CSCI 8810: Project #3

Due on Tuesday, April 7, 2015

Prof. Arabnia 08:00am

Sina Solaimanpour

Contents

I. Introduction

In this paper, I will discuss about the third phase of the ColonD Image processing project. The first two phases of the project were about implementing some basic operations like read/write, gray-scale conversion, thresholding and smoothing images by applying filters and some of the most famous high-pass filters along with the CCL algorithm. In this phase of the of the project, I will expand the program to make it available to the user the feature to create an "N Level" pyramid out of an image and expand the pyramid levels to the size of the original image for further processing tasks.
The following list shows what new features have been added to the program in phase 2:

- Create an "N Level" Pyramid
- Expand the pyramid using Zero Order Hold Scheme
- Expand the pyramid using First Order Hold Scheme

These features are all implemented and tested with different images, individually and in combination of other operations. In the next sections, I will go over each one of these features in more detail and will present some results from the program.

II. Creating the Pyramid

In order to create the pyramid, I go over each pixel of the original image and use the NS5 pixels to calculated the average intensity. After calculating this average, I will set the pixel in (i / 2, j / 2) in which i and j are the indexes for the current pixel in the original image. Other techniques could be used to down sample the image to create smaller size images, but when I tried this method, it turned out to be working fine. The resulting images from applying this technique to lena's image and the bike's image in shown in the previous reports can be shown in **Figure 1** and **Figure 2** respectively.

Figure 1: The resulting pyramid from applying the pyramid creation algorithm to the Lena's picture. The images shown in this figure have relatively true sizes comparing to the first image on the left side.

Now, we need to resize the smaller images to be the same size as the original picture which are shown as the left most image in the figures. This will be done in the following sections using Zero order hold scheme and First order hold scheme techniques.

III. Zero Order Hold Scheme

This technique can be implemented by using a filter on an expanded image. This expanded image is twice the size of the original image and it has 0 as its pixel values every other rows or columns. This time, I

III. Zero Order Hold Scheme continued on next page...

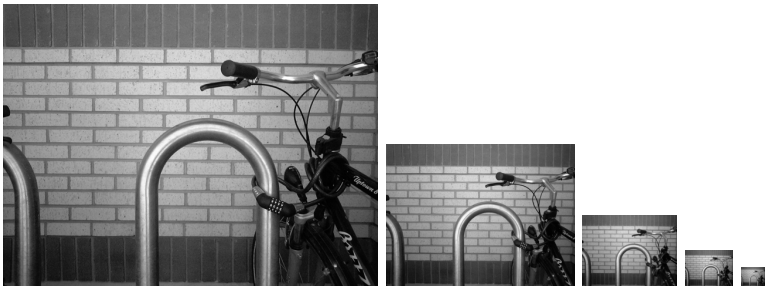

Figure 2: The resulting pyramid from applying the pyramid creation algorithm to the Bike's picture. The images shown in this figure are in relatively true sizes comparing to the first image on the left side.

preferred to implement this function without the help of my apply filter function just to see how it compares to its filter version. Instead, I used the algorithm discussed in class for zero order hold scheme without the use of filters. I create an image with twice the size of the original image and for each pixel, I create a 2 x 2 matrix in the result image. The resulting expanded images from the above pyramids using Zero order hold scheme are shown in **Figure 3** and **Figure 4**.

Figure 3: Expanded images using Zero order hold scheme from the pyramid made out of the lena's image. The original image is shown as the top-left image and the lowest resolution image is shown as the bottom-right image.

As it is visible in the images, when zero order hold scheme technique is applied multiple times to an image, it caused an box effect to appear in the resulting image. This boxing effect might be unpleasant when displaying the image but it also might be useful in other cases. In the following section, we will discuss about the First order hold scheme which will address this boxing effect issue.

