results is because rotation changes the coordinates for the pixels which changes the image matrix. Also Scaling changes, the location and the values of the image's matrix because it changes the size of the image and the value of the pixels.

Table 1. Results summary

Dataset / Result	Africans Dataset (Recognition Rate)	Airplanes Dateset (Recognition Rate)	Shapes Dataset (Recognition Rate)
Identical images (1 Singular Value)	100%	100%	100% (18 extra identical images found)
Identical images (2 Singular Values)	-	-	100%
Gaussian noised images (15 Singular Values)	95.7%	59.5%	39.8%
Salt & Pepper noised images (12 Singular Values)	79.7%	70%	63.95%
45° rotated images (15 Singular Values)	3.1%	0.25%	3.1%
Scaled images (15 Singular Values)	0.1%	0.1%	0.13%

5. Conclusion and future work

5.1 Conclusion

In this study, the uniqueness of the Singular Values when applied to image recognition is investigated. Also the effectiveness and the minimal number of values needed to recognize the images is investigated.

The Singular Values are unique and can be used to recognize images. The SVD works best when the images are identical with 100% recognition rate using only one Singular Value, and does not work well on rotation and scaling. Gaussian noised images show extreme variance between the dataset's results. On the other hand, Salt and Pepper noised images results are consistent between the datasets.

Gaussian noised images results have a high of 95% and a low of 39% recognition rate. These results are using 15 Singular Values. The recognition rate was low for singular values less than 15. As for the Salt and Pepper results, they are close with the high of 79% and the low of 63% recognition rate using 12 Singular Values. The recognition rate was low for singular values less than 12. The 45° rotated images and the scaled images recognition rates are extremely low. The recognition rate's achieved values are between 0.1% and 3.1%.

The Singular Values can be used to recognize identical images safely with recognition rate of 100% using just one Singular Value while using this technique to recognize noised images depends on the application and the accuracy needed. As for the rotated and scaled images, SVD can't be used due to the low recognition rate.

5.2 Future Work

This research has investigated the uniqueness of Singular Values and its potential to be used to recognize images. also found the minimal number of Singular Values to recognize the identical and distorted images.

This future work section presents some of the work that needs to be done to be able to verify even more on the potentials of using the SVD to recognize the images. This can be achieved by testing the SVD's capabilities by using more datasets. Additionally, testing this technique on colored images to investigate the capabilities of the SVD on recognizing colored images.

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