Channel Islands
CALIFORNIA STATE UNIVERSITY

DECONVOLUTION AND ENHANCEMENT

PHYS/MATH/COMP 510 ADVANCED IMAGE ANALYSIS TECHNIQUES

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Outline

- Introduction
- Image Enhancement
- Image Deconvolution
- Conclusion
- References

INTRODUCTION

- Problems when a picture is taken:
  - Noise
  - Blur
  - Out of Focus
- Solution:
  - Image Deconvolution
  - Image Enhancement

WHAT IS IMAGE ENHANCEMENT

- Process of improving the quality of original image
- Sharpens image features
- Needed when:
  - Low light image
  - Low contrast image

LOW LIGHT IMAGE

LOW CONTRAST IMAGE

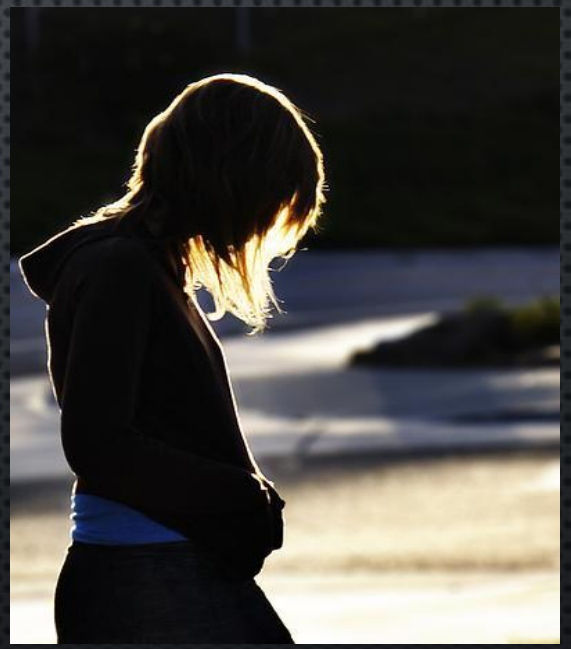
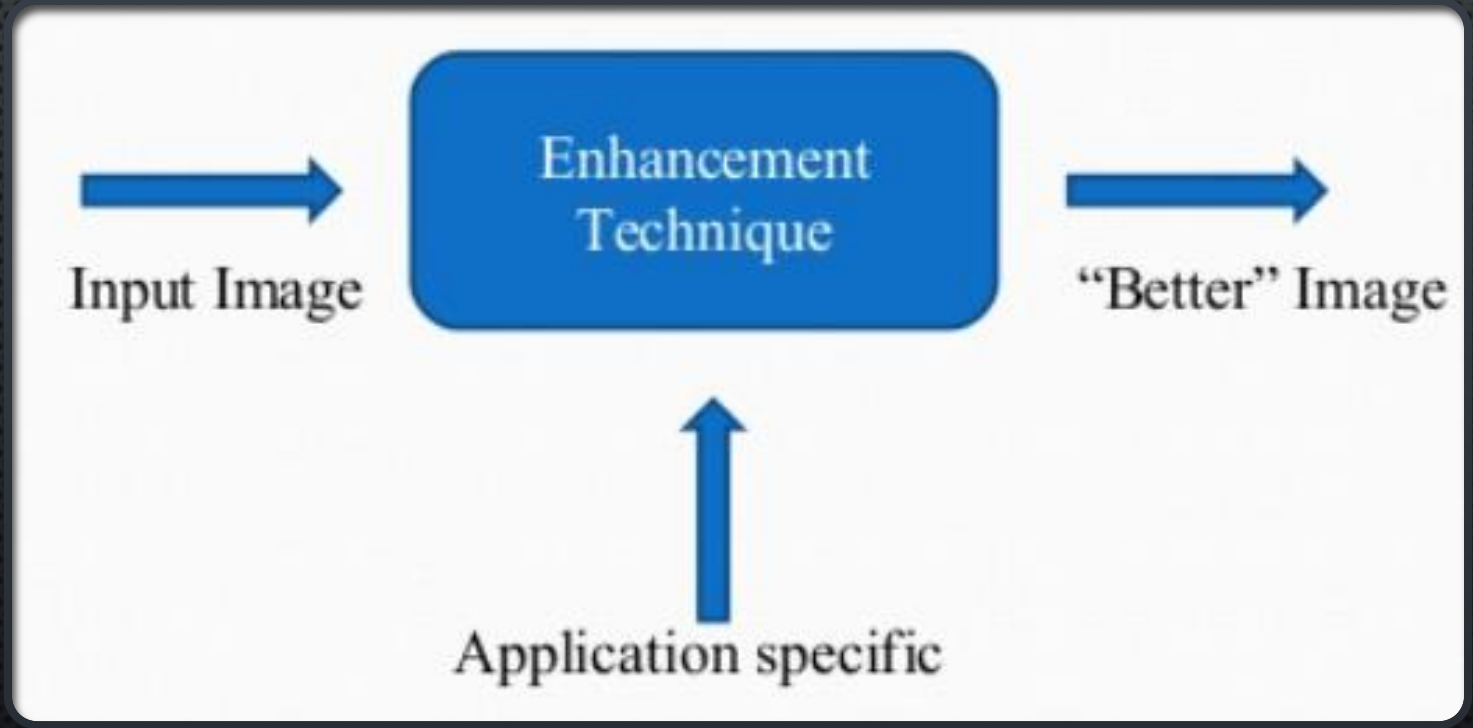


