PYRAMID BLENDING

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INTRODUCTION

Pyramid blending is a technique used in image processing to smoothly blend two images together. It involves creating a pyramid representation of the two images, with each layer of the pyramid representing a down sampled version of the original images. The pyramid is then combined using the blending function, which determines how the two images will be blended at each level of the pyramid. This allows for a smooth and gradual transition between the two images, resulting in a blended image that retains the features of both input images. Pyramid blending can be used for a variety of purposes, such as image stitching, super-resolution, and image composition.

ALGORITHM OUTLINE

1. **Alignment**

The foreground and background images are resized to the same square shape and aligned proportionately to each other so that the foreground patch falls on the same location mapped on the background image. first a black background image is generated of the same size as the target image, and then the "actual" small source image is placed at a proper location. The location can be manually aligned and tuned and then use as input argument for the function.

2. **Laplacian and Gaussian pyramids**

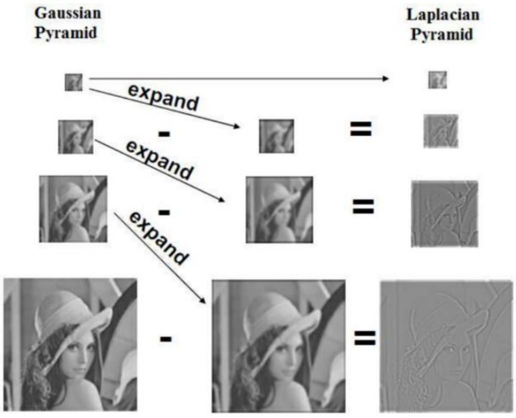


Figure 1 (Source: Design of FIR Filters for Fast Multiscale Directional Filter Banks DOI:10.14257/ijunesst.2014.7.5.20)

A Laplacian Pyramid is a direct invertible picture portrayal comprising of a bunch of band-pass pictures, divided an octave separated, in addition to a low-recurrence lingering. Officially, let $d(.)$ be a down-sampling function which obscures and decimates a $j*j$ picture I, with the goal that $d(I)$ is another picture of size $j/2*j/2$. Likewise, let $u(.)$ be an up-sampling operator which smooths and grows I to be two times the size, so $u(I)$ is another picture of size $2j*2j$. We first form a Gaussian pyramid, $G(I) = [I_0, I_1, \ldots, I_K]$ where $I_0 = I$ and I_K is k rehashed uses of $d(.)$ to

I. K is the quantity of levels in the pyramid, chose so the last level has tiny spatial degree $(\leq 8*8$ $pixels)$.

The coefficients h_k each level k of the Laplacian pyramid $L(I)$ are developed by taking the contrast between contiguous levels in the Gaussian pyramid, up-sampling the more modest one with *u(.)* so the sizes are viable:

$$h_k=L_k(I)=G_k(I)-u(G_{k+1}(I))=I_k-u(I_{k+1})$$

Naturally, each level catches picture structure present at a specific scale. The last level of the Laplacian pyramid h_k isn't a distinct picture but a residual equivalent to the last Gaussian pyramid level, i.e. $hk=I_K$. Recreation from a Laplacian pyramid coefficients $[h1,..., hk]$ is performed utilizing the retrogressive repeat:

$$I_k=u(I_{k+1})+h_k$$

which is begun with $I_K = h_k$ and the reproduced picture being $I=I_0$. As such, beginning at the coarsest level, we over and over up-sample and add the distinction picture h at the following better level until we return to the full goal picture.

3. Laplacian Blending

Laplacian blending is a technique used in image processing to smoothly blend two images together. It involves creating a Laplacian pyramid representation of the two images, with each layer of the pyramid representing the detailed content of the image at a particular scale. The pyramid is then combined using the blending function, which determines how the two images will be blended together at each level of the pyramid. This allows for a smooth and gradual transition between the two images, resulting in a blended image that retains the features of both input images.

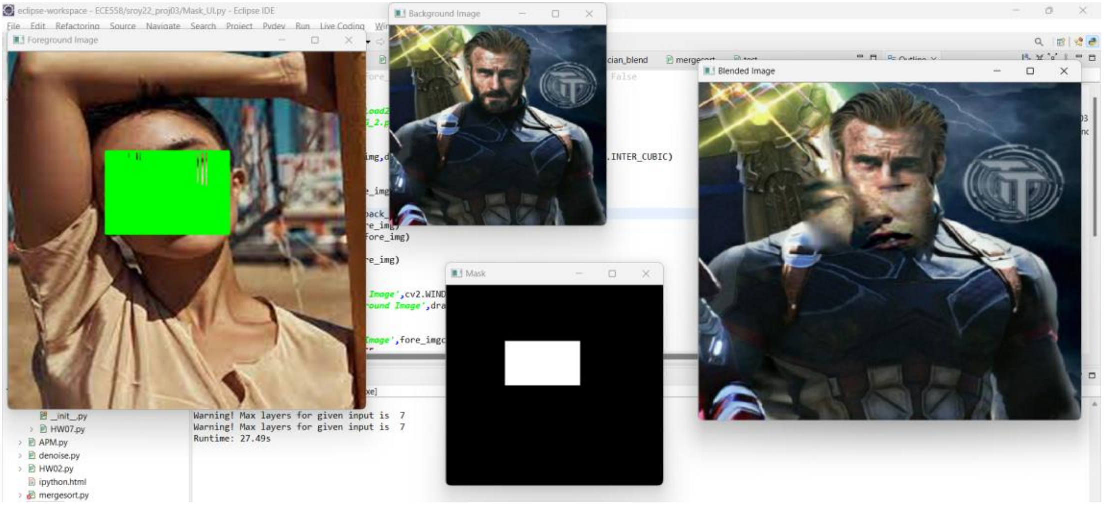
To create a Laplacian pyramid, the original images are first down-sampled using a Gaussian pyramid. This involves repeatedly applying a Gaussian blur and down-sampling the image at each step, until a pyramid of down-sampled images is obtained. The Laplacian pyramid is then constructed by taking the difference between each level of the Gaussian pyramid and the up-sampled version of the next level. This results in a pyramid of difference images, with each level representing the detailed content of the image at a particular scale.

