CV PROJECT REPORT

A BRIEF DISCUSSION ON HYBRID IMAGE

MAHENDRA NANDI

AND

SOURAV KARMAKAR

Guided By - **BR. TAMAL MAHARAJ**

MSc. COURSE ON BIG DATA ANALYTICS

Department of COMPUTER SCIENCE

Ramakrishna Mission Vivekananda Educational Research Institute, BELUR

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ABSTRACT

Hybrid images are based on the multiscale processing of images by the human visual system and are motivated by masking studies in visual perception. These images can be used to create compelling displays in which the image appears to change as the viewing distance changes. We show that by taking into account perceptual grouping mechanisms it is possible to build compelling hybrid images with stable percepts at each distance. We show examples in which hybrid images are used to create textures that become visible only when seen up-close, to generate facial expressions whose interpretation changes with viewing distance, and to visualize changes over time within a single picture.

Contents

0.1 Concepts as prerequisites

0.1.1 What Is Hybrid Image?

Hybrid images are a form of illusion which relates to perspective of human vision . Perspectives are created using a high pass filter which captures the prominent version of the image and another by passing low low pass filter which is a blurry version of the image. Adding the high and low frequencies together gives us the hybrid image. Hybrid images are static images that change in interpretation as a function of the viewing distance. The basic idea is that high frequency tends to dominate perception when it is available, but, at a distance, only the low frequency (smooth) part of the signal can be seen. By blending the high frequency portion of one image with the low-frequency portion of another, you get a hybrid image that leads to different interpretations at different distances.

0.1.2 Correlation of Image

Correlation of an image is defined by adding each pixel to its neighbouring pixels weighted by the kernel. It is slighlty different from matrix multiplication.
General form of correlation is given by:

$$G[i,j] = \sum_{u=-k}^{k} \sum_{v=-k}^{k} H[u,v] * F[i+u, j+v]$$

Here is an example of the correlation with a 3x3 kernel.

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} * \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} = (1*a)+(2*b)+(3*c)+(4*d)+(5*e)+(6*f)+(7*g)+(8*h)+(9*i)$$

0.1.3 Low-pass and High-pass filters

Low-pass filter: A low-pass filter reduce the effect of signals with frequencies higher than a cutoff frequency and passes signals with a frequency lower than the cutoff frequency.

High-pass filter: A high-pass filter reduce the effect of signals with frequencies lower than a cutoff frequency and passes signals with a frequency higher than a certain cutoff frequency.

0.1.4 Gaussian Blur

Mathematically applying Gaussian Blur in an image is same as applying convolution to the image with a gaussian function. In two dimensions, Gaussian function is the product of two such Gaussian functions, one in each dimension:

$$G(x,y) = e^{-\frac{x^2+y^2}{2\sigma^2}} \frac{1}{2\pi\sigma^2}$$

where x is the distance from the origin in the horizontal axis, y is the distance from the origin in the vertical axis, and σ is the standard deviation of the Gaussian distribution.

This is how a 3x3 Gaussian Kernel looks like: $\begin{bmatrix} \frac{1}{16} & \frac{2}{16} & \frac{1}{16} \\ \frac{2}{16} & \frac{4}{16} & \frac{2}{16} \\ \frac{1}{16} & \frac{2}{16} & \frac{1}{16} \end{bmatrix}$

The center element (2,2) has the largest value, decreasing symmetrically as distance from the center increases.

Since the Fourier transform of a Gaussian is another Gaussian, applying a Gaussian blur has the effect of reducing the image's high-frequency components; a Gaussian blur is thus a low pass filter.

0.2 Project Work

0.2.1 Construction of the filtering function

ALGORITHM:

step I: We use the function, which takes both image and a filter and returns the filtered image.
step II: We import an image of (m,n,c) and a filter of (k,k).
step III: We check that both dimension of the filter are odd.
step IV: We padded the matrix with reflect mode.
step V: We filter the image by applying convolution with each pixel.

