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Zongnan Bao - (zb3)
Han Chen - (hanc3)

CS445 Final Project Report

Focus Stacking

- **Motivation and Impact:**

- The motivation comes from our interests in photography as well as the usefulness of this technique used in photography. This tool can be widely used by photographers in post editings, and produces fairly good results. The topic is also a good hands-on experience of what we learned in the course, such as image alignment, laplacian pyramid and image reconstruction from the pyramid, etc.

- **Approach:**

- We divided the workflow into pipelines which can be more easily visualized. Also we approached two methods of focus stacking with different complexities, one being the simple maximum of Laplacian of Gaussian method, the other one is using laplacian pyramid decomposition and blending them using the techniques described in Wang and Chang's 2011 paper on [A Multi-focus Image Fusion Method Based on Laplacian Pyramid](#).

- **Workflow:**

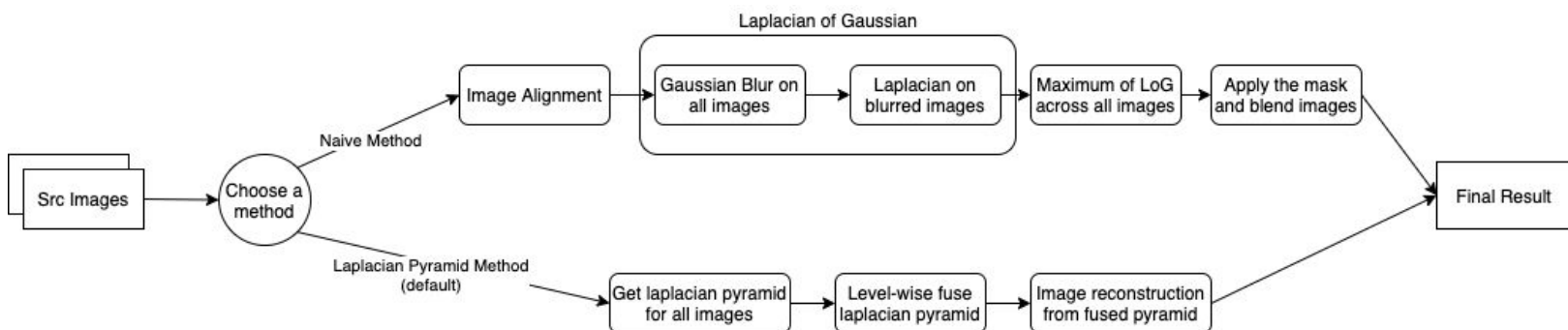


Figure 1. Overall workflow of the project

- **Results:**

- **test_img/test6 images:**

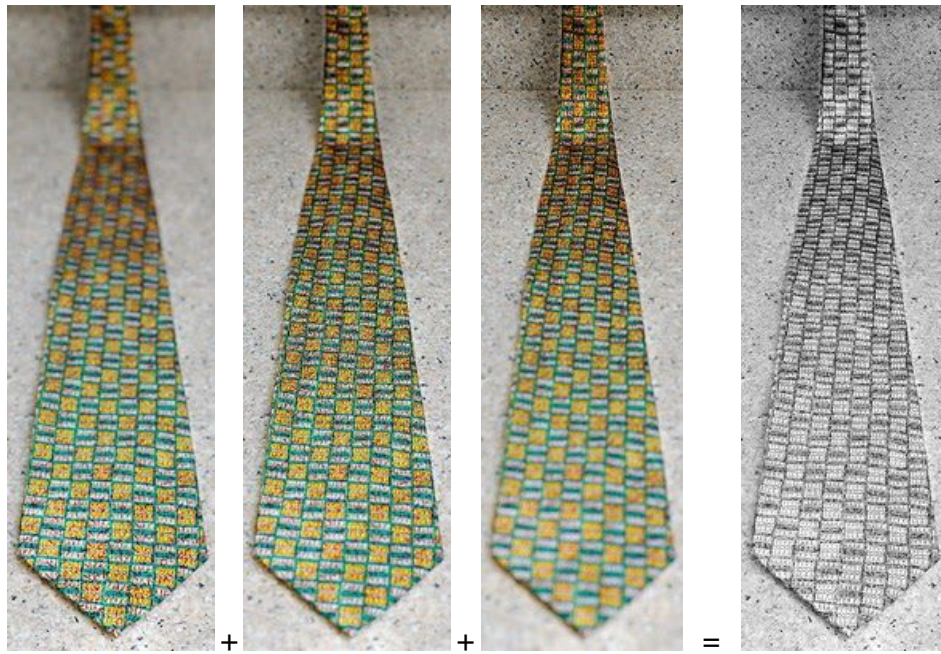


Figure 2. Source images of different depth of fields. (close, mid, far), and final result.

- Additional to visual result, we used standard deviation to evaluate the focusness(quality) of the final image, **higher is better**:

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	1st src img	2nd src img	3rd src img	Final result
Std deviation	43.3302	40.4064	41.2541	46.8988

- Maximum std deviation across source images = 43.3302
- Std deviation for final result image = 46.8988

- **Implementation Details:**

- We used Python as the programming language, and used Numpy, OpenCV and Matplotlib as external packages. We are guided by the paper [A Multi-focus Image Fusion Method Based on Laplacian Pyramid](#), and used some external code snippets such as deviation, entropy and energy function during pyramid fusion step. All external sources are cited in helper.py.

- **Challenge/Innovation:**

- The most challenging part of the project was to fuse the laplacian pyramids across all images and reconstruct the image from the fused laplacian pyramid. The

challenging part comes from that we need to understand the deviation and entropy of an image, and use those metrics to merge images to achieve the highest focusness. We borrowed ideas of deviation and entropy from the paper, and successfully produced a merged laplacian pyramid.

- Also the practical implementation of laplacian pyramids and image reconstruction from the laplacian pyramid was more difficult than the theories.
- Our innovation is to operate laplacian pyramid and reconstruction from a series of images instead of two images described in paper, also we set some optional arguments for the program so that you can tune the result using those arguments.

- **Sources:**

- Wang & Chang (2011), *[A Multi-focus Image Fusion Method Based on Laplacian Pyramid.](#)*
- [Test6 images source.](#)
- Some code snippets cited inside helper.py