Assignment - 3

Theory:

1)

A2] Given: $R = I$

$$\vec{t} = \begin{bmatrix} t_x \\ 0 \\ 0 \end{bmatrix}$$

$$E = [t_x] R = [t_x] I = [t_x]$$

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

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

Let $\vec{P_1}$ be the point in left image and $\vec{P_2}$ be the corresponding point in right image

$$\vec{P_1} = \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix}, \quad \vec{P_2} = \begin{bmatrix} x_2 \\ y_2 \\ 1 \end{bmatrix}$$

$$P_2^T E P_1 = 0$$

$$\begin{bmatrix} x_2 & y_2 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -t_x \\ 0 & t_x & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = 0$$

$$\begin{bmatrix} x_2 & y_2 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -t_x \\ t_x . y_1 \end{bmatrix} = 0$$

$$-y_2 t_x + t_x y_1 = 0$$

$$\therefore \boxed{y_1 = y_2}$$ Hence Proved

2)

Assignment - 3

A1) (1)

$$E = [t_x] R$$

$$\vec{t} = \begin{bmatrix} tx \\ ty \\ tz \end{bmatrix}, \quad [t_x] = \begin{bmatrix} 0 & -tz & ty \\ tz & 0 & -tx \\ ty & tx & 0 \end{bmatrix}$$

Let e be the right null space & f be the left null space of E, then

$$Ee = 0 \qquad \text{— (1)}$$

$$f^T E = 0 \qquad \text{— (2)}$$

Using eqn. (1),

$$[t_x] R\, e = 0$$

Let $e = R^T t$, then

$$[t_x] R . (R^T t) = [t_x] t$$

$$= \begin{bmatrix} 0 & -tz & ty \\ tz & 0 & -tx \\ ty & tx & 0 \end{bmatrix} \begin{bmatrix} tx \\ ty \\ tz \end{bmatrix} = 0$$

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

Using eqn 2,

$f^T E = 0, \quad f^T [t_x] R = 0,$

we know that $t^T [t_x] = 0$

$$\therefore \boxed{f = t}$$

3)

A3) We start with the essential Matrix E,

$E = [T_\times] R$, upon decomposition

Let $\vec{e}_1$ be the epipole in this case.

As given, after rotation translated epipoles lie at infinity

$\therefore$ Let $R_{rect} = \begin{bmatrix} \vec{r}_1^T \\ \vec{r}_2^T \\ \vec{r}_3^T \end{bmatrix}$

$$\boxed{\vec{r}_1 = \vec{e}_1 = \frac{T}{|T|}}$$

(Since epipole coincide with translation vector)

~~$\vec{r}_2 = \vec{e}_1 \times$~~

$$\boxed{\vec{r}_2 = \frac{1}{\sqrt{T_x^2 + T_y^2}} [-T_y \quad T_x \quad 0]}$$

[Cross product of e and the direction vector of the optical axis.

$$\boxed{\vec{r}_3 = \vec{r}_1 \times \vec{r}_2}$$

(Since $\vec{r}_3$ is orthogonal to $\vec{r}_1$ and $\vec{r}_2$

$\therefore R_{rect} = \begin{bmatrix} \vec{r}_1^T \\ \vec{r}_2^T \\ \vec{r}_3^T \end{bmatrix}$ using the above values for $\vec{r}_1$, $\vec{r}_2$ and $\vec{r}_3$

Panorama Generation:

1)

