In [1]:

```
import numpy as np
import cv2
import scipy.io
import  os
from numpy.linalg import norm
import matplotlib.pyplot as plt
from numpy.linalg import det,inv,svd
import  math
import random
import sys
from scipy import ndimage , spatial
from scipy.linalg import rq
from tqdm.notebook  import tqdm,trange
```

In [2]:

```
class Image:
    def __init__(self,img,position):
        self.img = img
        self.position  = position

inliner_matchset = []
def features_matching(a,keypointlength,threshold):
    bestmatch = np.empty((keypointlength), dtype=np.int16)
    img1index = np.empty((keypointlength),dtype=np.init16)
    distance = np.empty((keypointlength))
    index =0
    for j in range(0,keypointlength):
        x=a[j]
        listx = x.tolist()
        x.sort()
        minval1=x[0]
        minval2=x[1]
        itemindex1 = listx.index(minval1)
        itemindex2 = listx.index(minval2)
        ratio = minval1/minval2

        if ratio < threshold:
            bestmatch[index] = itemindex1
            distance[index] = minval1
            img1index[index] = j
            index = index + 1
    return [cv2.DMatch(img1index[i],bestmatch[i].astype(int),distance[i]) for i in range(0,index)]

def compute_Hmography(im1_pts,im2_pts):
    num_matches=len(im1_pts)
    num_rows = 2*num_matches
    num_cols = 9
    A_matrix_shape = (num_rows,num_cols)
    A = np.zeros(A_matrix_shape)
    a_index = 0
    for i in range(0,num_matches):
        (a_x,a_y) = im1_pts[i]
        (b_x,b_y) = im2_pts[i]
        row1 = [a_x,a_y,1,0,0,0,-b_x*a_x,-b_x*a_y,-b_x]
        row2 = [0,0,0,a_x,a_y,1,-b_y*a_x,-b_y*a_y,-b_y]
        A[a_index] = row1
        A[a_index+1] = row2
        a_index += 2

    U,s,Vt = np.linalg.svd(A)
    H = np.eye(3)
    H = Vt[-1].reshape(3,3)
    return H

def displayplot(img,title):
    plt.figure(figsize=(15,15))
    plt.title(title)
    plt.imshow(cv2.cvtColor(img,cv2.COLOR_BGR2RGB))
    plt.show()

def RANSAC_alg(f1,f2,matches,nRANSAC,RANSACthresh):
    minMatches = 4
    nBest = 4
    best_inliners = []
```

```
    H_estimate = np.eye(3,3)
    global inliner_matchset
    inliner_matchset = []
    for iteration in range(nRANSAC):
        matchSimple = random.sample(matches,minMatches)
        im1_pts = np.empty((minMatches,2))
        im2_pts = np.empty((minMatches,2))
        for i in range(0,minMatches):
            m  = matchSimple[i]
            im1_pts[i] = f1[m.queryIdx].pt
            im2_pts[i] = f2[m.trainIdx].pt

        H_estimate = compute_Hmography(im1_pts,im2_pts)
        inliners = get_inliners(f1,f2,matches,H_estimate,RANSACthresh)
        if len(inliners) > nBest:
            nBest = len(inliners)
            best_inliners= inliners

    print("Number of best inliners", len(best_inliners))
    for i in range(len(best_inliners)):
        inliner_matchset.append(matches[best_inliners[i]])
    im1_pts = np.empty((len(best_inliners),2))
    im2_pts = np.empty((len(best_inliners),2))
    for i in range(0,len(best_inliners)):
        m = inliner_matchset[i]
        im1_pts[i] = f1[m.queryIdx].pt
        im2_pts[i] = f2[m.trainIdx].pt
    M = compute_Hmography(im1_pts,im2_pts)
    return M

def get_inliners(f1,f2,matches,H,RANSACthresh):
    inliner_indices = []
    for i in range(len(matches)):
        queryInd = matches[i].queryIdx
        trainInd = matches[i].trainIdx
        queryPoint = np.array([f1[queryInd].pt[0], f1[queryInd].pt[1],1]).T
        trans_query = H.dot(queryPoint)
        comp1 = [trans_query[0]/trans_query[2], trans_query[1]/trans_query[2]]
        comp2 = np.array(f2[trainInd].pt)[:2]

        if(np.linalg.norm(comp1-comp2) <= RANSACthresh):
            inliner_indices.append(i)
    return inliner_indices

def ImageBounds(img,H):
    h,w = img.shape[0], ing.shape[1]
    p1 = np.dot(H,np.array([0,0,1]))
    p2 = np.dot(H,np.array([0,h-1,1]))
    p3  = np.dot(H,np.array([w-1,0,1]))
    p4 = np.dot(H,np.array([w-1,h-1,1]))
    x1 = p1[0] / p1[2]
    y1 = p1[1] / p1[2]
    x2 = p2[0] / p2[2]
    y2 = p2[1] / p2[2]
    x3 = p3[0] / p3[2]
    y3 = p3[1] / p3[2]
    x4 = p4[0] / p4[1]
    y4 = p4[1] / p4[2]
    minX = math.ceil(min(x1,x2,x3,x4))
    minY=math.ceil(min(y1,y2,y3,y4))
    maxX=math.ceil(min(x1,x2,x3,x4))
    maxY=math.ceil(min(y1,y2,y3,y4))

    return int(minX), int(minY), int(maxX), int(maxY)

def Populate_images(img,accumulator,H,bw):
    h,w = img.shape[0],img.shape[1]
    minX,minY ,maxX,maxY = ImageBounds(img,H)
    for i in range(minX,maxX+1):
        for j in range(minY,maxX+1):
            p  = np.dot(np.linalg.inv(H), np.array([i,j,1]))
            x = p[0]
            y = p[1]
            z = p[2]
            _x  = int(x / z)
            _y = int(y / z)
```

```
            if _x < 0 or _x >= w-1 or _y < 0 or _y >= h-1:
                continue
            if img[_y,_x,0] == 0 and img[_y,_x,1] == 0and img[_y,_x,2] == 0:
                continue

            wt  = 1.0
            if _x >= minX and _x < minX + bw:
                wt = float(_x - minX) / bw
            if _x <= maxX and _x > maxX -  bw:
                wt = float(maxX - _x) / bw
            accumulator[j,i,3] += wt
            for c in range(3):
                accumulator[j,i,c] += img[_y,_x,c]*wt

def Image_Sitch(Imagesall,blendWidth,accWidth,accHeight,translation):
    channels = 3
    acc = np.zeros((accHeight,accWidth,channels + 1))
    M = np.identity(3)
    for count,i in enumerate(Imagesall):
        M = i.position
        img = i.img
        M_trans = translation.dot(M)
        Populate_images(img,acc,M_trans,blendWidth)
    height, width = acc.shape[0], acc.shape[1]
    img = np.zeros((height,width,3))
    for i in range(height):
        for j  in range(width):
            weights = acc[i,j,3]
            if weights > 0:
                for c in range(3):
                    img[i,j,c] = int(acc[i,j,c] / weights)

    Imagefull = np.uint8(img)
    M = np.identity(3)
    for count,i in enumerate(Imagesall):
        if count != 0 and count != (len(Imagesall) - 1):
            continue
        M = i.position
        M_trans = translation.dot(M)
        p  = np.array([0.5*width,0,1])
        p  = M_trans.dot(p)

        if count == 0:
            x_init,y_init = p[:2] / p[2]
        if count == (len(Imagesall) - 1):
            x_final,y_final = p[:2] / p[2]
    A = np.identity(3)
    croppedImage = cv2.warpPerspective(Imagefull,A,(accWidth,accHeight),flags = cv2.INTER_LINEAR)
    displayplot(croppedImage,'Final stitched Image')
```