IMAGE ENHANCEMENT PROCESS



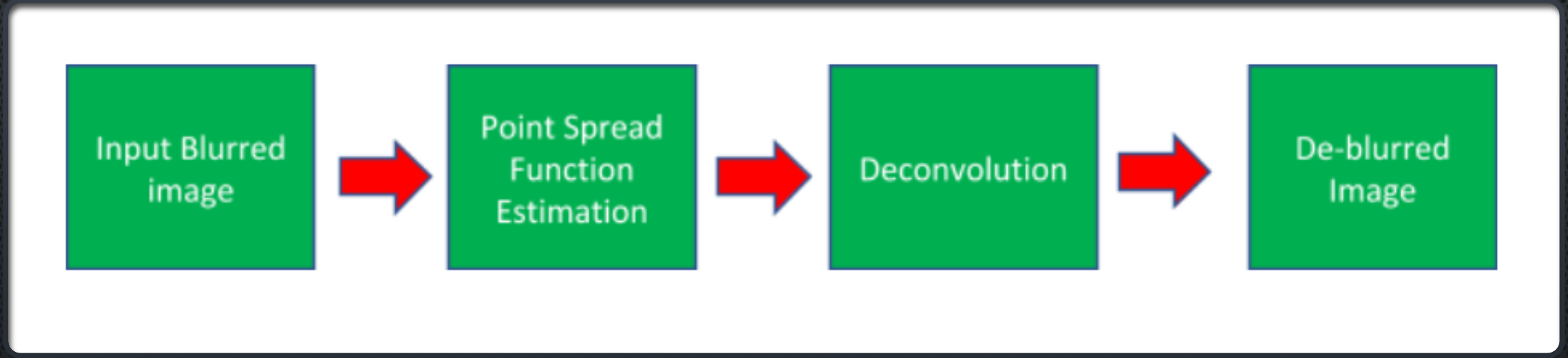
WHAT IS IMAGE DECONVOLUTION

- Process of reversing the optical distortion or degradation
- Motion deblur removes blur
- Reasons for blurry image:
  - Movement of the camera
  - Out-of-focus optical zoom
  - Short exposure time
  - Capturing image in Low light condition

MOTION BLUR

OUT OF FOCUS BLURRING

DEBLURRING PIPELINE



APPLICATIONS

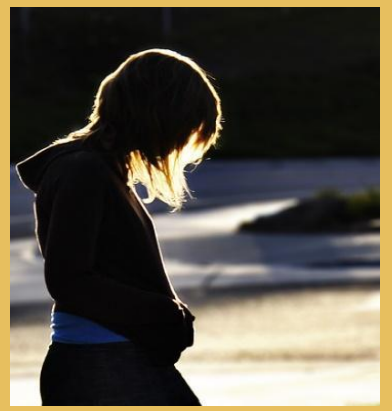
- Deep Learning Classification Pipeline
- Creation of Web Albums
- Forensic Work

RESULTS

IMAGE ENHANCEMENT

DARK TEST IMAGES

Given Images

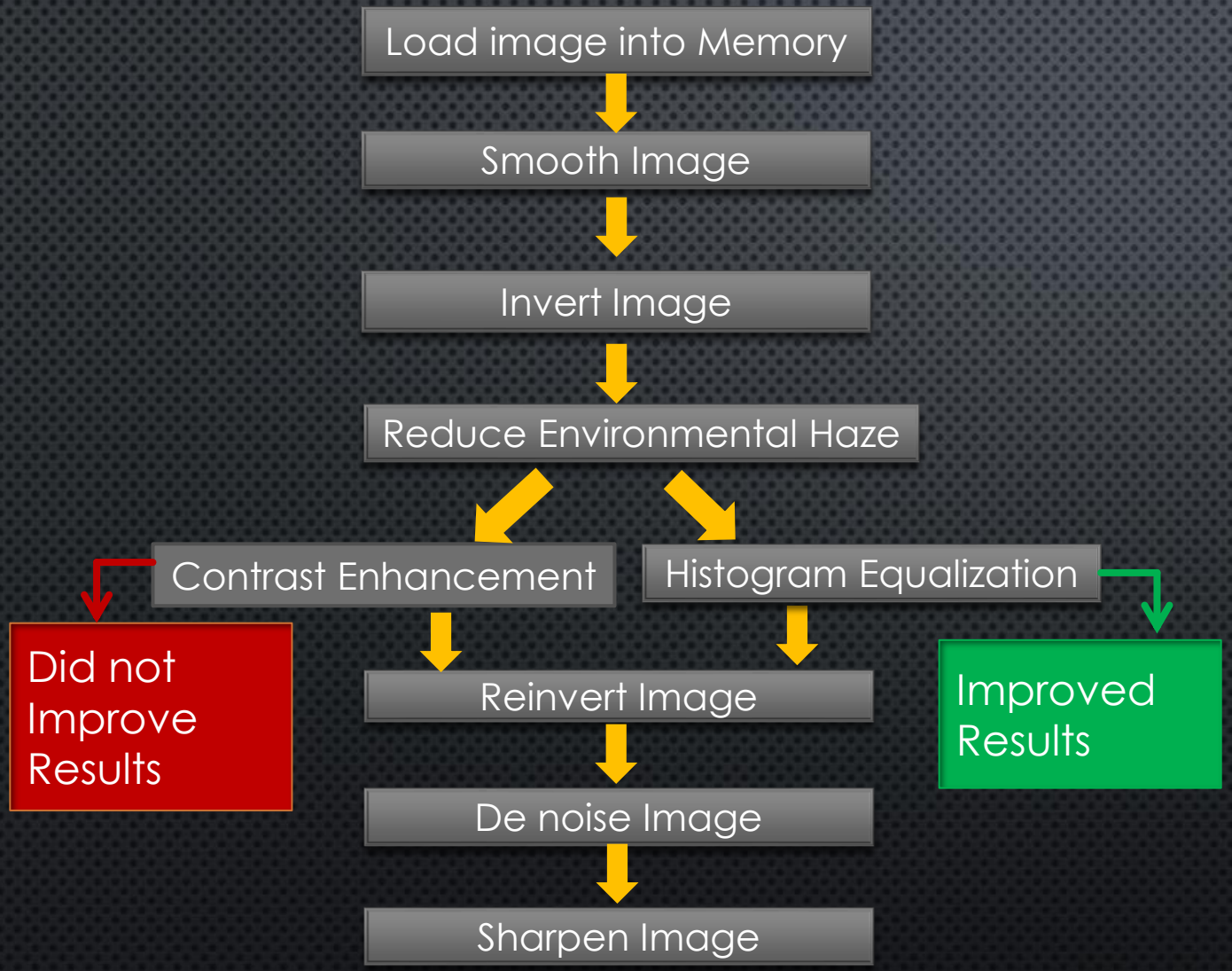


Additional Images

EVALUATED ALGORITHM

- Image Negative with Contrast Enhancement
- Image Negative with Histogram Equalization

IMAGE ENHANCEMENT ALGORITHM



Matlab Functions Used

- Imgaussfilt()
- Imcomplement()
- Imreducehaze()
- Imreducehaze('ContrastEnhancement','boost')
- histeq()
- Imguidedfilter()
- imsharpen()

