

Results



Input 1 Feature Points



Input 4 Feature Points

The Harris-Stephens detector is used to find feature points, which assigns the highest values to corners. This can be seen in the concentration of points along the corners of each window pane. Adaptive Non-Maximal Suppression is used to ensure a wider distribution of points. The blur added to higher bike inputs makes a dramatic gulf between strong and weak edges, meaning only the former feature points were selected without ANMS.



Nearest Neighbor Ratio Matches

SIFT is used to create feature descriptors, making the bike inputs especially difficult to match. With weaker edges

blurred, the feature distance between identical points in each image grows larger and similar points form a denser cluster. The primary solution to this was to grab a large number of features, selected for geographic uniqueness in addition to strength due to ANMS.



Nearest Match



Distance Threshold Matches

Somewhat better results for the Nearest Match and Distance Threshold strategies could have been obtained by more closely tailoring the threshold, but they are clearly inferior techniques. I dedicated most effort to refining the Nearest Neighbor Distance Ratio.

	Nearest Neighbor Distance Ratio	Nearest Match	Distance Threshold
Threshold	.85	30,000	30,000
Number of Detected Points	250	250	250

Number of Matched Points	27	38	174
TPR	56%	24%	5%
I am more than satisfied with a 56% TPR and believe it's fair to say that these images were successfully matched.			



Input 1 Feature Points

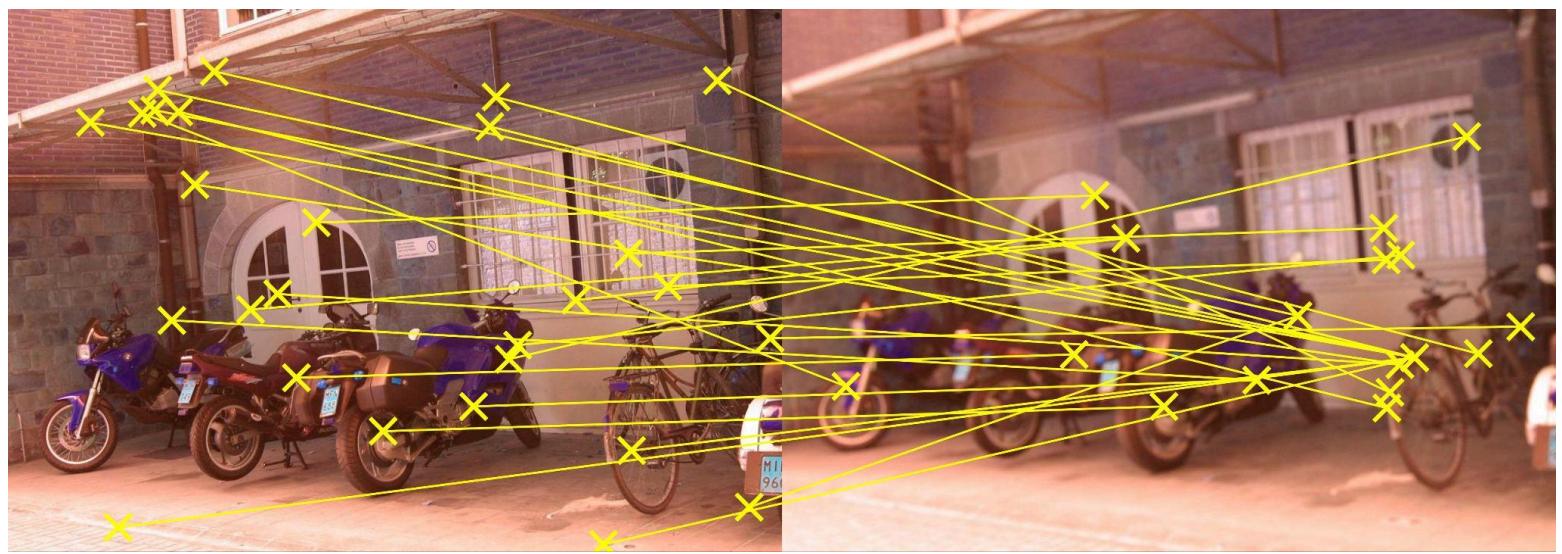


Input 5 Feature Points

I achieved similar success for matching input 5, although somewhat downgraded from input 4. Input 6 was too blurred for my descriptors. This could be countered with larger scale descriptors with a higher threshold for inclusion, so that features could be matched by the strong edges that the blur affects less.