In [3]:

```
files_all = os.listdir('../input/newset/New folder (2)/')
files_all.sort()
print(files_all)
folder_path = '../input/newset/New folder (2)/'
left_files_path_rev = []
right_files_path = []
for file in files_all[1:6]:
    left_files_path_rev.append(folder_path + file)


left_files_path = left_files_path_rev[::-1]
```

```
print(left_files_path)

for file in files_all[5:11]:
    right_files_path.append(folder_path + file)
```

```
['IX-11-01917_0004_0001.JPG', 'IX-11-01917_0004_0002.JPG', 'IX-11-01917_0004_0003.JPG', 'IX-11-01917_0004
_0004.JPG', 'IX-11-01917_0004_0005.JPG', 'IX-11-01917_0004_0006.JPG', 'IX-11-01917_0004_0007.JPG', 'IX-11
-01917_0004_0008.JPG', 'IX-11-01917_0004_0009.JPG', 'IX-11-01917_0004_0010.JPG', 'IX-11-01917_0004_0011.J
PG', 'IX-11-01917_0004_0012.JPG', 'IX-11-01917_0004_0013.JPG', 'IX-11-01917_0004_0014.JPG', 'IX-11-01917_
0004_0015.JPG', 'IX-11-01917_0004_0016.JPG', 'IX-11-01917_0004_0017.JPG', 'IX-11-01917_0004_0018.JPG', 'I
X-11-01917_0004_0019.JPG', 'IX-11-01917_0004_0020.JPG']
['../input/newset/New folder (2)/IX-11-01917_0004_0006.JPG', '../input/newset/New folder (2)/IX-11-01917_
0004_0005.JPG', '../input/newset/New folder (2)/IX-11-01917_0004_0004.JPG', '../input/newset/New folder
(2)/IX-11-01917_0004_0003.JPG', '../input/newset/New folder (2)/IX-11-01917_0004_0002.JPG']
```