Image 1 with keypoints

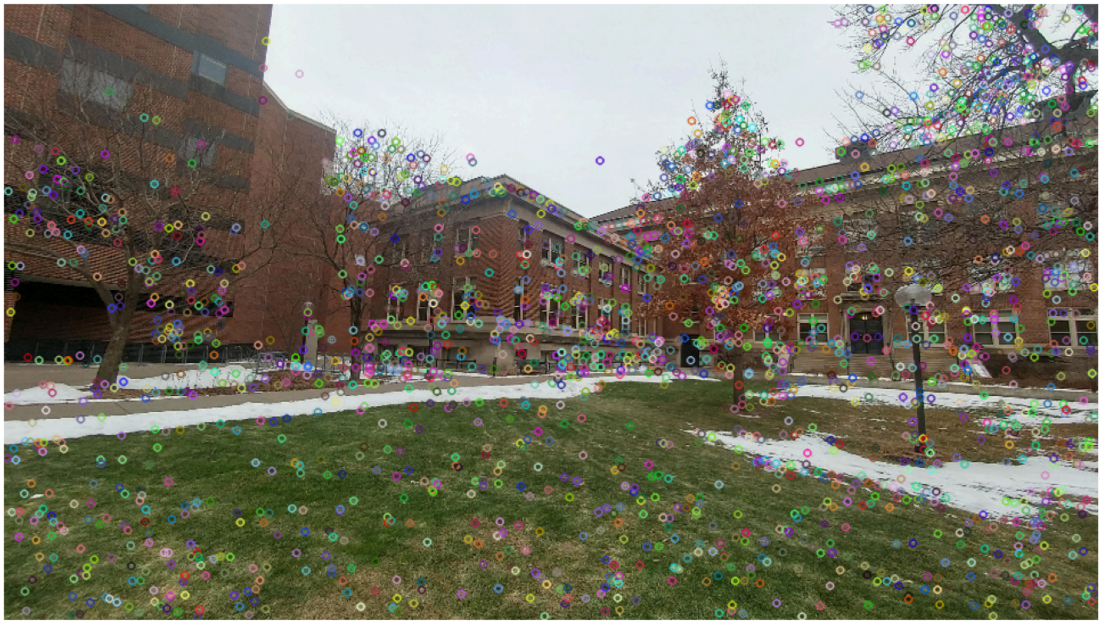
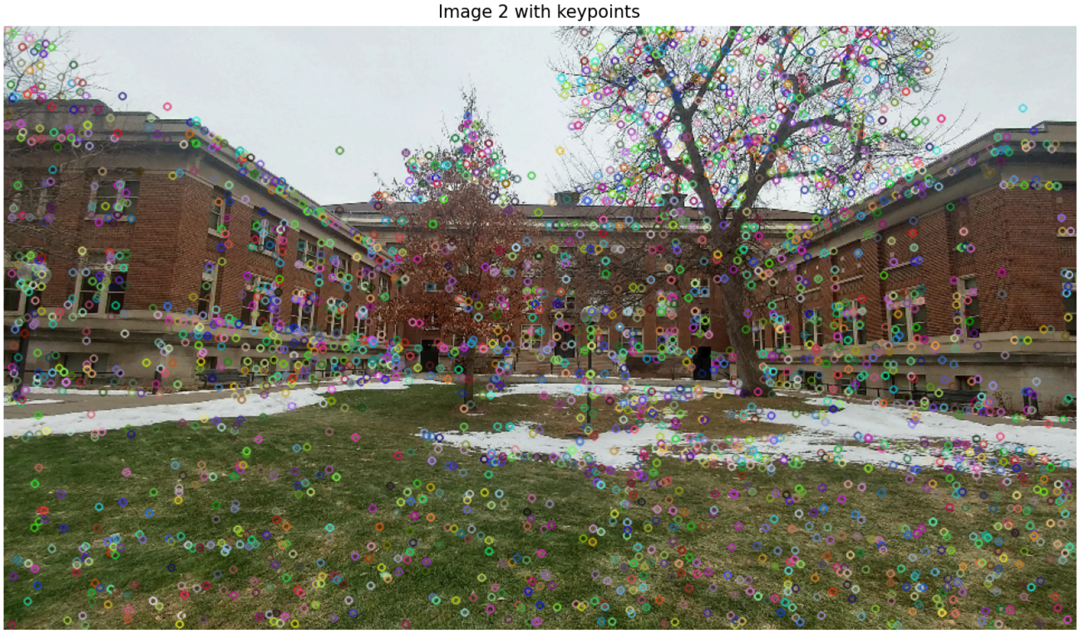
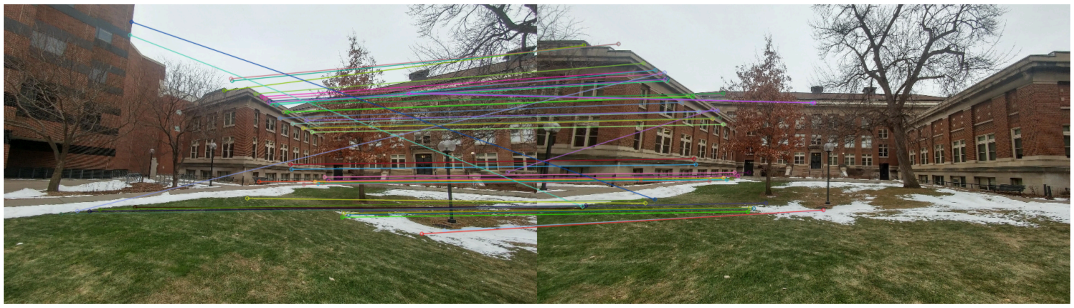


