1. Introduction

\*No Deliverables\*

1. Image Fidelity Metrics

\*No Deliverables\*

1. Thresholding and Random Noise Binarization
2. The original image and the result of thresholding

A picture containing text, tree, outdoor, white

Description automatically generated

*Figure 1: Original house.tif Image*

*![A picture containing text, building

Description automatically generated]()*

*Figure 2: Thresholded house.tif Image*

1. The computed RMSE and fidelity values

|  |  |
| --- | --- |
| **RMSE** | **Fidelity** |
| 87.3933 | 77.3371 |

1. Code for *fidelity* function - \*See Next Page\*

Text

Description automatically generated

1. Ordered Dithering
2. The three Bayer index matrices of sizes 2 × 2, 4 × 4, and 8 × 8
3. The three halftoned images produced by the three dither patterns

A black and white photo of a city

Description automatically generated with low confidence

*Figure 3: 2×2 Bayer Ordered Dither Halftone of house.tif*

*A picture containing text, outdoor

Description automatically generated*

*Figure 4: 4×4 Bayer Ordered Dither Halftone of house.tif*

*A picture containing text, outdoor, mammal, horse

Description automatically generated*

*Figure 5: 8×8 Bayer Ordered Dither Halftone of house.tif*

1. The RMSE and fidelity of each of the three halftoned images

|  |  |  |
| --- | --- | --- |
| **Bayer Threshold Matrix Used** | **RMSE** | **Fidelity** |
| 2 × 2 | 97.6690 | 50.0569 |
| 4 × 4 | 101.0069 | 16.5583 |
| 8 × 8 | 100.9145 | 14.6918 |

1. Error Diffusion
2. Error Diffusion Python Code

\* See Next Page ↓ \*

1. Error Diffusion Result

A picture containing building

Description automatically generated

*Figure 6: Error Diffusion Halftone of house.tif*

1. RMSE and fidelity of the error diffusion result

|  |  |
| --- | --- |
| **RMSE** | **Fidelity** |
| 98.8471 | 13.4273 |

1. Tabulating the RMSE and fidelity results from the Lab

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Threshold** | **2×2 Bayer Dither** | **4×4 Bayer Dither** | **8×8 Bayer Dither** | **Error Diffusion** |
| **RMSE** | 87.3933 | 97.6690 | 101.0069 | 100.9145 | 98.8471 |
| **Fidelity** | 77.3371 | 50.0569 | 16.5583 | 14.6918 | 13.4273 |

Comments & Observations:

Between the different halftoning methods, the RMSE does not change significantly. In fact, as more sophisticated methods are used the RMSE increases slightly. The fidelity varies significantly between the different halftoning methods. The thresholded image has the largest fidelity, but its quality is not great and many features from the original image are not preserved. As the Bayer dither window size is increased or if error diffusion is used, the fidelity decreases. However, these results contain more distinguishable features and are more representative of the original grayscale image when viewed from a slight distance. It appears that RMSE is not an effective metric to measure perceived image quality using the human eye, and lower fidelity corresponds to better visual representation of the original grayscale image.