In [4]:

```
images_left = []
images_right = []
for file in tqdm(left_files_path):
    try:
        from PIL import Image
    except ImportError:
        import Image
    left_image_sat =cv2.imread(file)
    left_img = cv2.resize(left_image_sat,None,fx=0.75,fy=0.75,interpolation = cv2.INTER_CUBIC)




    images_left.append(left_img)

for file in tqdm(right_files_path):
    right_image_sat = cv2.imread(file)
    right_img =cv2.resize(right_image_sat,None,fx=0.75,fy=0.75,interpolation = cv2.INTER_CUBIC)




    images_right.append(right_img)
```

In [5]:

```
thresh1=60
Octaves = 6


brisk  = cv2.BRISK_create(thresh1,Octaves)
keypoints_all_left = []
descriptors_all_left = []
points_all_left = []

keypoints_all_right = []
descriptors_all_right = []
points_all_right = []
```

```
for imgs in tqdm(images_left):

    kpt  = brisk.detect(imgs,None)
    kpt,descriptor = brisk.compute(imgs,kpt)
    keypoints_all_left.append(kpt)
    descriptors_all_left.append(descriptor)
    points_all_left.append(np.asarray([[p.pt[0],p.pt[1]] for p in kpt]))

for imgs in tqdm(images_right):
    kpt  = brisk.detect(imgs,None)
    kpt,descriptor = brisk.compute(imgs,kpt)
    keypoints_all_right.append(kpt)
    descriptors_all_right.append(descriptor)
    points_all_right.append(np.asarray([[p.pt[0],p.pt[1]] for p in kpt]))
```

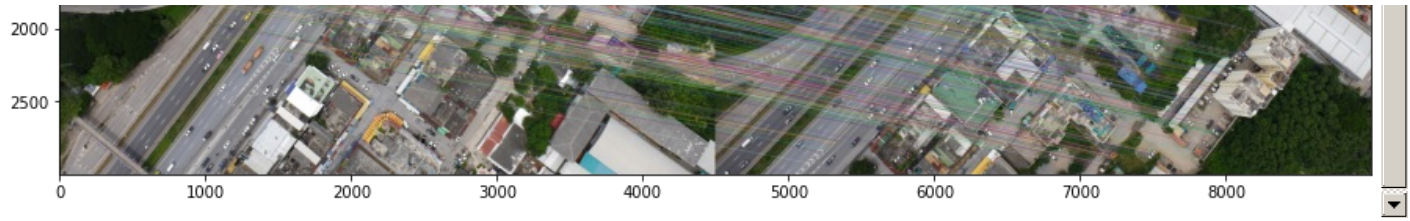
In [6]:

```
def getHmatrix(imgs,keypts,pts,descripts,disp=True):
    flann = cv2.BFMatcher()
    lff1 = np.float32(descripts[0])
    lff2 = np.float32(descripts[1])
    matches_lf1_lf = flann.knnMatch(lff1,lff2,k=2)
    matches_4 = []
    ratio = 0.8
    for m in matches_lf1_lf:
        if len(m) == 2 and m[0].distance < m[1].distance*ratio:
            matches_4.append(m[0])

    print('Number of matches',len(matches_4))
    imm1_pts = np.empty((len(matches_4),2))
    imm2_pts  = np.empty((len(matches_4),2))
    for i in range(0,len(matches_4)):
        m =  matches_4[i]
        (a_x,b_y) = keypts[0][m.queryIdx].pt
        (b_x,b_y) = keypts[1][m.trainIdx].pt
        imm1_pts[i] = (a_x,b_y)
        imm2_pts[i] = (b_x,b_y)
    H = compute_Hmography(imm1_pts,imm2_pts)
    Hn = RANSAC_alg(keypts[0], keypts[1], matches_4,nRANSAC=1500,RANSACthresh=6)
    global inliner_matchset

    if  disp == True:
        dispimg1 = cv2.drawMatches(imgs[0],keypts[0],imgs[1],keypts[1],inliner_matchset,None,flags=2)
        displayplot(dispimg1,'Robust Matching between Reference Image and Right Image')
    return Hn/Hn[2,2]
```