Construction of the hybrid image function

ALGORITHM:

step I: We use the function which takes two image and a filter.
step II: We construct a low frequency image by passing the image through a low-pass filter.
step III: We construct a high frequency image by removing low-pass components from the image.
step IV: We construct a hybrid image by adding with same weightage from both the images.

0.2.2 Applying the filter

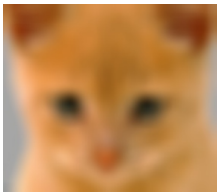
Different filters are implemented with the filter function that we have created.

Filtering with identity filter

Figure 1: Original image

Filtering with box filter

Figure 2: Blurred Image

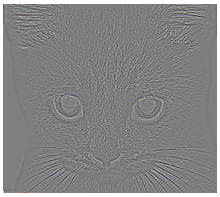


Filtering with gaussian kernel

Figure 3: Heavily blurred image

Filtering with sobel filter

Figure 4: sharpened Image



Filtering with laplacian filter.

Figure 5: sharpened Image

Removed blurred part from the image

Figure 6: sharpened Image

0.2.3 Hybrid Image Creation of Cat and Dog

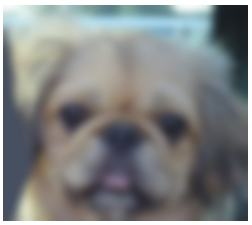


Figure 7: Low-pass image of dog

Figure 8: High-pass image of Cat

Combining these two imagees with same weight.

Figure 9: Hybrid image of Cat and Dog

Image pyramid will help us to see the hybrid image from different perspective.

Figure 10: Image Pyramid of the Hybrid Image

0.2.4 Hybrid Image Creation of Narendra Modi and Rabindranath Tagore

Figure 11: Low-pass image of Narendra Modi

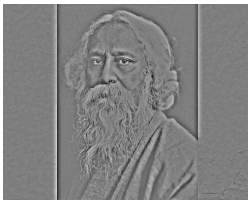


Figure 12: High-pass image of Rabindranath

Combining these two imagees with same weight.

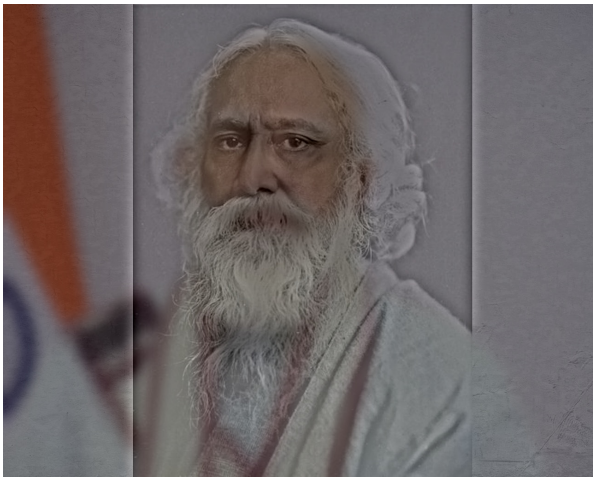


Figure 13: Hybrid image of Rabindranath Tagore

Image pyramid will help us to see the hybrid image from different perspective.