Nearest Neighbor Ratio Matches



Nearest Match



Distance Threshold Matches

	Nearest Neighbor Distance Ratio	Nearest Match	Distance Threshold
Threshold	.9	30,000	30,000
Number of Detected Points	250	250	250
Number of Matched Points	18	27	260
TPR	39%	15%	2%

I had to raise the Nearest Neighbor Distance Ratio threshold, as the input 5 descriptors were more similar than for input 4, but the results are still satisfactory. A reasonable match can be made with 7 correct out of 18.



Input 1 Feature Points



Input 6 Feature Points

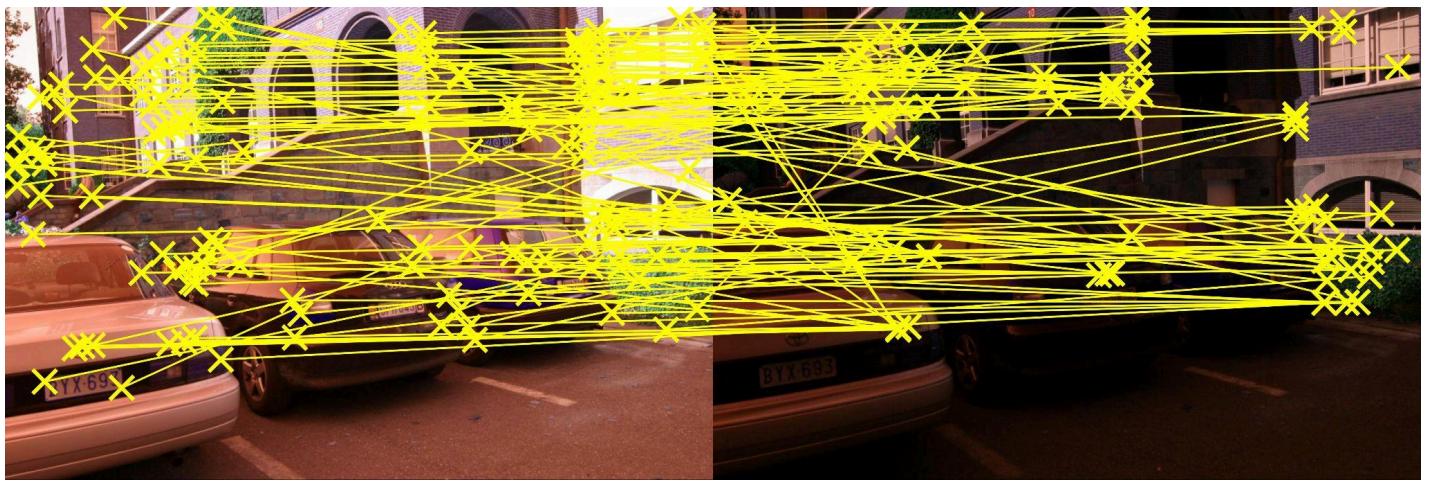
One of SIFT's primary advantages is that it is totally intensity invariant, which meant the car image was least challenging for my methods. Although fewer feature points are detected in the low-contrast areas of input 6, those that were detected were matched with a high level of reliability.

Additionally, the image features a slight tilt. My adaptation of SIFT is not totally rotationally invariant, as I did not individually determine each feature's dominant orientation, but it can handle a reasonable amount of change as long as it is not enough to move pixels into adjacent orientation bins. I would estimate that it can handle $\sim 22.5^\circ$ in either direction, though this is pure guesswork based off of how I implemented it.



Nearest Neighbor Ratio Matches

Although there are a few false matches, the vast majority are correct.



Nearest Match



Distance Threshold Matches

	Nearest Neighbor Distance Ratio	Nearest Match	Distance Threshold
Threshold	.8	40,000	40,000
Number of Detected Points	500	500	500
Number of Matched Points	70	132	1334
TPR	0%	0%	0%

For some reason, though, my calculations using the transformation matrix for the car images seem to be incorrect. My function worked for the other two sets of images, but is completely useless for these images. I simply did not have the energy to figure out what was going on, but my TPR for the Nearest Neighbor Distance Ratio should really be ~90%.