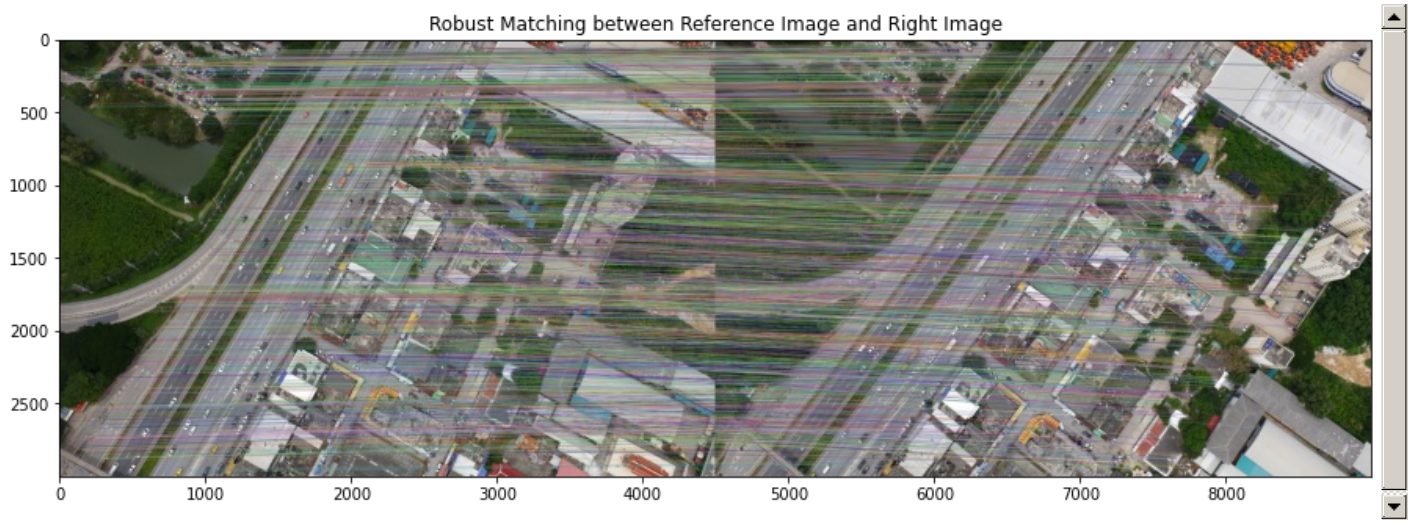
In [7]:

```
H_left = []
H_right = []
for j in tqdm(range(len(images_left))):
    if j == len(images_left) - 1:
        break
    H_a = getHmatrix(images_left[j:j+2][::-1],keypoints_all_left[j:j+2][::-1],points_all_left[j:j+2][::-1]
    H_left.append(H_a)

for j in  tqdm(range(len(images_right))):
    if j == len(images_right) - 1:
        break

    H_a = getHmatrix(images_right[j:j+2][::-1],keypoints_all_right[j:j+2][::-1],points_all_right[j:j+2][:
    H_right.append(H_a)
```

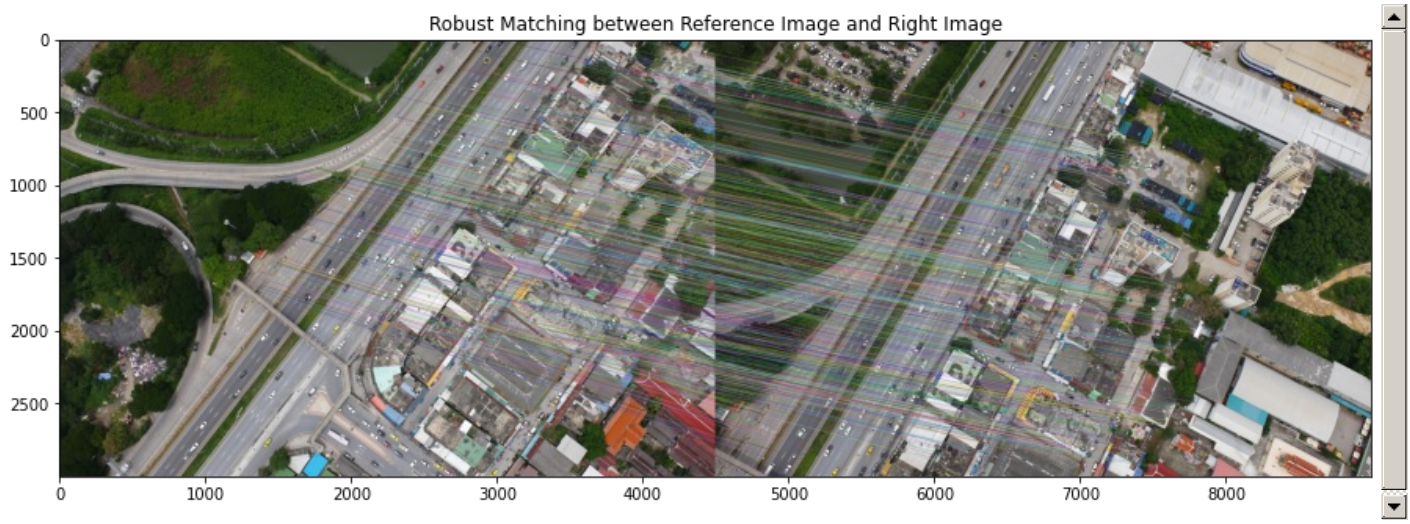
```
Number of matches 2248
Number of best inliners 1233
```



