A=UΣVTA=UΣVT

Using SVD to Efficiently Analyze Data

Midshipman 4/c Karl Schwarzkopf

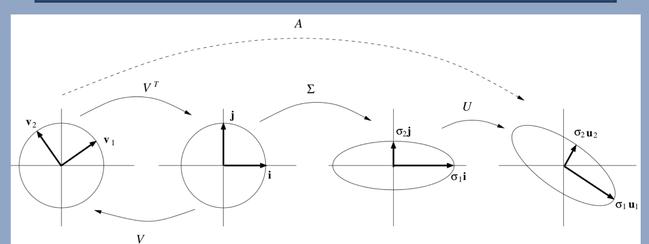
Professor Malek-Madani, Mathematics Department & Professor Avramov-Zamurovic Weapons and Systems Department

Abstract

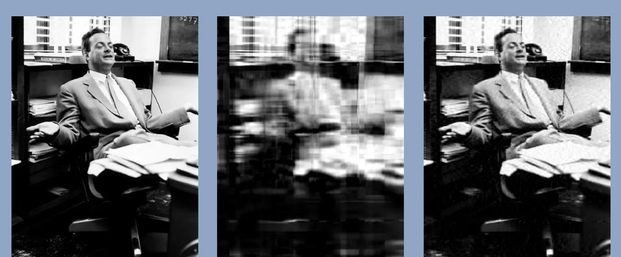
This project aims to develop a MATLAB code utilizing singular value decomposition to address, analyze, and quantify the changes in images of laser propagation.

Background

Singular value decomposition (SVD), determines the singular values of a matrix. A large singular value indicates a large contribution that value/vector pair has on the data. Data analyzing is simplified by using the most influential singular values,



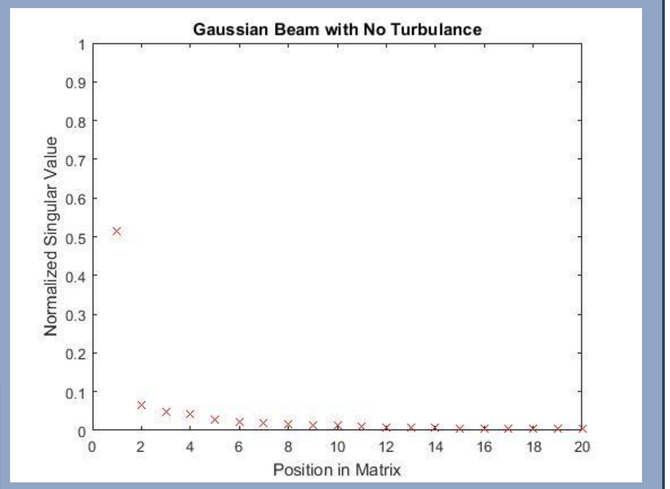
$A=U\Sigma V^T$

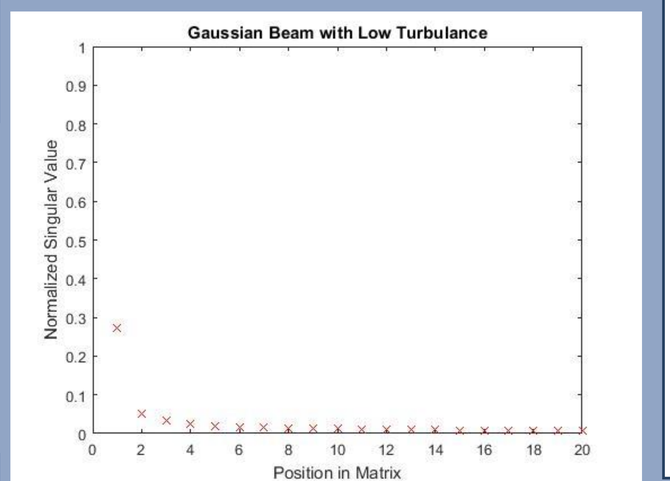


400 Values 10 Values 50 Values

Method

Images from laser propagation data were isolated from TIF files, uploaded into MATLAB, and converted into column vectors of one aggregate matrix. SVD was taken of the matrix and the singular values were scaled so their sum equaled one.



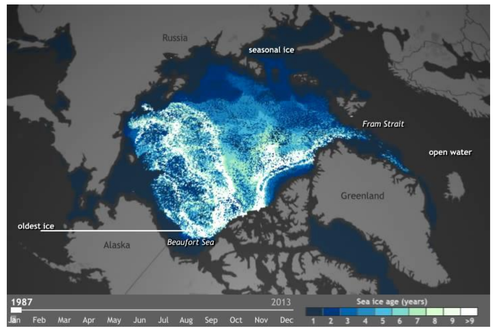


Results

- Row estimates of A are calculated with linear combinations of corresponding singular vectors to the singular values desired
- With only several of the singular values much of the data can be analyzed
- Data with no turbulence showed one singular value with significantly more influence
- Using one singular value mimics one degree of freedom so an image rendering would only distinguish brightness
- Confirmed as data with no turbulence is a laser shone directly into the camera with minimal interference from water movement

Future Applications

- Any Image Data



Arctic Ice

References

Images:

Singular Value Decomposition:
https://math.stackexchange.com/questions/243811/visualization-of-singular-value-decomposition-of-a-symmetric-matrix

Feynman Photos:
https://www.quora.com/What-is-an-intuitive-explanation-of-singular-value-decomposition-SVD

Lagrangian Coherent Structure:
http://shaddenlab.berkeley.edu/uploads/LCStutorial/index.html

Compressed Sensing and Dynamic Mode Decomposition:
https://www.youtube.com/watch?v=4tLSq_PEFms

Acknowledgements

Special thanks to Professors Malek-Madani and Avramov-Zamurovic for their assistance in the project.

For the board: MSC Graphics