Assignment 3

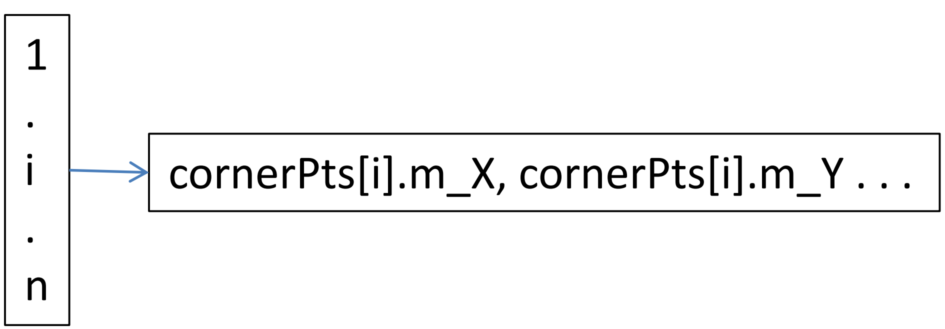
Creating Panoramas

Step 1: (10 pts) Implement the Harris corner detector.

- void HarrisCornerDetector(QImage image, double sigma, double thres, CIntPt **cornerPts, int &numCornerPts, QImage &imageDisplay)
  - image is the input image
  - sigma is the standard deviation for the Gaussian
  - thres is the threshold for detection corners
  - cornerPts is an array that will contain the returned corner points
  - numCornerPts is the number of points returned
  - imageDisplay – image returned to display for debugging

Step 1: (10 pts) Implement the Harris corner detector.

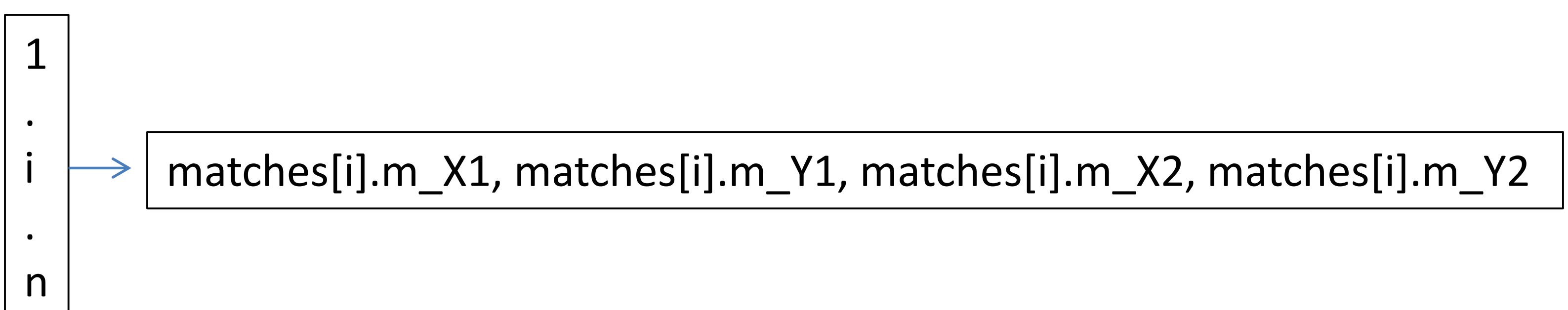
- Part b. void HarrisCornerDetector(QImage image, double sigma, double thres, CIntPt **cornerPts, int &numCornerPts, QImage &imageDisplay)
- To do:
  1. Compute x and y derivatives of the image, use them to produce 3 images (I_x^2, I_y^2, and I_x*I_y) and smooth each of them with the Gaussian.
  2. Compute the Harris matrix H for each pixel.
  3. Compute corner response function R = Det(H)/Tr(H), and threshold R. Try threshold 50 on the UI.
  4. Find local maxima of the response function using nonmaximum suppression.
- **Note**: We provide **Convolution** and **GaussianBlurImage** functions for you to use. You can index a pixel (c,r) by image[r*w + c]



Step 2: (10 pts) Implement MatchCornerPoints.

- void MatchCornerPoints(Qimage image1, Cintpt *cornerPts1, int numCornerPts1, Qimage image2, Cintpt *cornerPts2, int numCornerPts2, CMatches **matches, int &numMatches, Qimage &image1Display, Qimage &image2Display)

- **image1** is the first input image
- **image 2** is the second (match from image 1 to image 2)
- **cornerPts1** is a vector of interest points found in image1
- **cornerPts2** is a vector of interest points found in image 2
- **numCornerPts1** is the number of interest points in image1
- **numCornerPts2** is the number of interest points in Image 2
- **matches** is a vector of matches; each match has X and Y coordinates from each image



Step 2: (10 pts) Implement MatchCornerPoints.

- void MatchCornerPoints(Qimage image1, Cintpt *cornerPts1, int numCornerPts1, Qimage image2, Cintpt *cornerPts2, int numCornerPts2, CMatches **matches, int &numMatches, Qimage &image1Display, Qimage &image2Display)

To do this you'll need to follow these steps:

a. Compute the descriptors for each interest point.
   This code has already been written for you.

b. For each corner point in image 1, find its best match in image 2.
   The best match is defined as the closest distance (L1-norm distance.)

c. Add the pair of matching points to "matches".

d. Display the matches using DrawMatches (code is already written.)
   Just pass it the required parameters.
   You should see many correct and incorrect matches.

Step 3: (8 pts) Compute the **homography** between the images using **RANSAC**

```
void RANSAC (Cmatches *matches , int numMatches, int numIterations,
             double inlierThreshold, double hom[3][3], double homInv[3][3],
             Qimage &image1Display, Qimage &image2Display)
```

- matches is a set of numMatches matches
- numIterations is the number of times to iterate
- inlierThreshold is a real number so that the distance from a projected point to the match is less than its square
- hom is the homography and homInv its inverse
- Image1Display and Image2Display hold the matches to display

We provide **Project** and **ComputeInlierCount** functions for you to use

c. void RANSAC (Cmatches *matches , int numMatches, int numIterations,
double inlierThreshold, double hom[3][3], double homInv[3][3],
Qimage &image1Display, Qimage &image2Display)

a. Iteratively do the following for "numIterations" times:
   i. Randomly select 4 pairs of potentially matching points from "matches".
   ii. Compute the homography relating the four selected matches with the function "**Project**. "
   iii. Using the computed homography, compute the number of inliers using "**ComputeInlierCount**".
   iv. If this homography produces the highest number of inliers, store it as the best homography.

b. i. Given the highest scoring homography, once again find all the inliers.
   ii. Compute a new refined homography using all of the inliers (not just using four points as you did previously.)
   iii. Compute an inverse homography as well (the fourth term of the function ComputeHomography should be false), and return their values in "hom" and "homInv".

c. Display the inlier matches using "DrawMatches".

Step 4: (2 pts) Stitch the images together by calling the function directly following **Step3**.