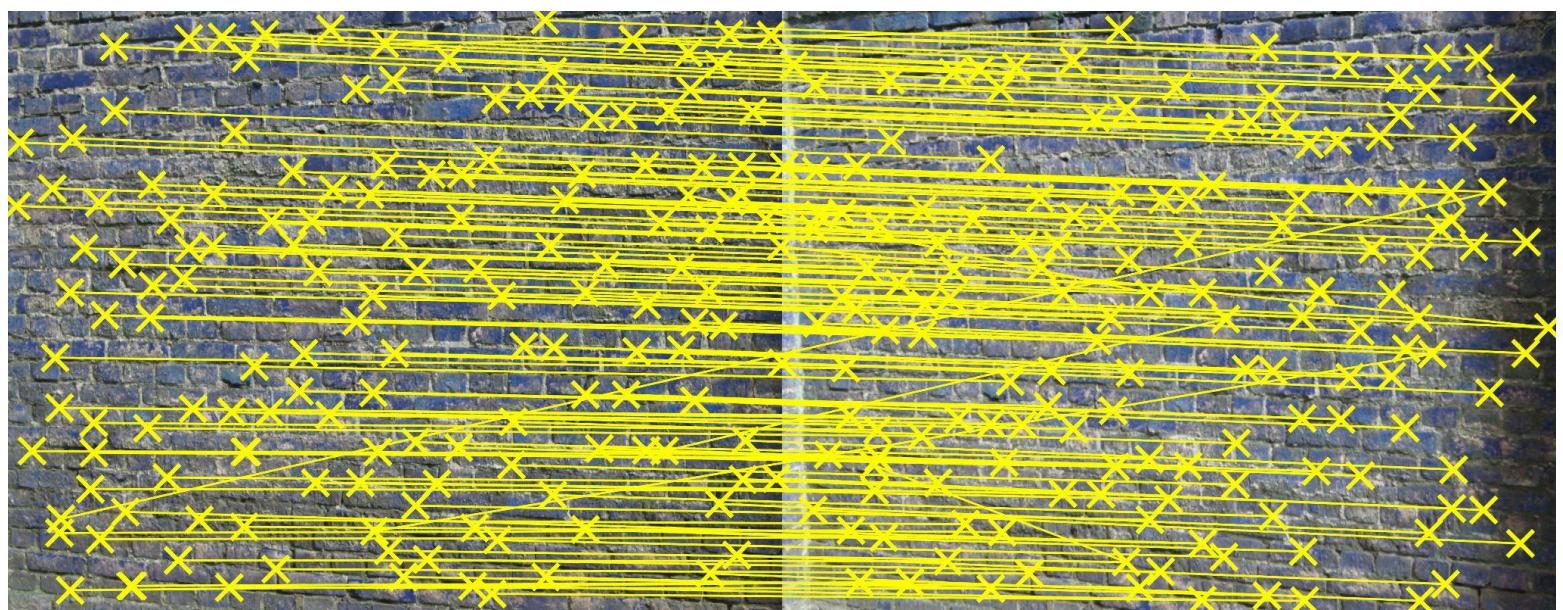


Input 1 Feature Points

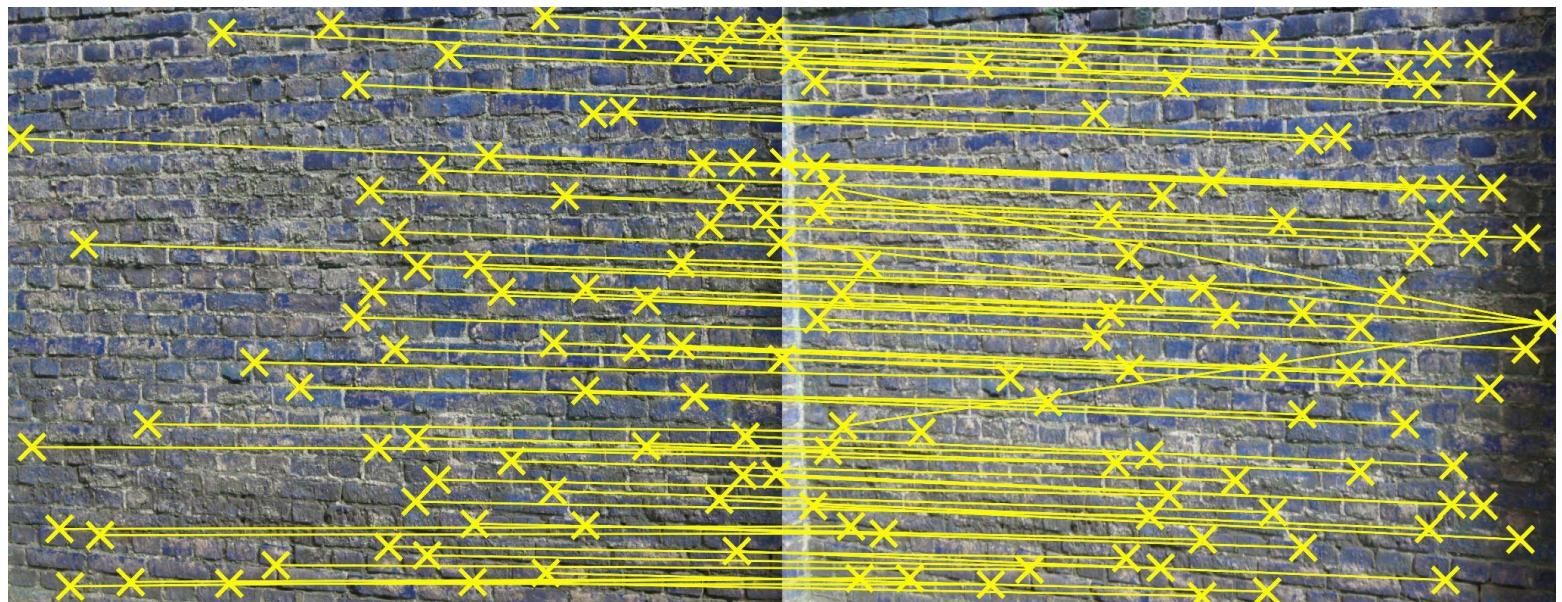


Input 2 Feature Points

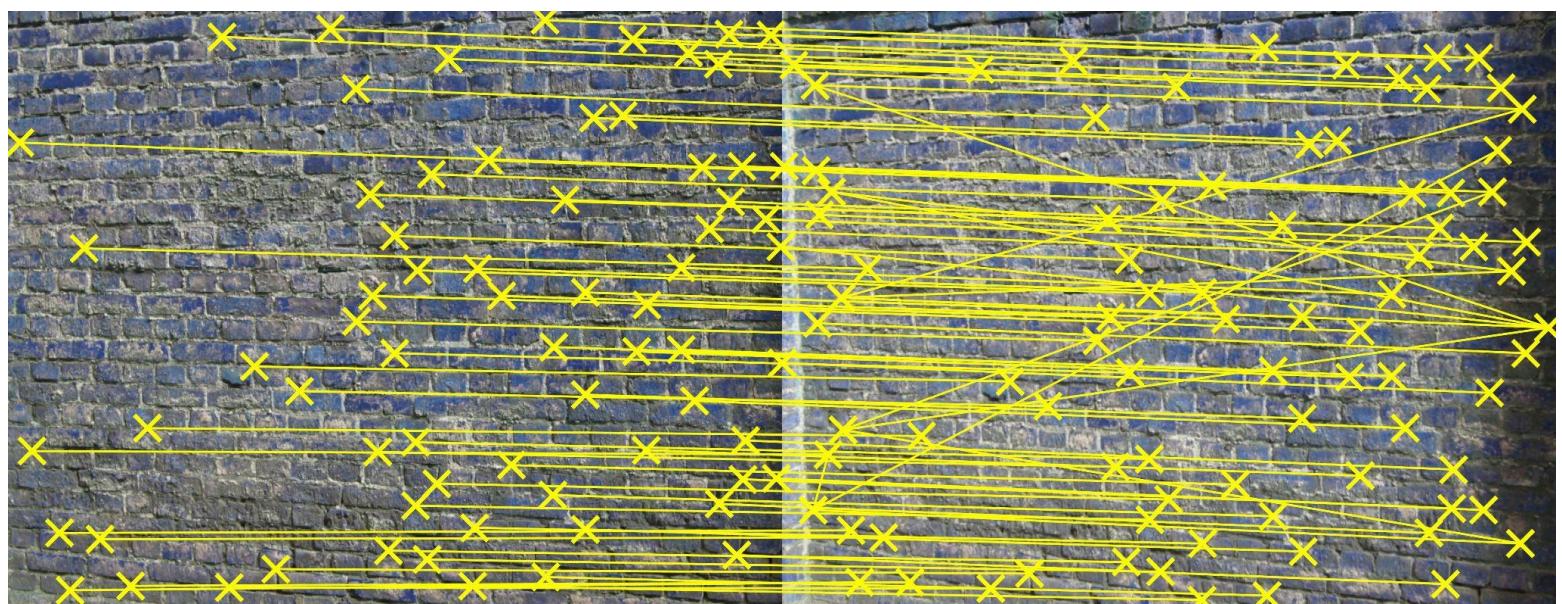
SIFT has most difficulty dealing with affine transformations. I managed a reasonable match with input 1 and 2, but nothing further.



Nearest Neighbor Ratio Matches



Nearest Match



Distance Threshold Matches

	Nearest Neighbor Distance Ratio	Nearest Match	Distance Threshold
Threshold	.8	30,000	30,000
Number of Detected Points	250	250	250
Number of Matched Points	158	77	85
TPR	16%	8%	7%