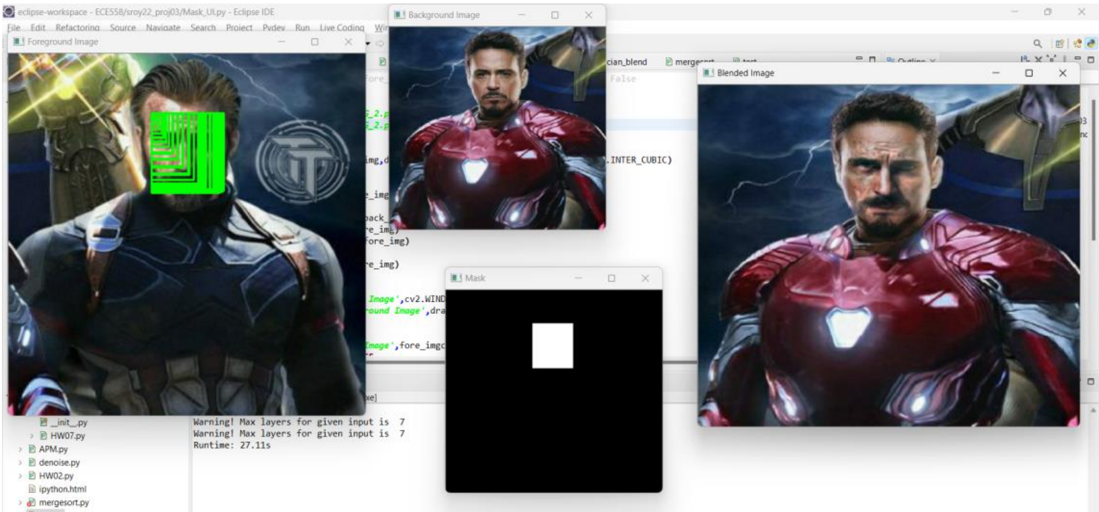
Once the Laplacian pyramids have been created for both input images, they are combined using the blending function. This function determines how the two images will be blended together at each level of the pyramid. The blended pyramid is then reconstructed to create the final blended image.

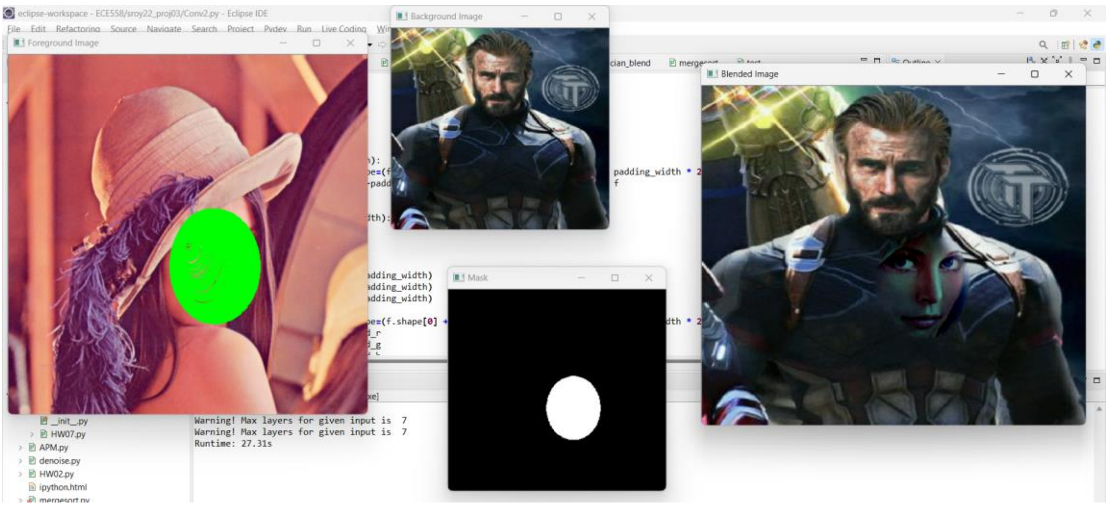
Laplacian blending allows for a smooth and gradual transition between the two input images, and is often used for tasks such as image stitching, super-resolution, and image composition.

RESULTS

Foreground Image, Background Image, Binary Mask, Blended Image and Runtimes for various cases

- 

- 

- 

It is observed that runtime is constant and depends on the implementation of the convolution function.

LIBRARIES USED

numpy, opencv, time

FOLDER STRUCTURE

```
PS C:\Software\eclipse\eclipse-workspace\ECE558\sroy22_proj03> tree /f
Folder PATH listing for volume OS
Volume serial number is 1CDA-0251
C:.
│   ComputePyr.py
│   Conv2.py
│   Laplacian_blend.py
│   lena.png
│   Mask_UI.py
│   P3_BG_2.png
│   P3_FG_2.png
│   __init__.py
│
└───__pycache__
        ComputePyr.cpython-38.pyc
        Conv2.cpython-38.pyc
        Laplacian_blend.cpython-38.pyc
        __init__.cpython-38.pyc

PS C:\Software\eclipse\eclipse-workspace\ECE558\sroy22_proj03>
```