SIFT Feature Matching:
By using opencv library, I could extract the key points and descriptors of both my template and target image. By using the descriptors, I applied nearest neighbors algorithm bidirectionally (from target to template and template to target) to filter the outliers and only keep those matching points that were the same from both sides.

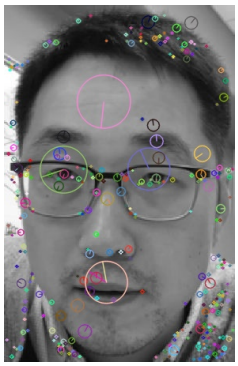
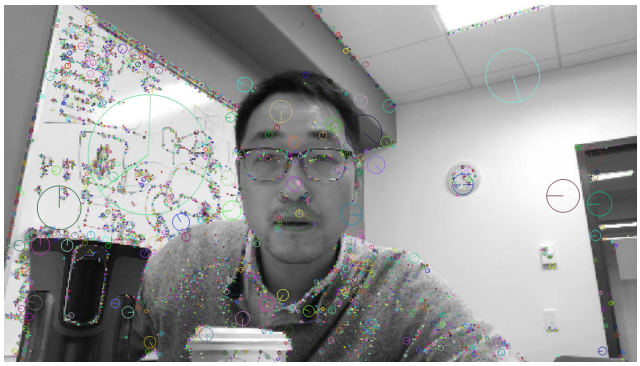
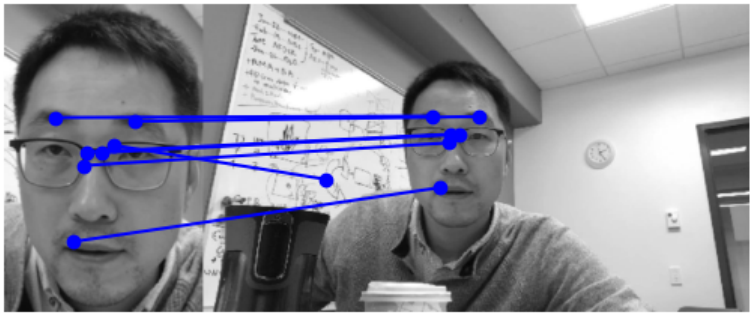
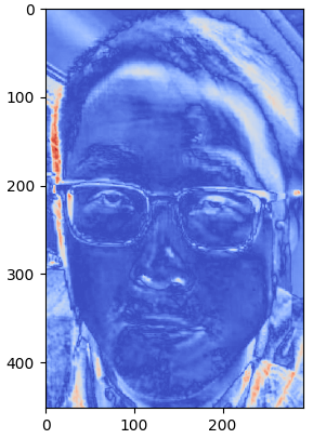
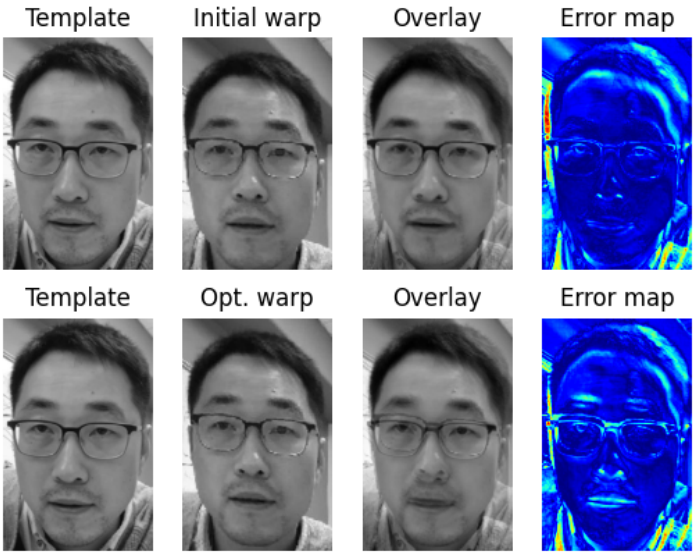




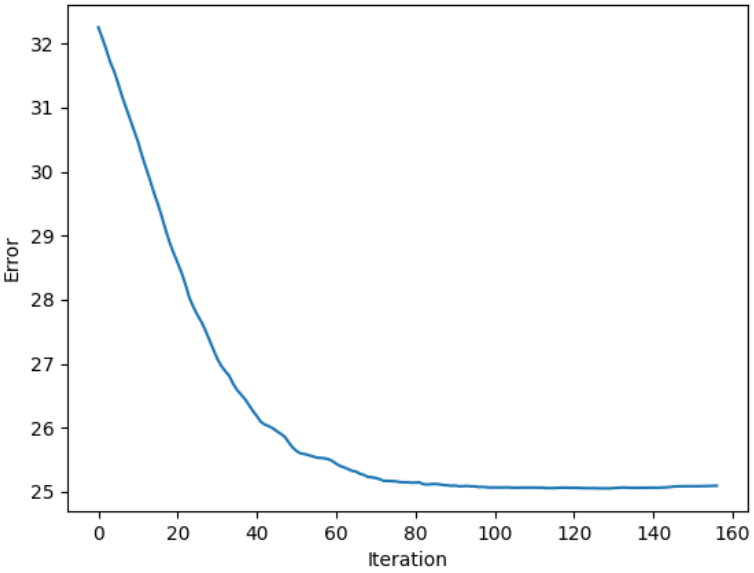
Image Alignment:
The goal is to find the best Affine transform that can describe these matching points from previous section. In order to do that I applied RANSAC algorithm meaning picked 3 random matching points from both template and target and solved Ax=b where A is based on random points from template and b are points from target and finally x is the desired Affine matrix. Then you transform template with new Affine matrix, find the Euclidean distance between the points and use the threshold (I chose 10) to count inliers. I repeated the RANSAC for 10,000 times to get the best Affine model with highest inliers counts.

Image Warping:
Now that the outliers are fully filtered out, we warp the template using the Affine transform from last section. We go from target to template to not loose any pixels due to floating points. Here is the warped image and also the error image (template - warped image):

Inverse Compositional Image Alignment:
The purpose of this section is now that we have found the initial Affine transform, we can now apply Inverse Compositional Image Alignment Algorithm to align track the next frames. I followed the pseudo code and by visualizing the error map I found out that the error starts decreasing for each iteration but for sake of our time I just decided to run the while loop for 100 iterations. I computed the gradient from last HW first and computed the Hessian, second I calculated the F and got the delta_p, so I'll update my Affine matrix iteratively. Here is the overlay and error map image:





Multiframe Tracking:
Finally I will apply the previous methods for all target images and will track the frames.
Found matching points using template and first target image. With the Affine output after aligning image, we warp the template. Finally we align target using Inverse Compositional Image Alignment Algorithm. Will warp the template again and do the alignment for next target images. Below is the result of Alignment for 4 target images: