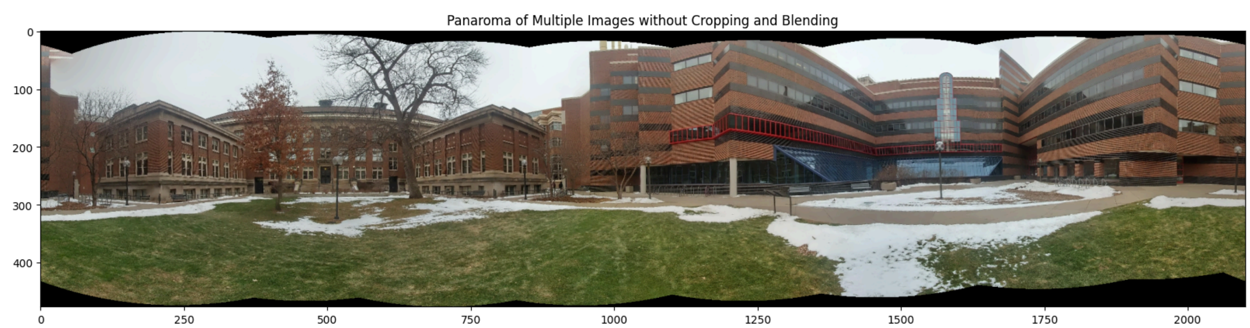




(5) For stitching the two images, first the images were stitched without implementing cropping and blending techniques. Later, the images were stitched together with cropping and blending methods.



(6) Multi-stitching was performed using the cv2.stitcher() function, and the panorama obtained before cropping and blending is as follows -



Post cropping and blending, we obtain the following panorama, where the background black edges are removed -