Result set of Images with Contrast Enhancement

ENHANCED IMAGES WITH CONTRAST ENHANCEMENT

Original Enhanced

Original Enhanced

ENHANCED IMAGES WITH CONTRAST ENHANCEMENT

Original

Enhanced

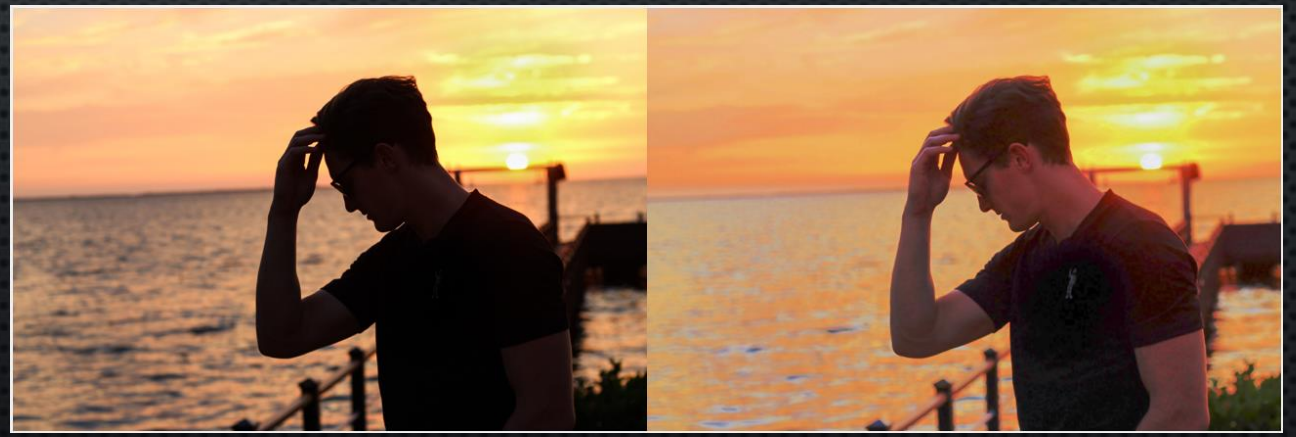
Original Enhanced

Result set of Images with Histogram Equalization

ENHANCED IMAGES WITH HISTOGRAM EQUALIZATION

Original Enhanced

Original Enhanced



ENHANCED IMAGES WITH HISTOGRAM EQUALIZATION

Original

Enhanced

Original

Enhanced

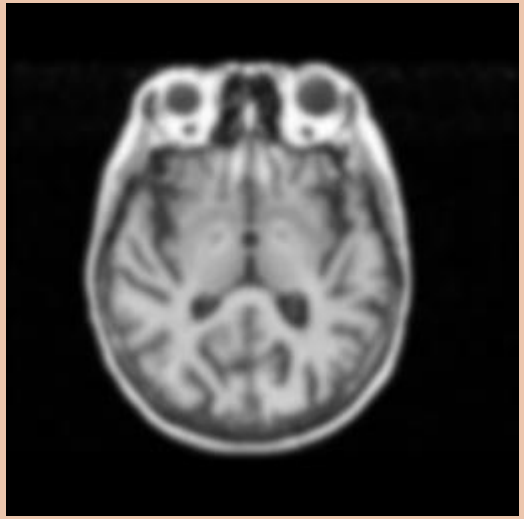
SUMMARY

- Investigated image negative with contrast enhancement and image negative with histogram equalization
- Single algorithm was developed using image negative & Histogram Equalization
- Image preprocessing using Gaussian filter worked better for some images
- Reduction of environmental haze and histogram equalization played a key role