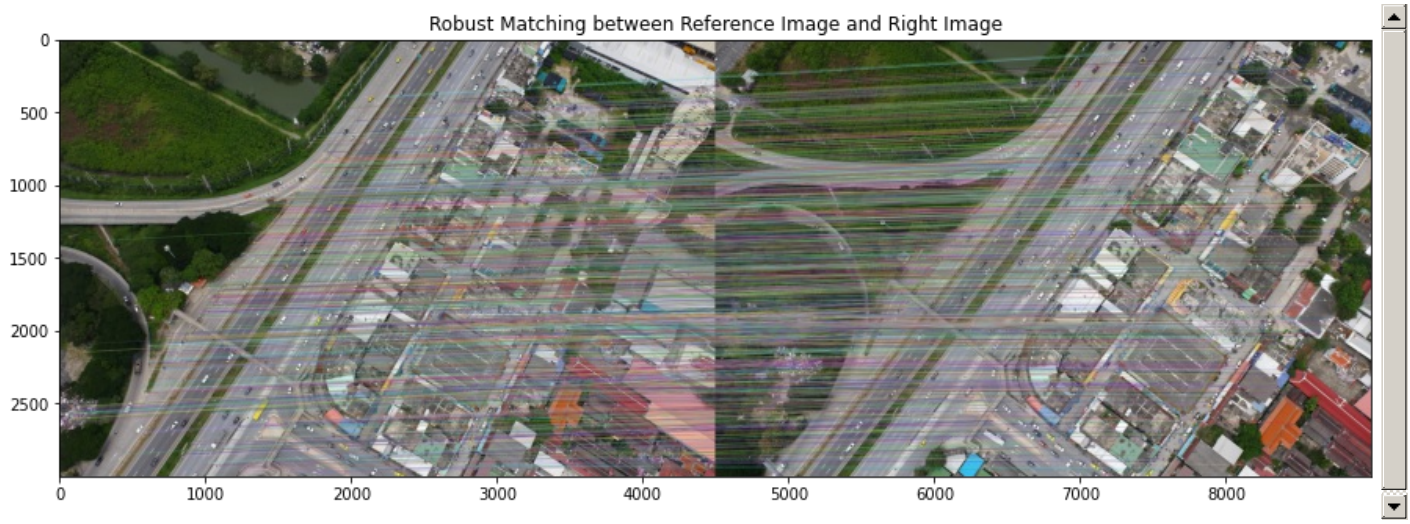
```
Number of matches 3875
Number of best inliners 1978
```



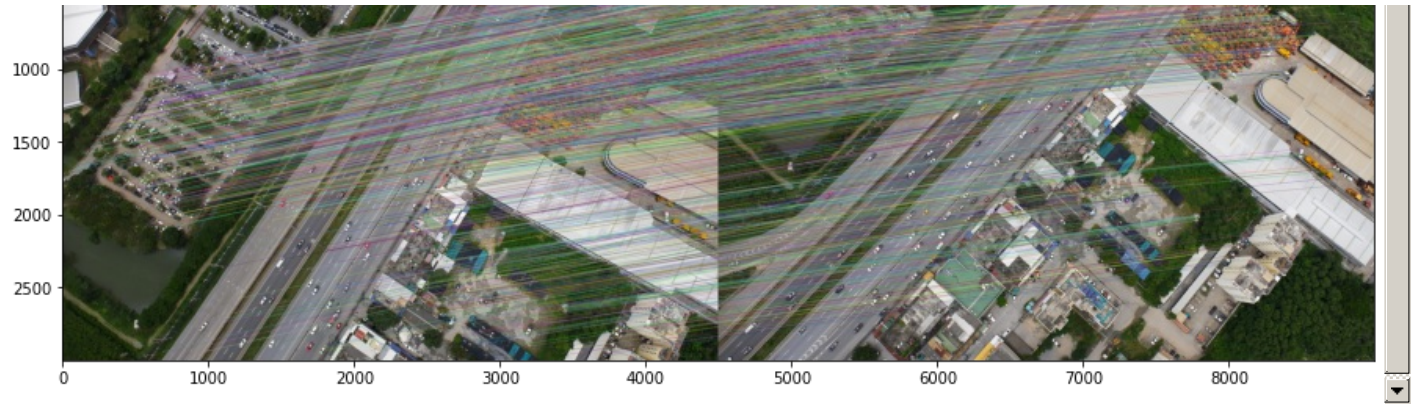

```
Number of matches 2072
Number of best inliners 878
```



