Project Title	**Face recognition and image compression using PCA and SVD**		
Course Code	Math 301	**Course Name**	Linear algebra
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Problem Summary	Human beings can detect and recognize faces skillfully even when conditions like face expression, lighting condition, or viewing angle change. In this paper, we describe a procedure for facial recognition using PCA and SVD after explaining both concepts thoroughly. To validate our theoretical results, we develop a facial recognition application that are efficient even under the change of the mentioned conditions using linear dimensionality reduction techniques. We've also found that the dimensionality reduction technique used in face recognition can be used for image compression and this is also validated in the results.		
Methodology	We'll start our work by gathering a training set of face pictures. This set must be collected carefully so that it's all aligned (i.e. the eyes have the same position in all images. Firstly, we build our data matrix A by flattening all images in our dataset and stack them row on row. Secondly, we calculate the mean face (our new reference point). We subtract the mean from each row. Then, we obtain A's principle components using dimensionality reduction tools like SVD. SVD decomposes the face matrix into three parts: U, S, and V. the columns of U are the eigenfaces (i.e. the new reduced basis). Our goal is simply to find the weight of every image in our dataset on each eigenface and to compare these weights to our test images, the closest weights probably belong to the same person. So ultimately what we've done is changing our coordinate system which has a reference point (0, 0, 0, …, 0) and 30,000 dimensions (dependent on the size of images in the dataset) to a new origin (the mean face) and new dimensions (the eigenfaces) of much lower dimensions. This will help us both in face recognition and image compression to an acceptable resolution.		
Achievements and Skills Gained	Our project is divided into three sub goals: face detection, face recognition, and image compression. We've learned opencv to achieve the face detection part and learned dimensionality reduction tools to be able to recognize faces we've detected using opencv.		

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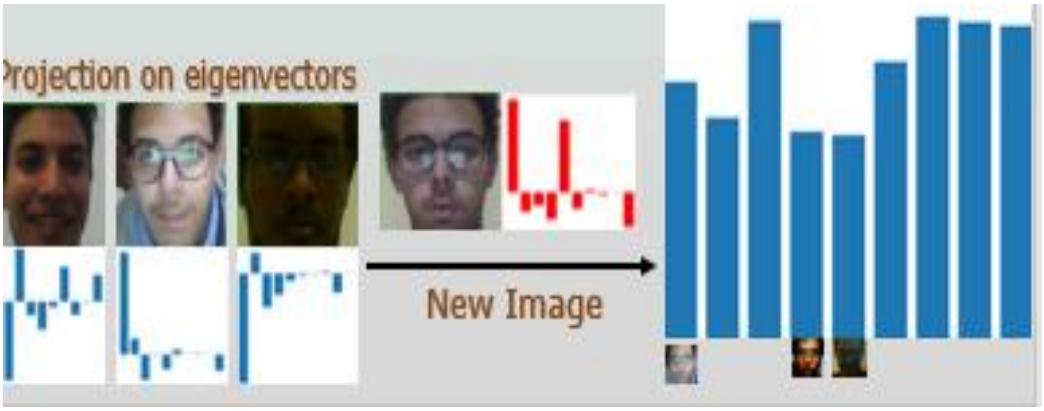
Main Results	The following graphs shows the calculated weights of dataset images and test image, and the Euclidean distance between them. 
Discussion and Conclusion	Based on the results, the distance between the test image and the dataset images shows that using dimensionality reduction tools has its limitations like: it's not robust to misalignment or changing lighting conditions. Improvements like non-linear dimensionality reduction can deliver better results.
References	- Kutz, J. (2013). Data-driven modeling and scientific computation. Oxford [etc.]: Oxford U.P. - Turk, M. and Pentland, A. (1991). Eigenfaces for Recognition. Journal of Cognitive Neuroscience, 3(1), pp.71-86 - Brownlee, J. (2019). A Gentle Introduction to Singular-Value Decomposition
Future Work and Suggestions	We may try different techniques for recognition including non-linear techniques that we think will achieve better results especially under different lighting or illumination conditions.
Group Photo