DIP Project

AnshuL Lahoti(20161183)

Rohan Maheshwari(20161017)

Professor - Mr. Ravi Kiran

Mentor - Ashwin Pathak

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Image Replacement Through Texture synthesis

Problem Statement

Photographs and images often have regions which are in some sense flawed. Often, there may be a stain or an undesired feature covering a significant portion of the image. Our task to remove an undesired feature or object from photographs and images by replacing them with the best possible background match.

What is Texture Synthesis?

Texture synthesis is the process of constructing a large image from a small digital sample image by taking advantage of its structural content. The

output is the synthesised image that match the texture appearance of the given digitized image.

Motivation

Texture synthesis has a variety of applications in computer vision, graphics, and image processing. General techniques for Texture mapping - repeating the texture.

1. Can lead to unacceptable artifacts in visible seams , visible repetition.

2. Distortion in map to 3-D – often no natural map from planar texture image to the geometry/ topology of the surface. (There are some partial solutions , but no universal solution for mapping an image onto arbitrarily shaped surface.)

3. Create (paint) textures by hand directly onto the 3-d surface model very labor intensive. And Requires considerable artistic skills.

4. Computer-synthesized textures as much texture can generated as needed. Some of the synthesis techniques produce textures that tile seamlessly.

Overview

Photographs and images often have regions which are in some sense flawed. At times, the flaw is due to a minute artifact: there may bescratches on the image, or perhaps a visible special effects wire. Fast interactive techniques exist for removing this type of small-scale noise. At other times, the flaw is present in a large region of the image: there may be a stain on the photograph, or some unsightly object may be present in the scene. One simplistic approach is to copy and blend in a similar region from somewhere else in the image. This approach has two major drawbacks. First, visible repetition may appear when a small region is used to fill a large stain. Second, the compositing of the replacement region with the areas surrounding the stain may lead to visible boundaries even with the use of multi-resolution Compositing techniques.

We used an approach that utilizes synthetic textures for image replacement. This approach in different algorithm, has several advantages. Since synthetic textures may be created with arbitrary size, repetition artifacts are avoided.

Furthermore, by integrating a composition step into our texture synthesis algorithm, boundary problems are .reduced

Approaches

Pyramid generation :-

There are two main types of pyramids: lowpass and bandpass.