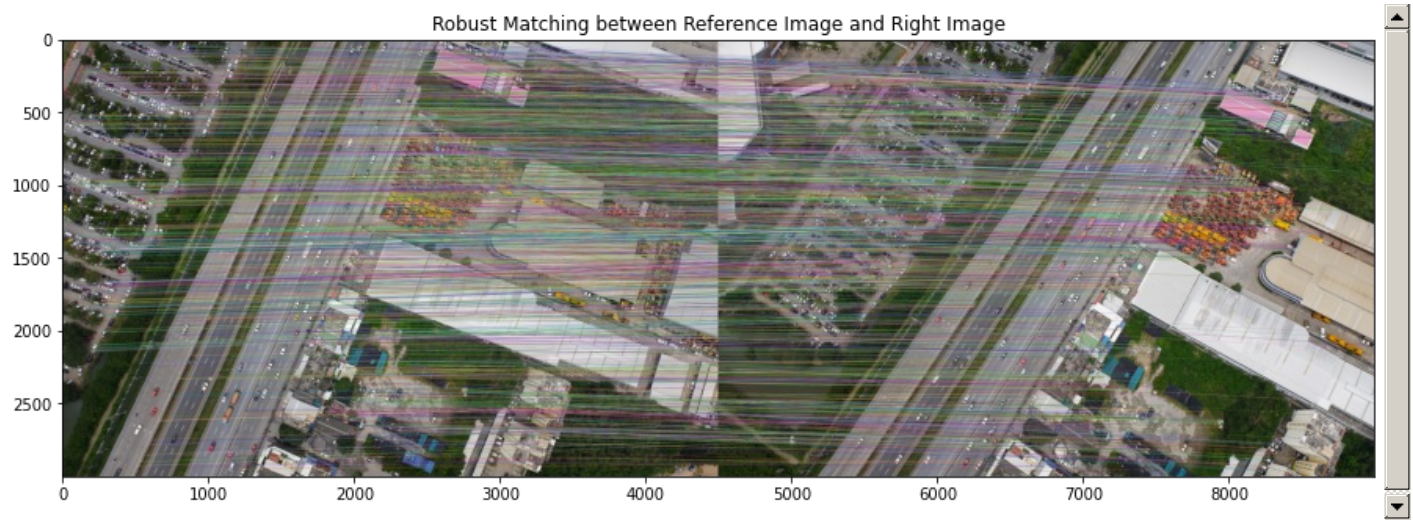

```
Number of matches 3451
Number of best inliners 1507
```



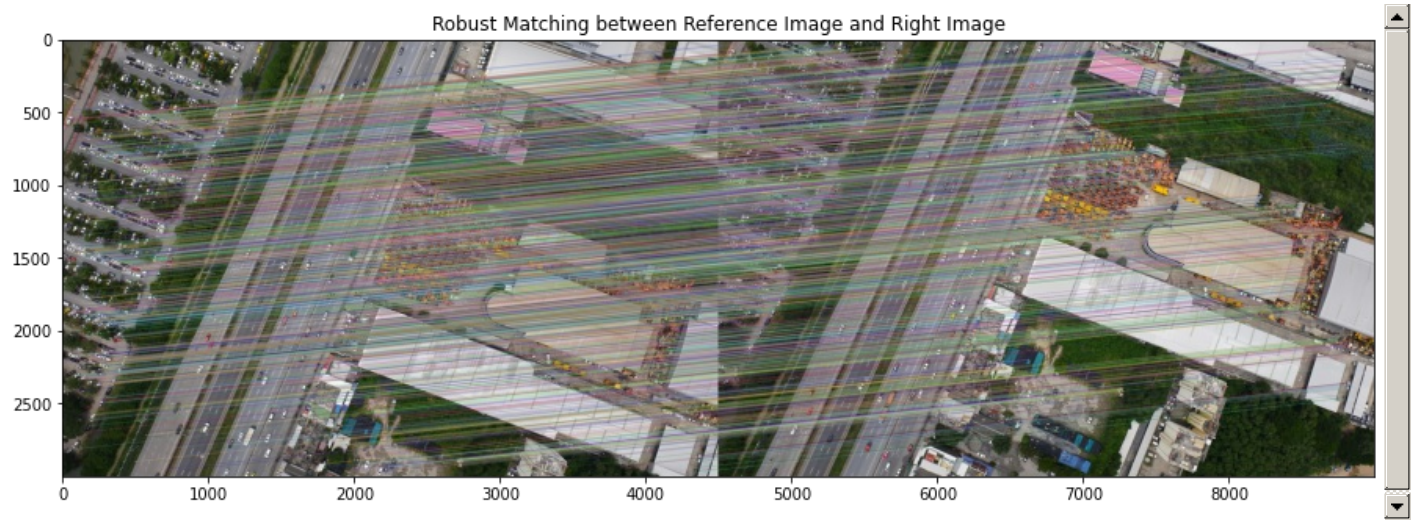

```
Number of matches 2990
Number of best inliners 2042
```