Image 2 with keypoints

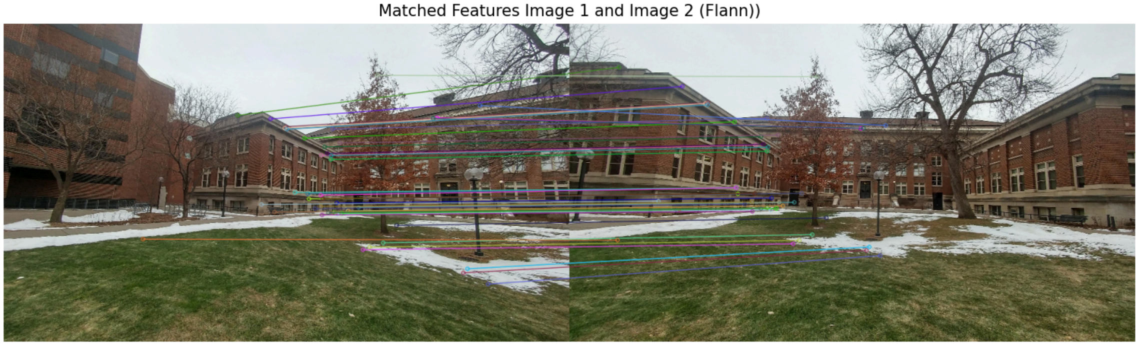


2)

Matched Features Image 1 and Image 2(BruteForce) top 50



Matched Features Image 1 and Image 2 (Flann))



3)

M1 = [[1.00000000e+00 -3.50352753e-15 5.08577867e-13]
 [5.55869079e-16 1.00000000e+00 -2.15281097e-13]
 [1.70258304e-18 -6.01106207e-18 1.00000000e+00]]

M2 = [[-8.01861610e-03 6.14169817e-03 3.61138757e+02]
 [-3.05569239e-01 5.83969849e-01 1.25043406e+02]
 [-1.01678677e-03 -5.90206554e-05 1.00000000e+00]]

4)

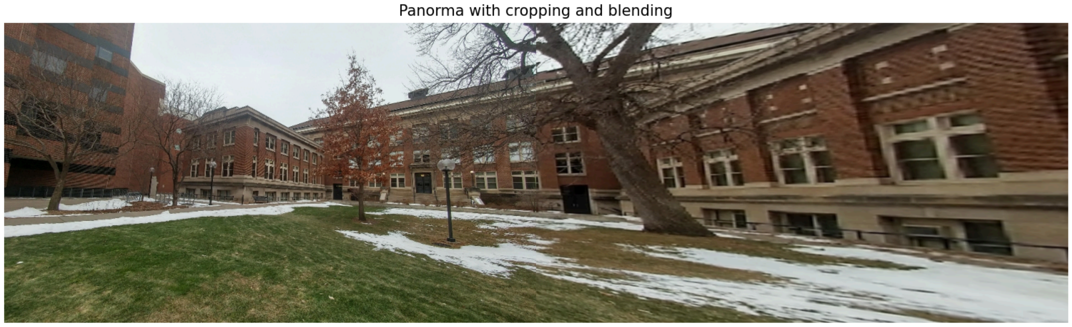
First Warped Image

Second Warped Image

5)

Panorma without cropping and blending

Panorma with cropping and blending



6)

Panorma of all images