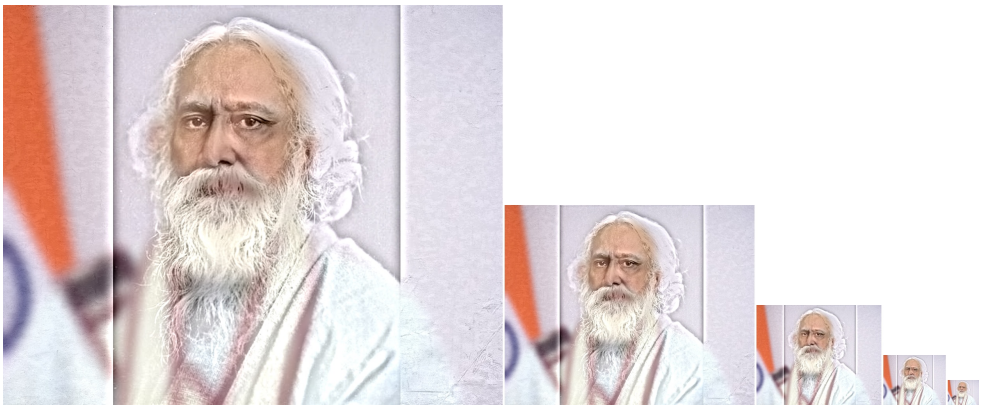


Figure 14: Image Pyramid of the Hybrid Image

0.2.5 Hybrid Image Creation of Plane and Bird

Figure 15: Low-pass image of plane

Figure 16: High-pass image of Bird

Combining these two imagees with same weight.

Figure 17: Hybrid image of Plane and Bird

Image pyramid will help us to see the hybrid image from different perspective.

Figure 18: Image Pyramid of the Hybrid Image

0.2.6 Hybrid Image Creation of Fish and Submarine

Figure 19: Low-pass image of fish

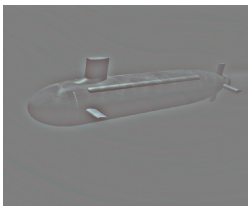


Figure 20: High-pass image of submarine

Combining these two imagees with same weight.

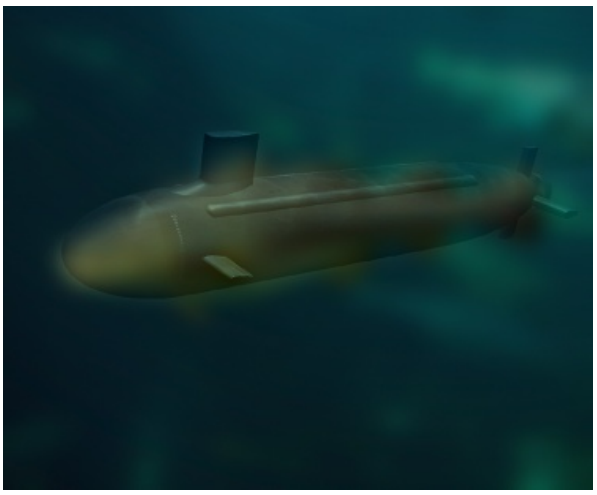


Figure 21: Hybrid image of Fish and Submarine

Image pyramid will help us to see the hybrid image from different perspective.

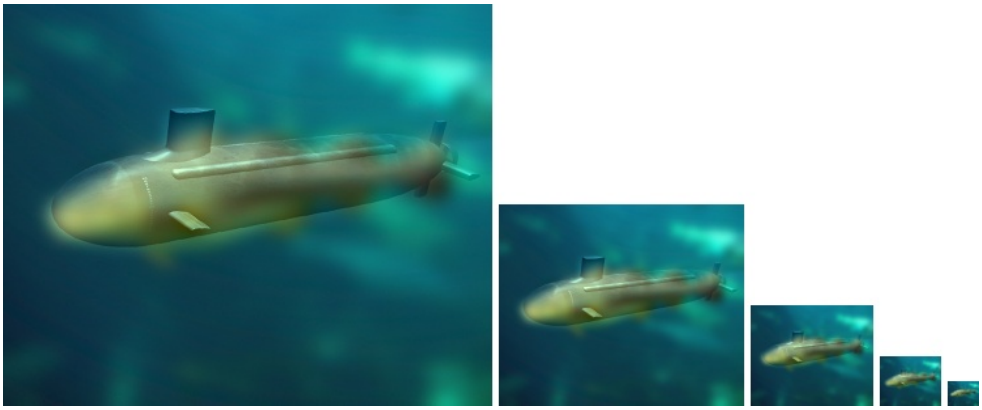


Figure 22: Image Pyramid of the Hybrid Image

CONCLUSION

It was amazing to see limitation of human eyes. We had a great amount of fun with his project and created and tested many different hybrid images. We had fun creating hybrid images of celebrities,popular images and random pictures together. In this project our filter function run in a few second on the given data images and a few minutes on some google images.We also have done dimension matching in different image size.

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