RESULTS

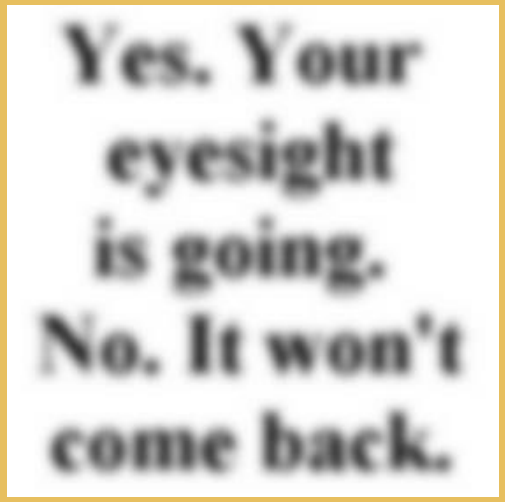
IMAGE DECONVOLUTION

BLURRED TEST IMAGES



Given Images

Additional Image



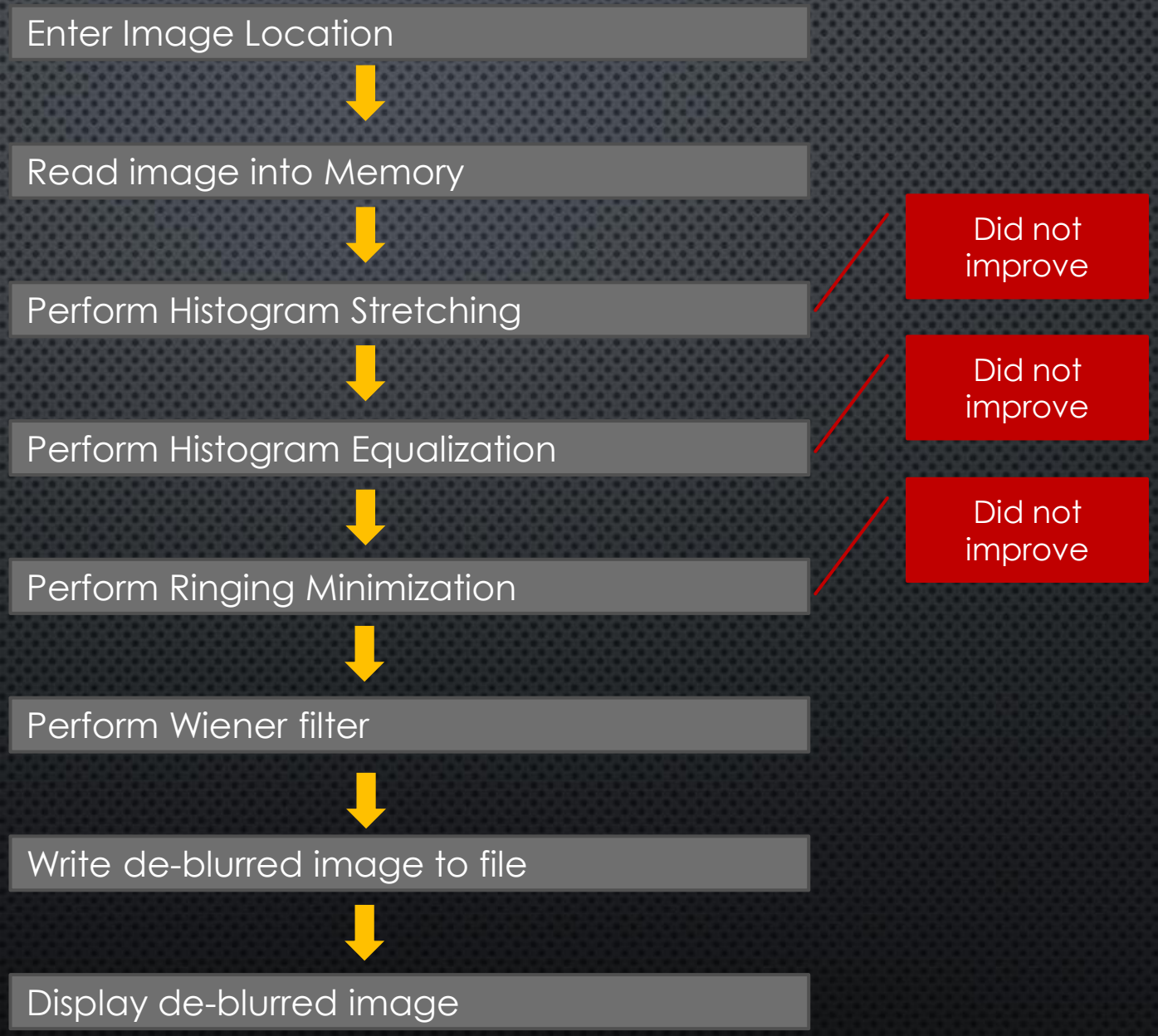
EVALUATED ALGORITHMS

- Wiener Filter
- Lucy Richardson
- Iterative Blind Deconvolution

EVALUATED ALGORITHMS

Wiener Filter Algorithm

ALGORITHM BASED ON WIENER FILTER



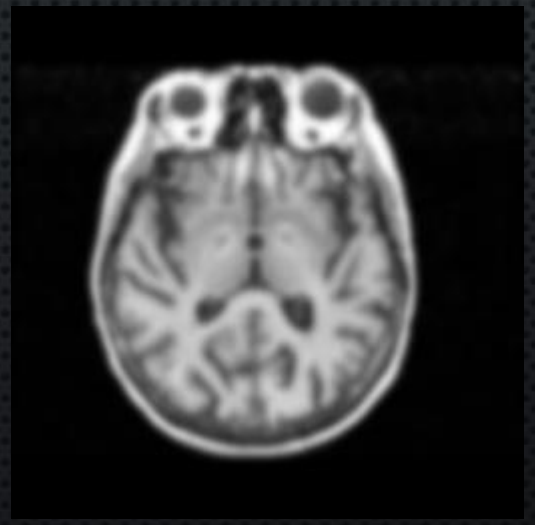
DE-BLURRED IMAGES

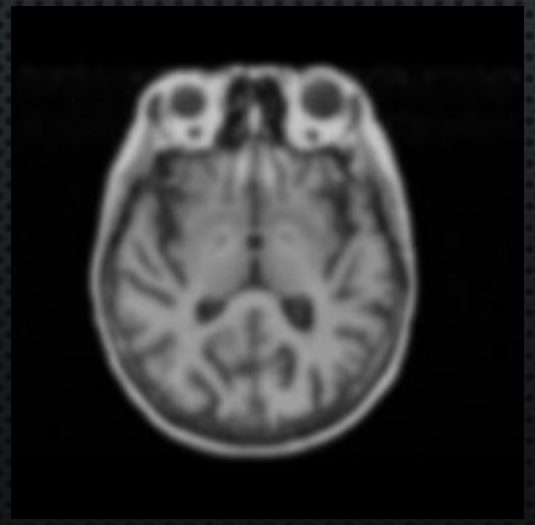
Blurred

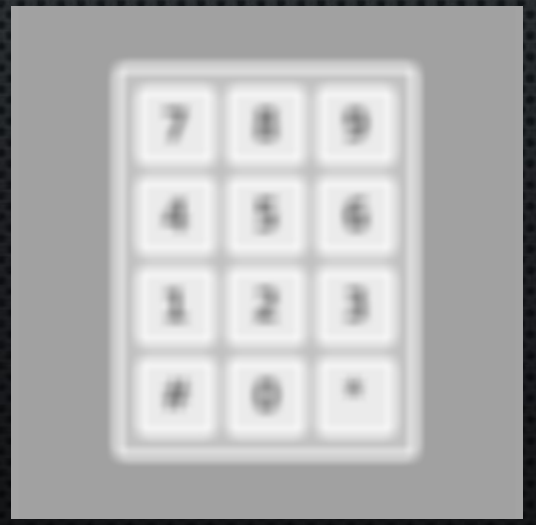
De-Blurred

Blurred

De-Blurred



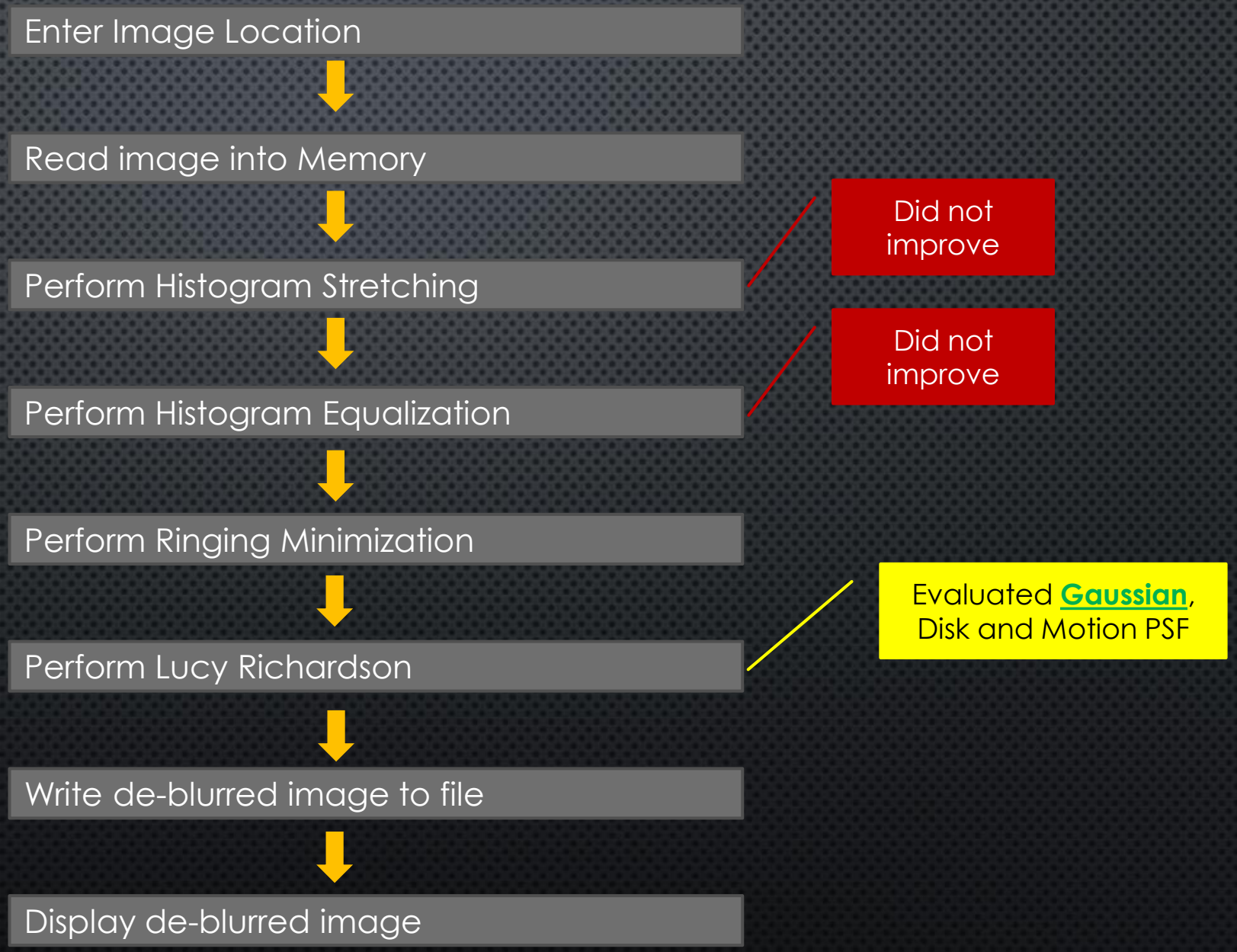




EVALUATED ALGORITHMS

Lucy Richardson Algorithm

ALGORITHM BASED ON LUCY RICHARDSON