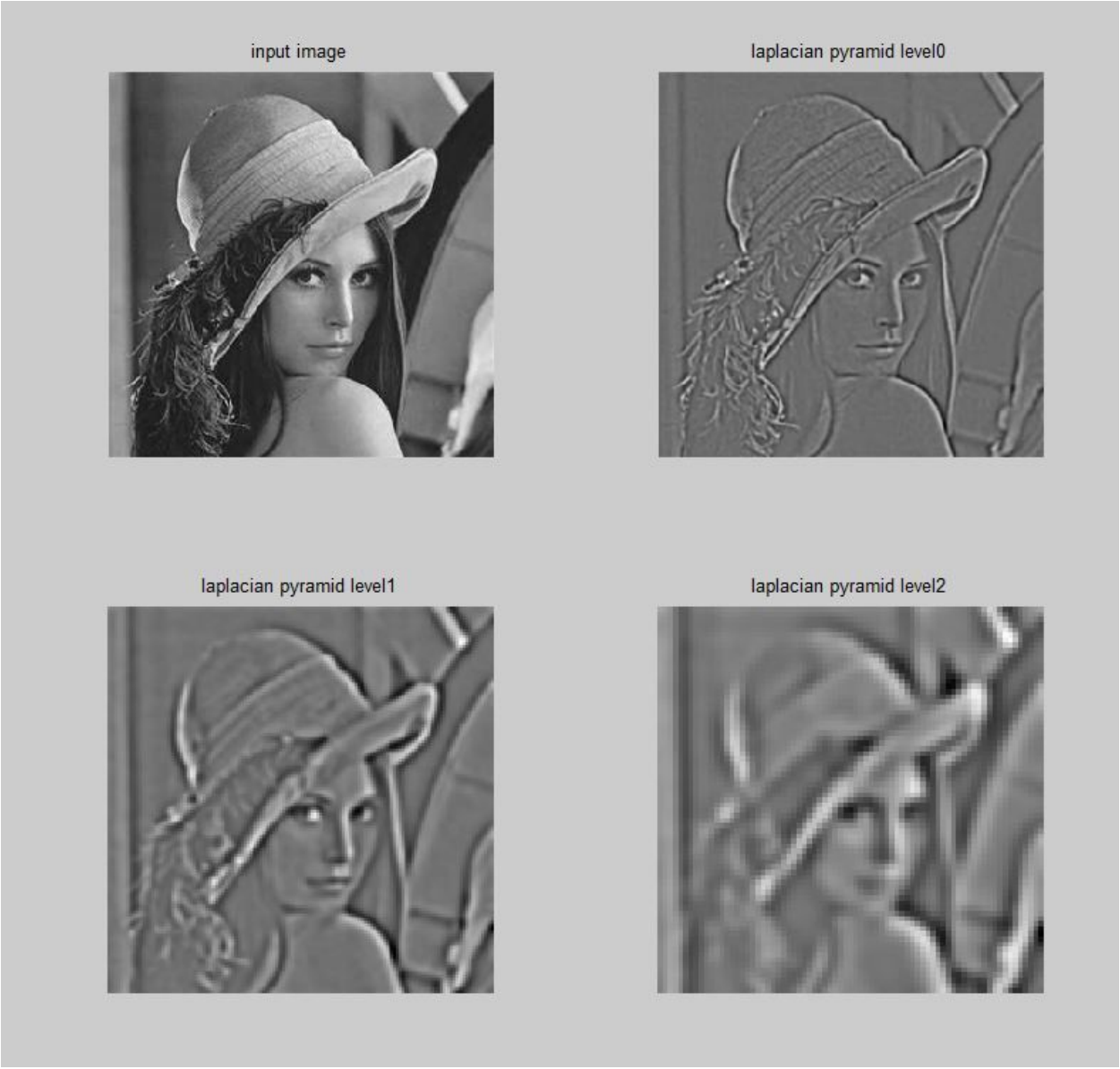
A lowpass pyramid is made by smoothing the image with an appropriate smoothing filter and then subsampling the smoothed image, usually by a factor of 2 along each coordinate direction. The resulting image is then subjected to the same procedure, and the cycle is repeated multiple times. Each cycle of this process results in a smaller image with increased smoothing, but with decreased spatial sampling density (that is, decreased image resolution). If illustrated graphically, the entire multi-scale representation will look like a pyramid, with the original image on the bottom and each cycle resulting smaller image stacked one atop the other.

A bandpass pyramid is made by forming the difference between images at adjacent levels in the pyramid and performing some kind of image interpolation

between adjacent levels of resolution, to enable computation of pixel wise differences.