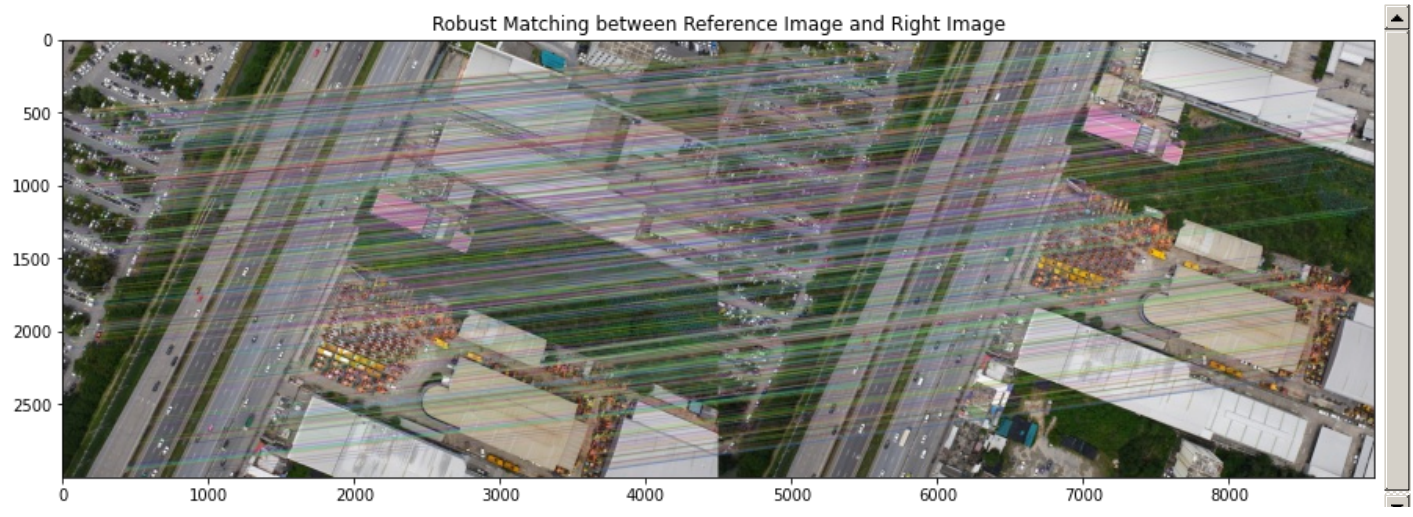
Number of matches 2362
Number of best inliners 1670



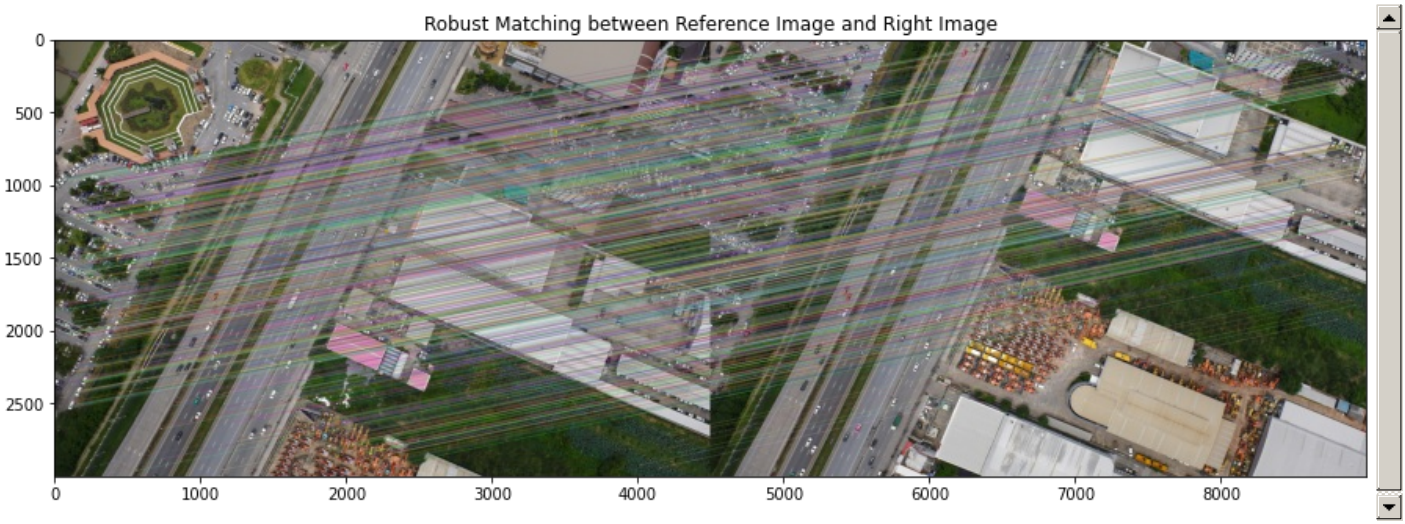
Number of matches 2994
Number of best inliners 2305