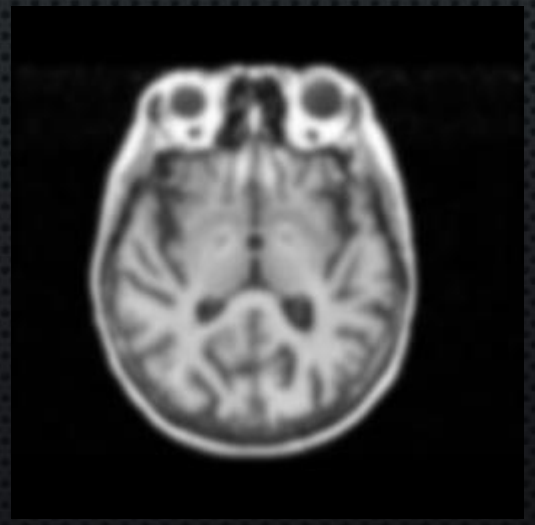
DE-BLURRED IMAGES

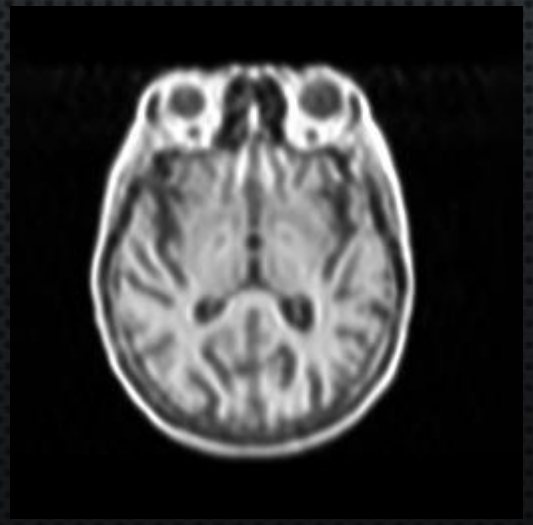
Blurred

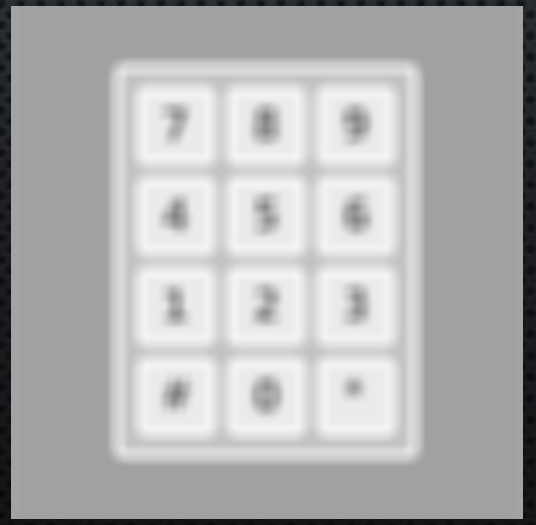
De-Blurred

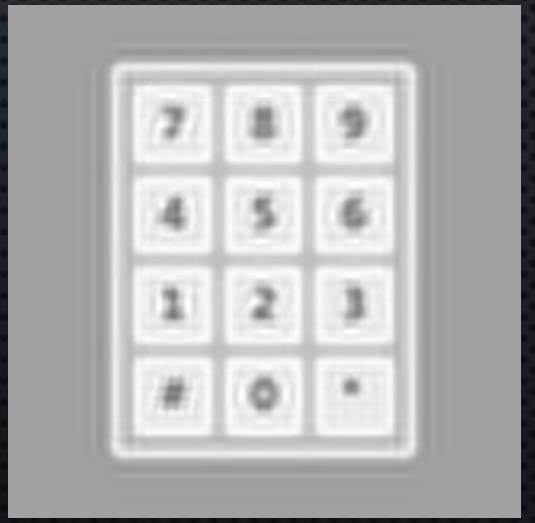
Blurred

De-Blurred





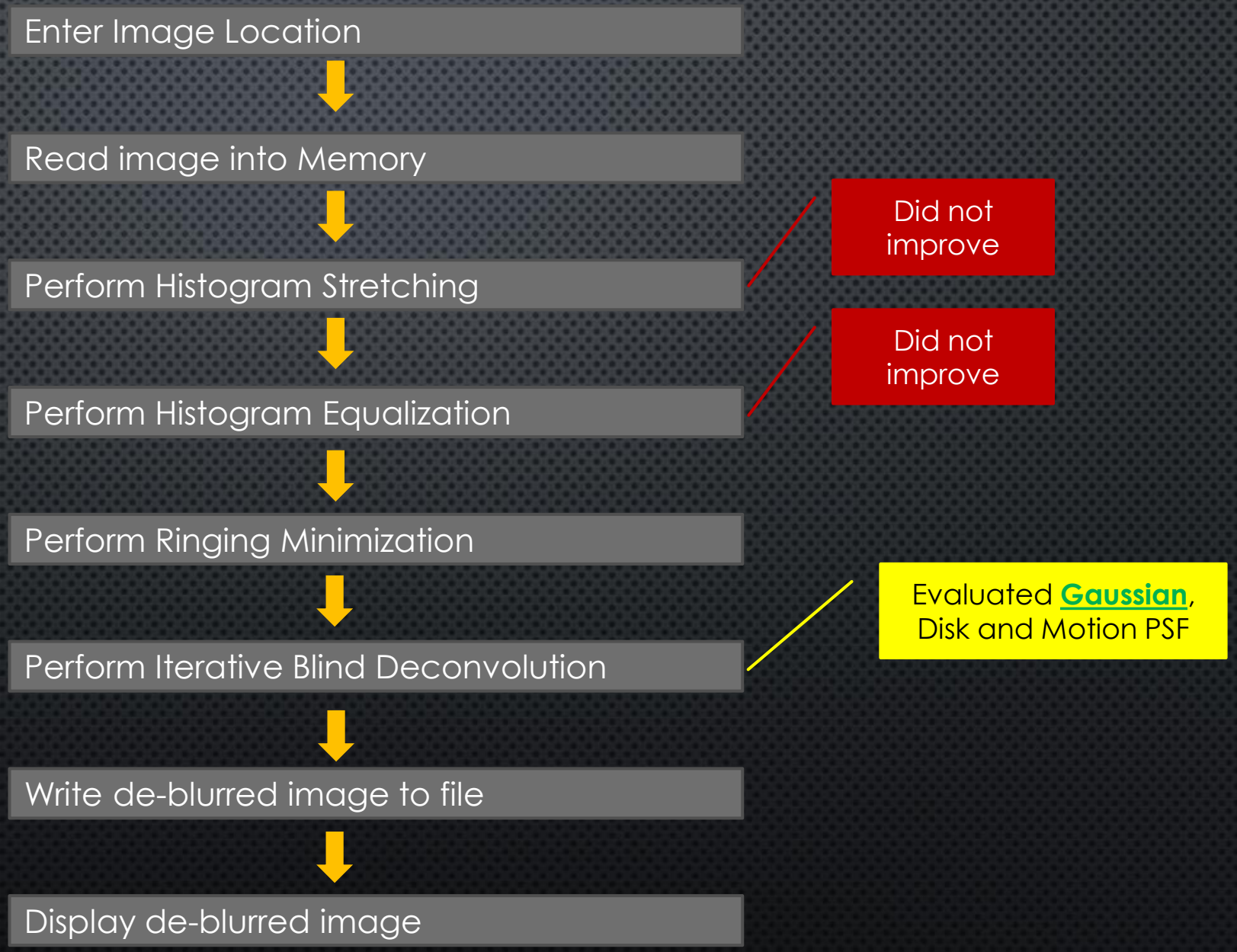




EVALUATED ALGORITHMS

Iterative Blind Deconvolution Algorithm

ALGORITHM BASED ON ITERATIVE BLIND DECONVOLUTION



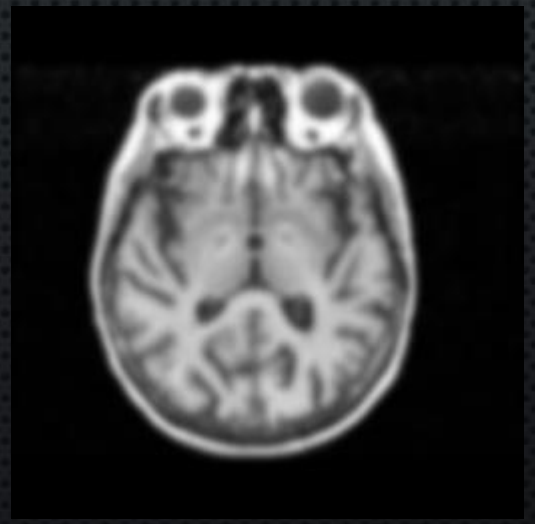
DE-BLURRED IMAGES

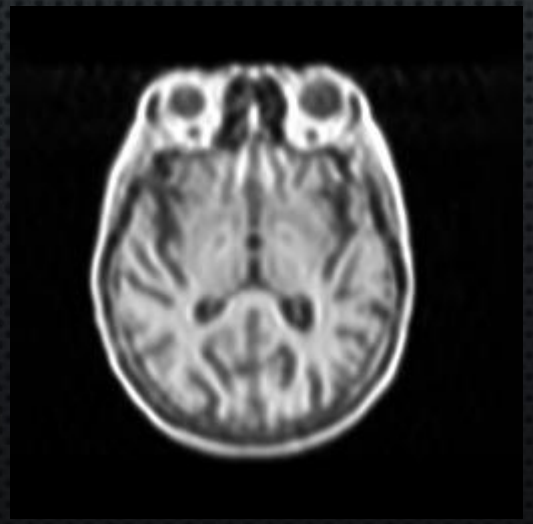
Blurred

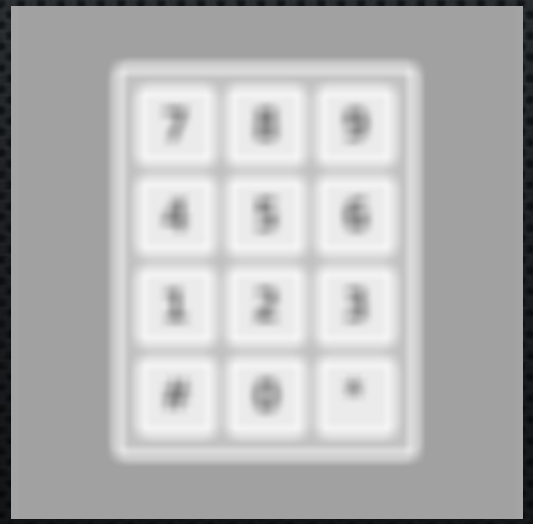
De-Blurred

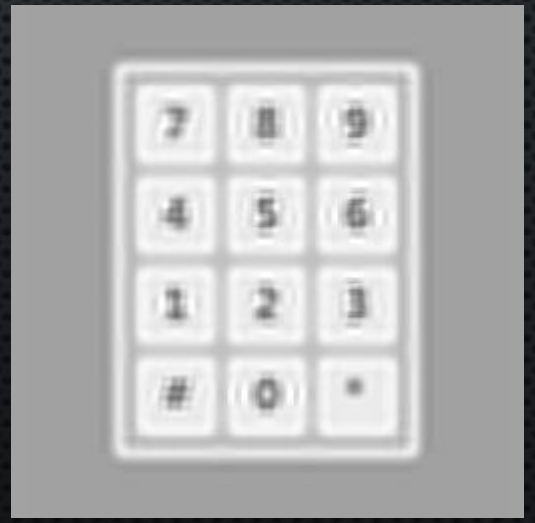
Blurred

De-Blurred





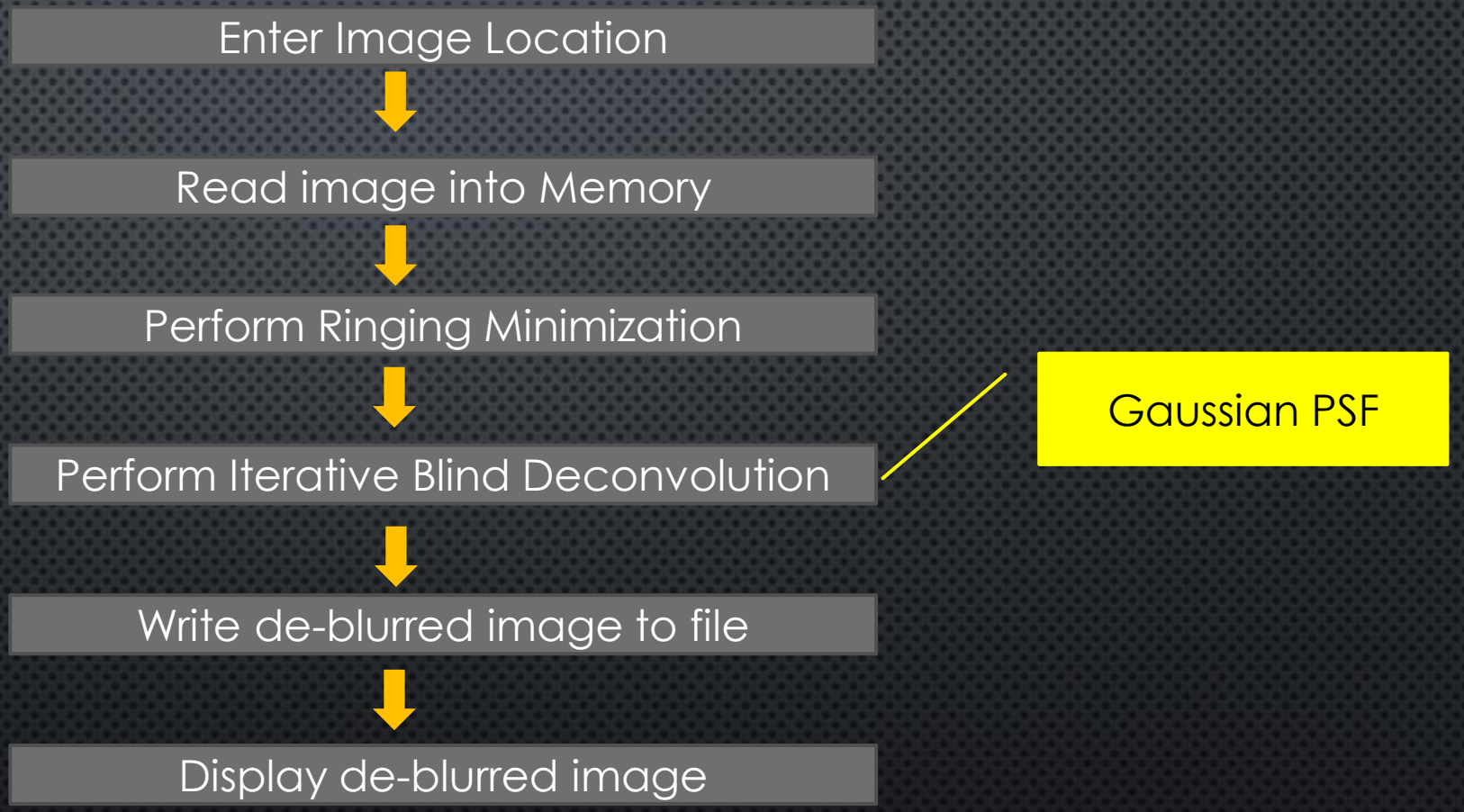