Gaussian Pyramid

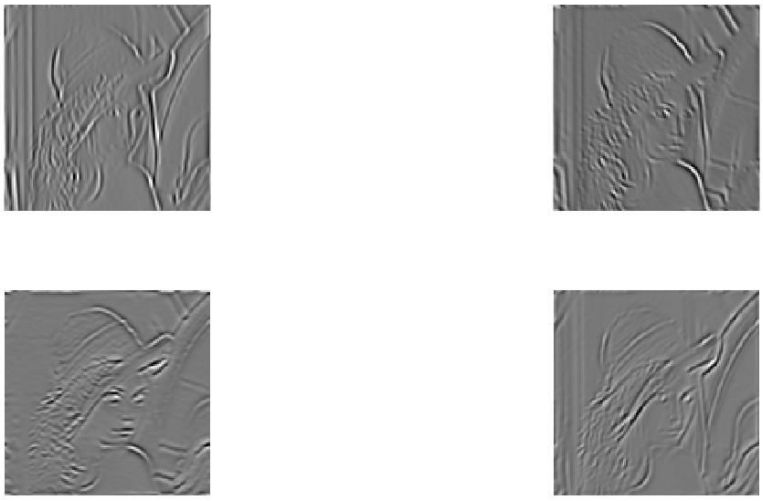
Laplacian Pyramid



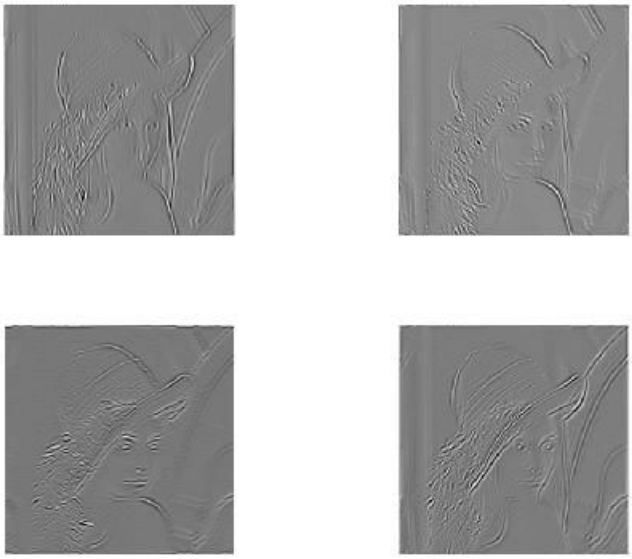
Steerable Pyramid

The Steerable Pyramid is a linear multi-scale, multi-orientation image decomposition that provides a useful front-end for image-processing and computer vision applications.

Orientations for Level 1



Orientations for level 2



Orientations for level 3

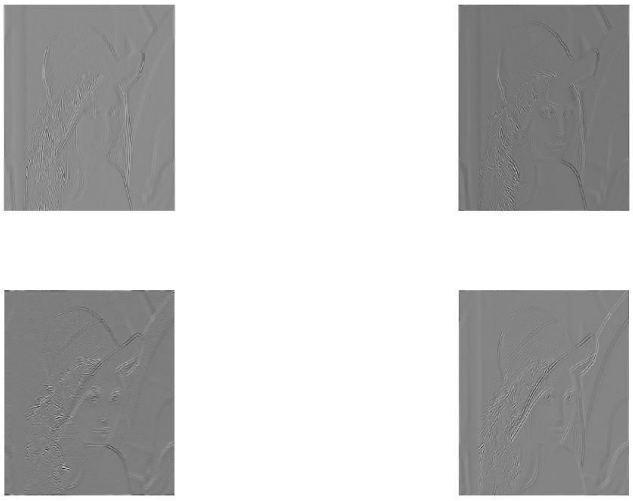
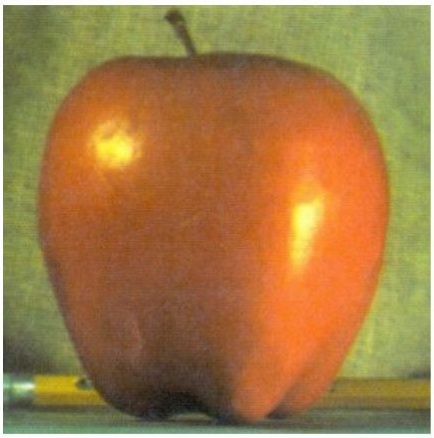


Image Blending

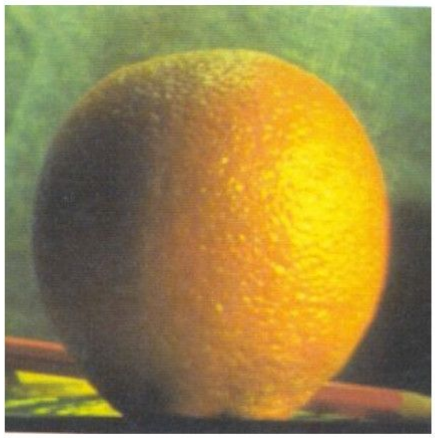
Laplacian Pyramid: Blending

General Approach:

1. Build Laplacian pyramids *LA* and *LB* from images *A* and *B*
2. Build a Gaussian pyramid *GR* from selected mask region ***M***
3. Form a combined pyramid *LS* from *LA* and *LB* using nodes of *GR* as weights:
   - *LS(i,j) = GM(I,j,)*LA(I,j) + (1-GM(I,j))*LB(I,j)*
4. Collapse the *LS* pyramid to get the final blended image



apple1.jpg



orange1.jpg

mask512.jpg

blended.jpg

Work Performed

We use Heeger and Bergen algorithm for texture synthesis:-

Heeger & Bergen :-

Original: Feature we want to replace

Target: Reference for synthesis

Noise: It will be converted to Required texture

Mask: To reduce artifacts

Algorithm

1.Noise = Match Histogram of Noise and Target

2. Noise = Blend Noise and Original image using suitable mask

3. Pyramid_Target = Make Pyramid of target

4. Loop

    a. Pyramid_Noise = Make Pyramid of noise

    b. Match Histogram at every level and put in Pyramid_Noise

c. Noise = Collapse Pyramid_Noise (expand and add)

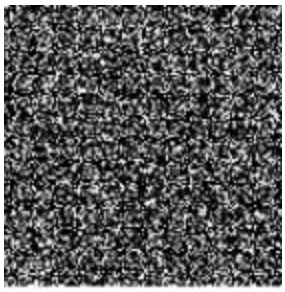
d. Noise = Match Histogram of Noise and Target

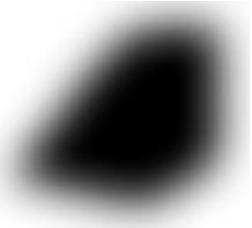
e. Noise = Blend Noise and Original image using same mask.

Results

Input image

Noise Target Original Mask



Output image

Input Image

Noise Original Mask Target

Output Image

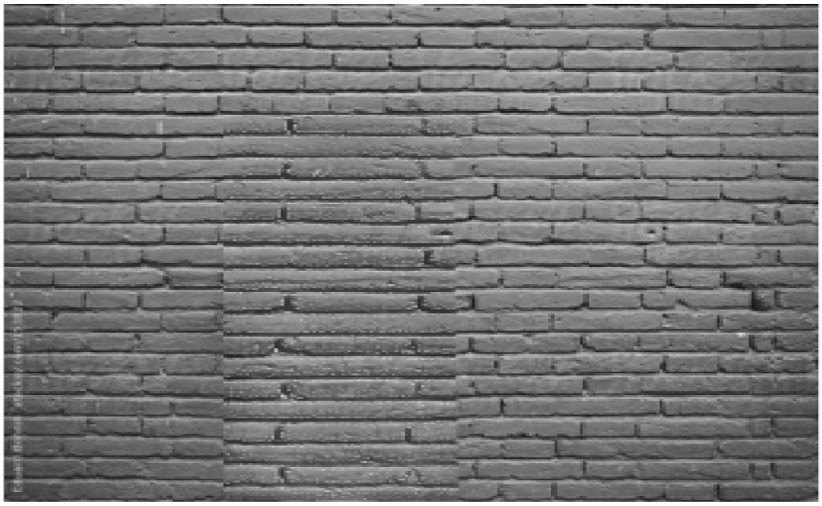
Limitations:

Does not work well on deterministic textures

Deterministic Textures: Characterized by set of primitive and a placement rule

E.g. Brick wall, Floor Tiles

Input Image



Output Image

Github Link :

https://github.com/rohan750/ImageReplacement

Work Division :

Anshul Lahoti	For blending (blend.m ,blendpyramid.m), Pyramid Matching (matchpyramid.m), steerable pyramid ,replace texture .
Rohan Maheshwari	Pyramids construction (gaussian pyramid , laplacian pyramid , steerable pyramid) , Heeger bergen implementation(maketexture.m), mask formation.

Acknowledge:

https://github.com/LabForComputationalVision/matlabPyrTools?fbclid=IwAR2Ny7G4TWCSynRXHqvTwjxPxs01BWt5Rl_X8HZiq3lXXaDv-1B_r0sNvLY