

Image Registration

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1 Comparing Image Match Metrics

In this project, we compare the performance of various image match metrics for optimal image registration. The three measures are:

1. Normalized Cross Correlation (NCC)
2. Mutual Information (MI)
3. Quantile Function

We further use three methods to compare our image match measures:

1. Accuracy: This is basically the global max angle output relative to the correct angle by which the rotation was made in the target image.
2. Relative Difference: Specifically, this is the relative difference between the global max (peak at $\theta = \frac{0.25}{k}$) and the local max (peak at $\theta = \frac{-0.75}{k}$)
3. Peakiness: This is basically the negative second derivative around the global max

1.1 Quantile Functions

We use built-in functions for normalized cross correlation and mutual information, with traditional definitions. For our third image match measure, we build our own quantile functions. We selected a region in the image and chose gradient magnitudes as our feature of interest. Gradient magnitude is a natural choice for an image feature and has the added benefit of being resistant to change in image contrast. Thus it works for negative \mathbf{A} values. We calculate the Euclidean distances between the quantile functions of the target image and the reference image, where a low distance points to an optimal registration. We then normalize these distances between 0 and 1 and subtract them from 1. The last step is simply done so that our analysis corresponds with looking for the maximum value retrieved from the quantile function metric. The region we ended up selecting was the bottom left quadrant of the image. We tried a myriad of regions and this quadrant seemed to work the best. Given our knowledge of how the fan is displayed and rotating, this makes sense as the rotations will effect the image intensities in this quadrant the most. Thus we can expect image match to be very high for an optimal registration.

1.2 Observations

Next, from our analysis we observed that all of our measures were able to obtain the best possible registration. The angle output from each metric was exactly equal to the amount by which we rotated the fan in the target image. However, we note that Mutual Information seemed to perform the best when we compare the relative differences from the global max to the optimal max. The global peaks obtained by Mutual Information were much higher than the other two. This would mean that in a less contrived scenario, where there is a lot of noise in the images and many possible objects which could result in multiple local maxima, Mutual Information would be able to isolate the global max much more effectively.

2 Results

We will now display the various values retrieved from running different the registration with different values of **A** and **B**.

2.1 A=1, B=0

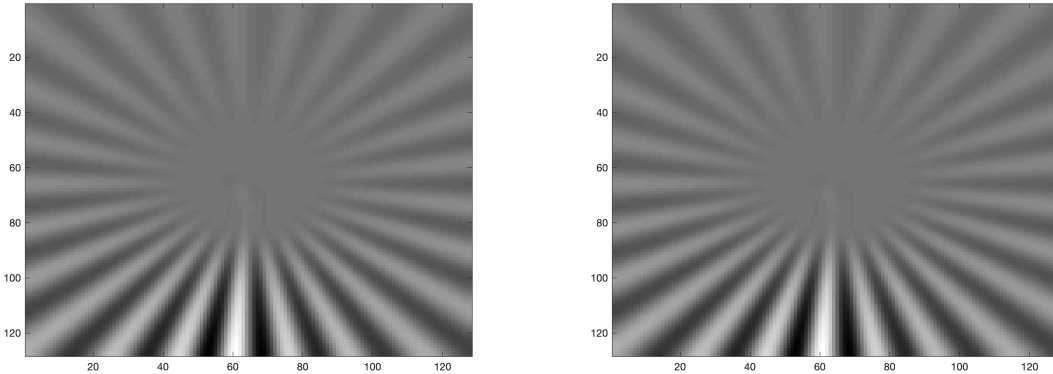


Figure 1: Target Image on the right with the optimal registration reference image on the left

Table 1: Image Match metrics for A=1, B=0

	Accuracy(%)	Relative Difference from Local Max	Peakiness (2nd Derivative)
NCC	100	0.0528	-13052.08
MI	100	0.3708	-97134.01
QF	100	0.0528	-13052.08

2.2 A=1000, B=0

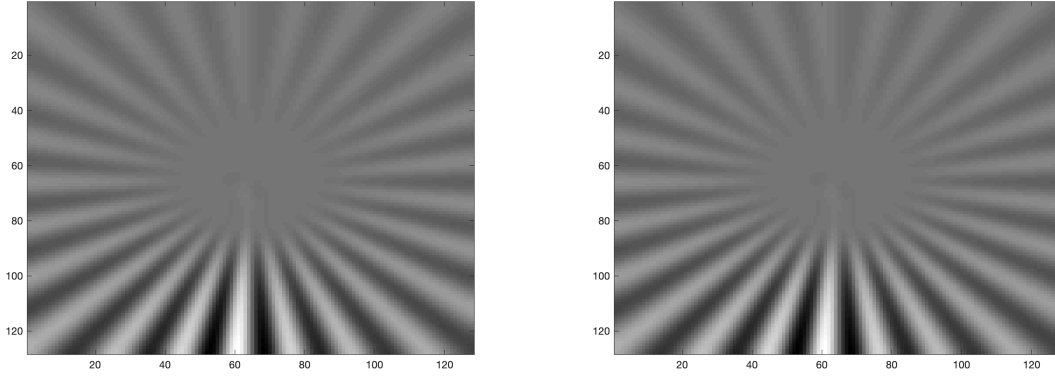


Figure 2: Target Image on the right with the optimal registration reference image on the left

Table 2: Image Match metrics for A=1000, B=0

	Accuracy(%)	Relative Difference from Local Max	Peakiness (2nd Derivative)
NCC	100	0.0528	-13052.08
MI	100	0.3708	-97134.01
QF	100	0.0528	-13052.08

2.3 A=1000, B=1000

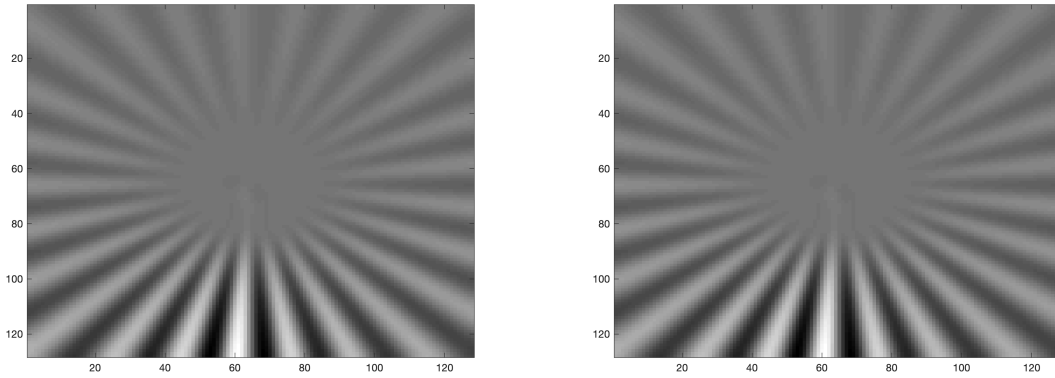


Figure 3: Target Image on the right with the optimal registration reference image on the left

Table 3: Image Match metrics for A=1000, B=1000

	Accuracy(%)	Relative Difference from Local Max	Peakiness (2nd Derivative)
NCC	100	0.0528	-19086.12
MI	100	0.3708	-139372.25
QF	100	0.0528	-19086.12

2.4 A=-500, B=1000

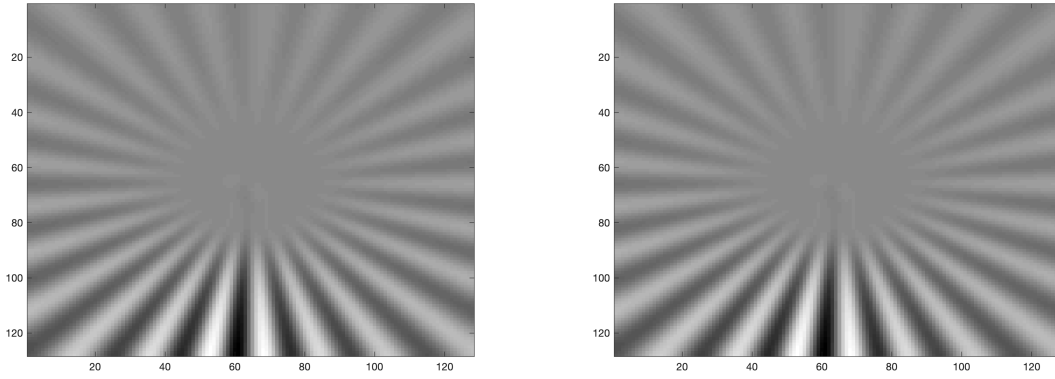


Figure 4: Target Image on the right with the optimal registration reference image on the left

Table 4: Image Match metrics for A=-500, B=1000

	Accuracy(%)	Relative Difference from Local Max	Peakiness (2nd Derivative)
NCC	100	0.0528	-25508.43
MI	100	0.3708	-184328.44
QF	100	0.0528	-25508.43