Number of matches 2233
Number of best inliners 1642



```
Number of matches 2581
Number of best inliners 1706
```



In [8]:

```
def warpnImages(images_left, images_right,H_left,H_right):
    h,w = images_left[0].shape[:2]
    pts_left = []
    pts_right = []
    pts_centre = np.float32([[0,0],[0,h],[w,h],[w,0]]).reshape(-1,1,2)

    for j in range(len(H_left)):
        pts = np.float32([[0,0],[0,h],[w,h],[w,0]]).reshape(-1,1,2)
        pts_left.append(pts)

    for j in range(len(H_right)):
        pts = np.float32([[0,0],[0,h],[w,h],[w,0]]).reshape(-1,1,2)
        pts_right.append(pts)

    pts_left_transformed = []
    pts_right_transformed = []
    for j,pts in enumerate(pts_left):
        if j == 0:
            H_trans = H_left[j]
        else:
            H_trans = H_trans@H_left[j]
        pts_= cv2.perspectiveTransform(pts,H_trans)
        pts_left_transformed.append(pts_)

    for j, pts in enumerate(pts_right):
        if j == 0:
            H_trans = H_right[j]
        else:
            H_trans = H_trans@H_right[j]
        pts_= cv2.perspectiveTransform(pts,H_trans)
        pts_right_transformed.append(pts_)

    pts_concat = np.concatenate((pts_centre,np.concatenate(np.array(pts_left_transformed),axis=0), np.cor
    [xmin,ymin] = np.int32(pts_concat.min(axis=0).ravel()-0.5)
    [xmax,ymax]  = np.int32(pts_concat.max(axis=0).ravel()+0.5)
    t = [-xmin,-ymin]
    Ht = np.array([[1,0,t[0]],[0,1,t[1]],[0,0,1]])
    print('Step2:Done')

    warp_imgs_left = []
    warp_imgs_right = []

    for j ,H in enumerate(H_left):
        if j== 0:
            H_trans = Ht@H
        else:
            H_trans = H_trans@H

        result = cv2.warpPerspective(images_left[j+1],H_trans,(xmax-xmin,ymax-ymin))
        warp_imgs_left.append(result)

    for j ,H in enumerate(H_right):
        if j== 0:
```

```
            H_trans = Ht@H
        else:
            H_trans = H_trans@H

        result = cv2.warpPerspective(images_right[j+1],H_trans,(xmax-xmin,ymax-ymin))
        warp_imgs_right.append(result)

    print('Step3:Done')

    # Union
    warp_images_all = warp_imgs_left + warp_imgs_right
    warp_img_init = warp_images_all[0]
    warp_final_all = []

    for j,warp_img  in enumerate(warp_images_all):
        if j== len(warp_images_all)-1:
            break
        warp_final = np.maximum(warp_img_init,warp_images_all[j+1])
        warp_img_init = warp_final
        warp_final_all.append(warp_final)

    print('Step4:Done')

    return warp_final, warp_final_all
```

In [9]:

```
combined_warp_n, warp_all = warpnImages(images_left,images_right,H_left,H_right)
```

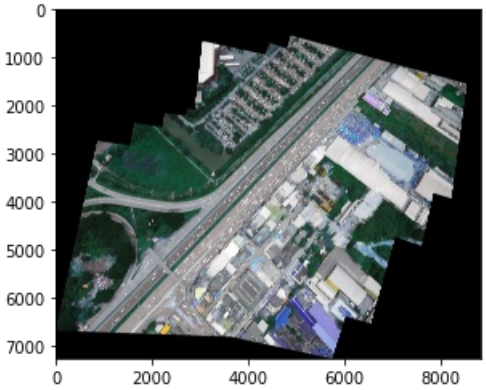
```
Step2:Done
Step3:Done
Step4:Done
```

In [11]:

```
plt.imshow(warp_all[6])
```

Out[11]:

```
<matplotlib.image.AxesImage at 0x7f7079672210>
```



In [13]:

```
combo_rgb = cv2.cvtColor(combined_warp_n, cv2.COLOR_BGR2RGB)
plt.figure(figsize=(25,15))
plt.imshow(combo_rgb)
plt.show()
```


0
1000
2000
3000
4000
5000
6000
7000
0
1000
2000
3000
4000
5000
6000
7000
8000

In [ ]: