COMP 775
Assignment 3: **Registration**
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Three measures of performance

I used three different measures to validate the image match metrics.
They are —

1. **Measure 1**: Accuracy of the angle of rotation (0 being the highest accuracy, lower is better).

2. **Measure 2**: Lowering of the image match measure relative to its value at correct answer (Higher is better).

3. **Measure 3**: Sharpness of peak at the correct answer (Being negative at maxima, lower is better).

Table 1: Measures for $(A, B) = (1, 0)$

Image Match Metrics	Measure 1	Measure 2	Measure 3
Normalized Cross Correlation	0	1.8117	-9.3510
Quantile Function	0	4.9449	-1.9234
Mutual Information	0	22.4729	-27.8299

Table 2: Measures for $(A, B) = (1000, 0)$

Image Match Metrics	Measure 1	Measure 2	Measure 3
Normalized Cross Correlation	0	1.8117	-9.3510
Quantile Function	0	4.9449	-1.9234
Mutual Information	0	0.7724	-0.7502

Table 3: Measures for $(A, B) = (1000, 1000)$

Image Match Metrics	Measure 1	Measure 2	Measure 3
Normalized Cross Correlation	0	1.8117	-9.3510
Quantile Function	0	4.9449	-1.9234
Mutual Information	0	0.7724	-0.7502

Table 4: Measures for $(A, B) = (-500, 1000)$

Image Match Metrics	Measure 1	Measure 2	Measure 3
Normalized Cross Correlation	2	3.3557	-9.3070
Quantile Function	0	4.9449	-1.9234
Mutual Information	0	1.4243	-1.3727

Comment on the image match metrics

Normalized Cross Correlation seems to fail when the image is multiplied by a negative value i.e when the contrast is reversed. Among the other two methods, quantile function seems to perform well. But it requires careful selection of features whereas mutual information performs reasonably well without any such feature.

Example of registered image for each (A, B) tuple

Here are few example images of the registered images with their corresponding target image for each (A, B) tuple.
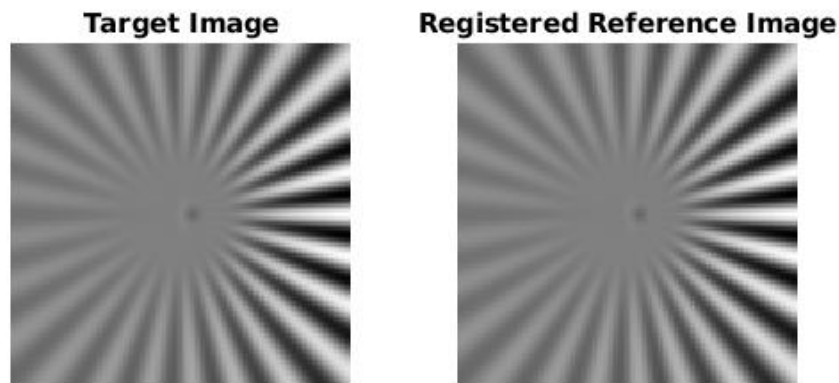
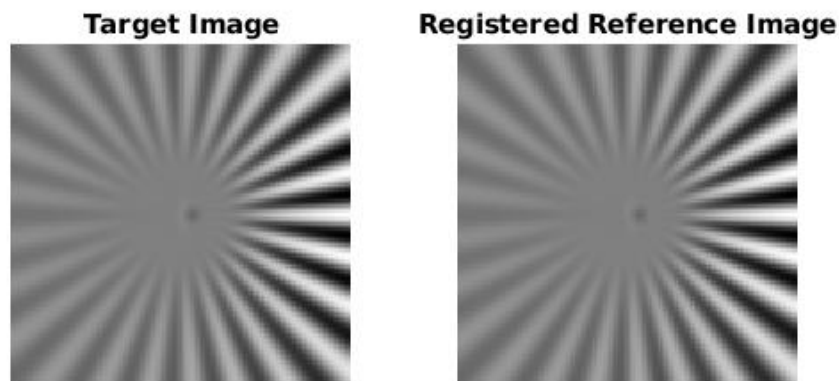Figure 1: Result of Normalized Cross Correlation for $(A, B) = (1, 0)$.

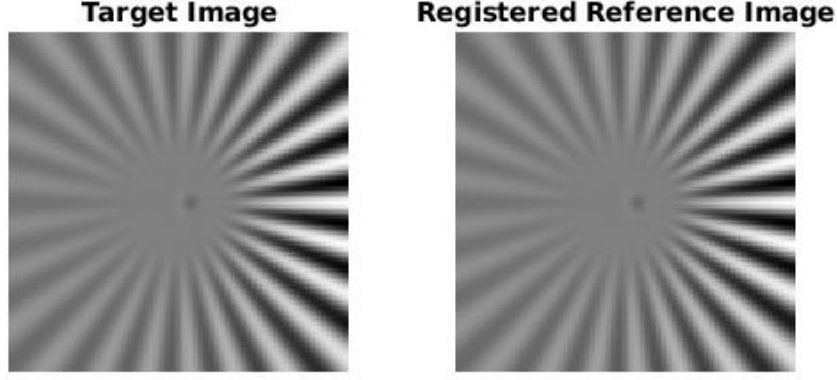Figure 2: Result of Quantile Function for $(A, B) = (1000, 0)$.

Target Image   **Registered Reference Image**

Figure 3: Result of Mutual Information for $(A, B) = (1000, 1000)$.

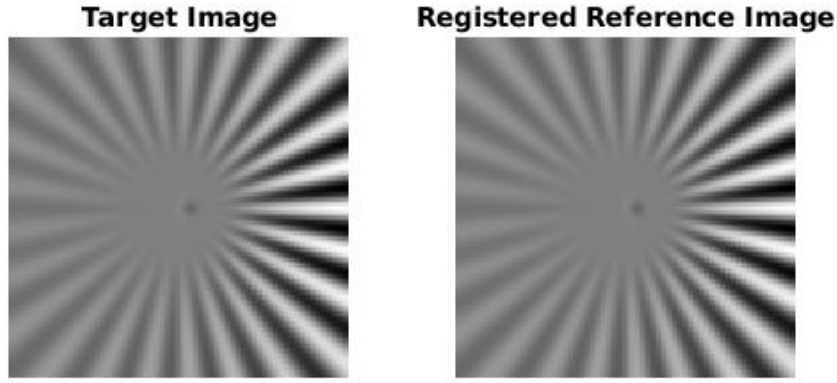**Target Image**   **Registered Reference Image**

Figure 4: Result of Quantile Function for $(A, B) = (-500, 1000)$.

Features used in quantile function

To make the quantile function work for reverse contrast images, I did the following —

1. Normalize both the target($I1$) and the moving image($I2$) between 0 and 1.

2. Create a new image $I3$ where $I3 = -1 * I2$ and normalize it between 0 and 1.

3. Compute quantile function $q1$, $q2$, and $q3$ for $I1$, $I2$ and $I3$ respectively.

4. Compute earth mover distances $d1$, $d2$ from $(q1, q2)$ and $(q1, q3)$ respectively.

5. Take the max of $d1$, $d2$.

Image match at different angle

Here are some plots of the image match metrics at different angles for each A, B pairs.
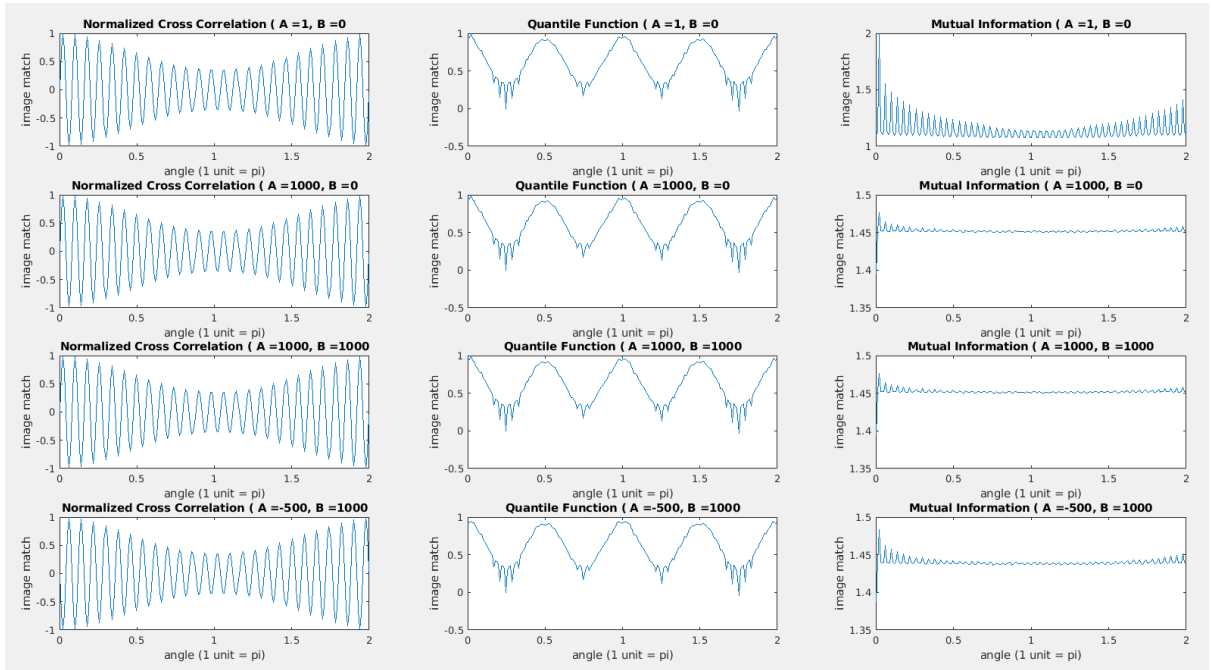
Figure 5: Plots of image match at different angle for each pair of (A, B).