EVALUATED ALGORITHMS

Single Image De-Blur Algorithm

SINGLE ALGORITHM FOR DE-BLURRING



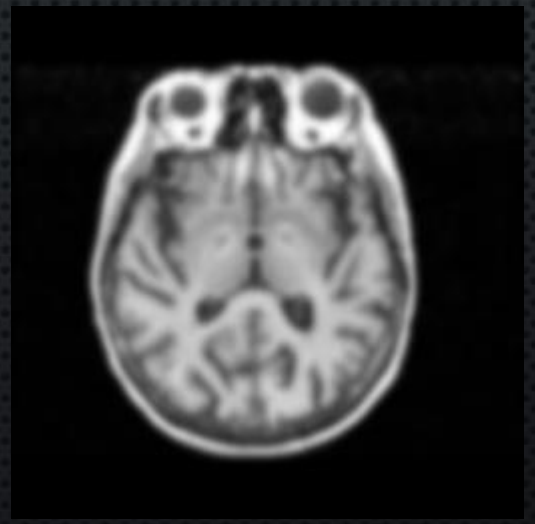
DE-BLURRED IMAGES

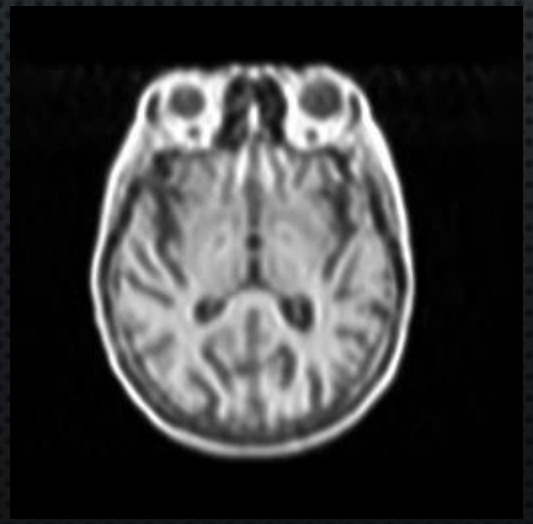
Blurred

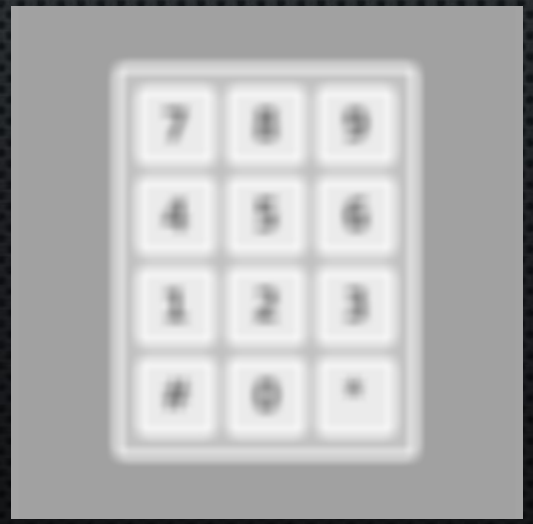
De-Blurred

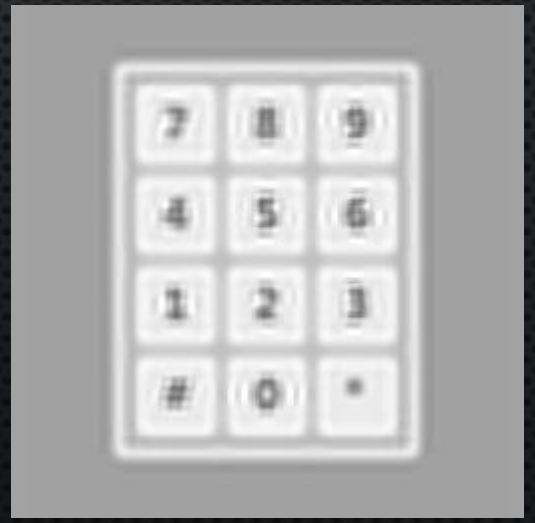
Blurred

De-Blurred



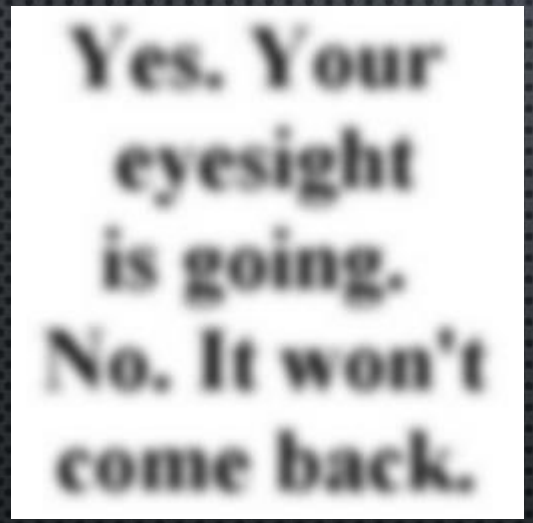




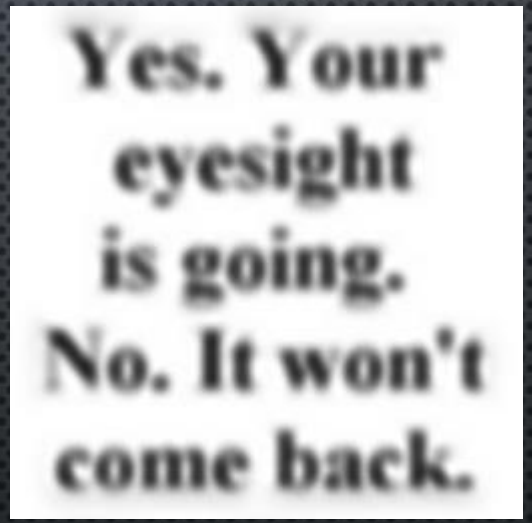


DE-BLURRED IMAGES

Blurred



De-Blurred



SUMMARY

- Investigated Wiener filter, Lucy Richardson and Iterative Blind deconvolution algorithms
- Single algorithm was developed using Iterative Blind deconvolution
- Number of Iterations played a key role
- Gaussian PSF performed better than Disk and Motion for initial guess PSF shape
- Image preprocessing with histogram equalization and/or histogram stretching worked better for some image only
- Image tapering function was used to minimize Ringing in the de-blurred images

STRETCH GOAL

De-Blur and Enhance Blurred and Low Contrast Image

DE-BLURRED AND ENHANCED IMAGE

Low Contrast Blurred

De-Blurred

Enhanced

Low Contrast Blurred

Enhanced

De-Blurred

CONCLUSION

- Challenging to recover an image degraded by motion blur and low contrast
- Achieved de-blurring and image enhancement using single algorithms developed
- Sequential order of application of image enhancement and then de-blurring worked well

REFERENCES

[1] Dougherty, G. (2014). *Digital image processing for medical applications*. Cambridge, UK: Cambridge University Press.

[2] Owlnet.rice.edu. (n.d). *Image Restoration*. [online] Available at: http://www.owlnet.rice.edu/~elec539/Projects99/BACH/proj2/intro.html

[3] Garg, G. (2015). Restoration of Motion Blurred Images using Non Blind Technique-A Review. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 3(V).

[4] Mathworks.com. (n.d.). *Image Enhancement*. [online] Available at: https://www.mathworks.com/discovery/image-enhancement.html.

THANK YOU