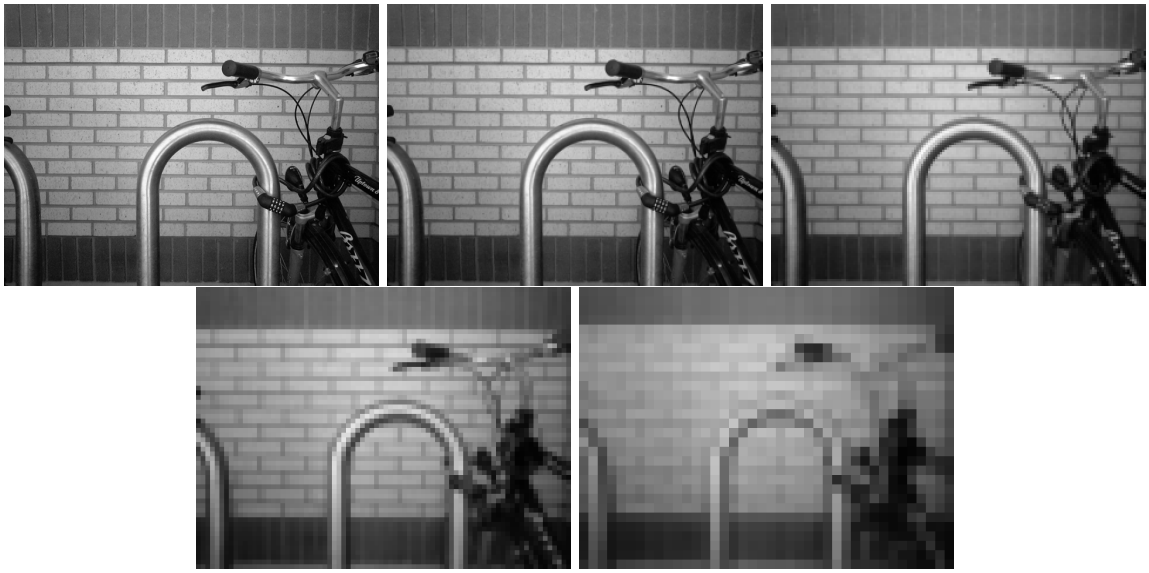

Figure 4: Expanded images using Zero order hold scheme from the pyramid made out of the bike's image. The original image is shown as the top-left image and the lowest resolution image is shown as the bottom-right image.

IV. First Order Hold Scheme

Unlike the zero order hold scheme technique, I implemented this one using the filter version algorithm. I expand the image just as described in the previous section and apply the filter introduced in class on the expanded image.
First order hold scheme technique, as depicted in **Figure 5** and **Figure 6**, will result in a much smoother expanded image in comparison with the Zero order hold scheme results. As it can be seen in the figures, the boxing effect is eliminated to some extend. This removal of the boxing effect is because of the use of interpolation between the pixel instead of just copying the same value four times. Using interpolation is because of the fact that pixel in true pictures change smoothly instead of jumping from one value to another in one step.

In the following section, I try to show some interesting results from the experiments I had with the project.

V. Experiments

In this section, I will show the results from the experiments that I did using the features implemented in this iteration of the project in combination of the features from the previous iterations. I used the pyramid in different combinations of different functions. The interesting result that saw was from the experiment which is described below,

1. Create a 5 level pyramid out of the input image
2. Expand the pyramid levels using the First order hold scheme technique
3. Apply two 3 x 3 average smoothing to the image
4. Apply Iterative Threshold to each level of the image

The resulting images for both the lena and bike's pictures are shown in **Figure 7** and **Figure 8**.

Figure 5: Expanded images using First order hold scheme from the pyramid made out of the lena's image. The original image is shown as the top-left image and the lowest resolution image is shown as the bottom-right image.

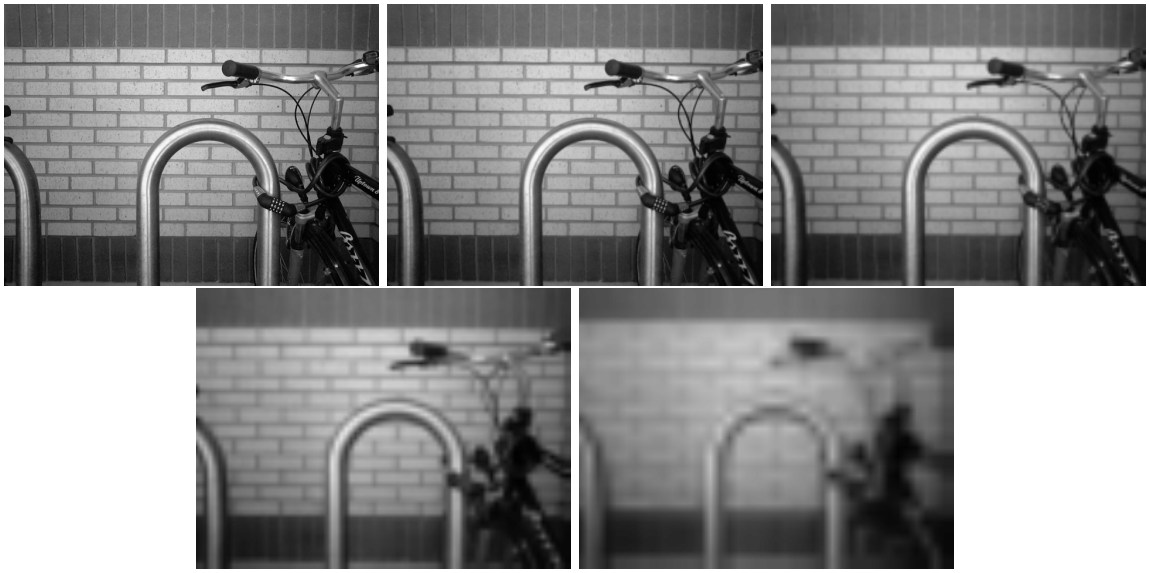

Figure 6: Expanded images using First order hold scheme from the pyramid made out of the bike's image. The original image is shown as the top-left image and the lowest resolution image is shown as the bottom-right image.

As you can see, even though the images which are the result of the lower resolution images have less detail in them, they still have the overall structure of the image and the context can be understood even from looking

Figure 7: Results from the experiment explained applied on the lena's picture.

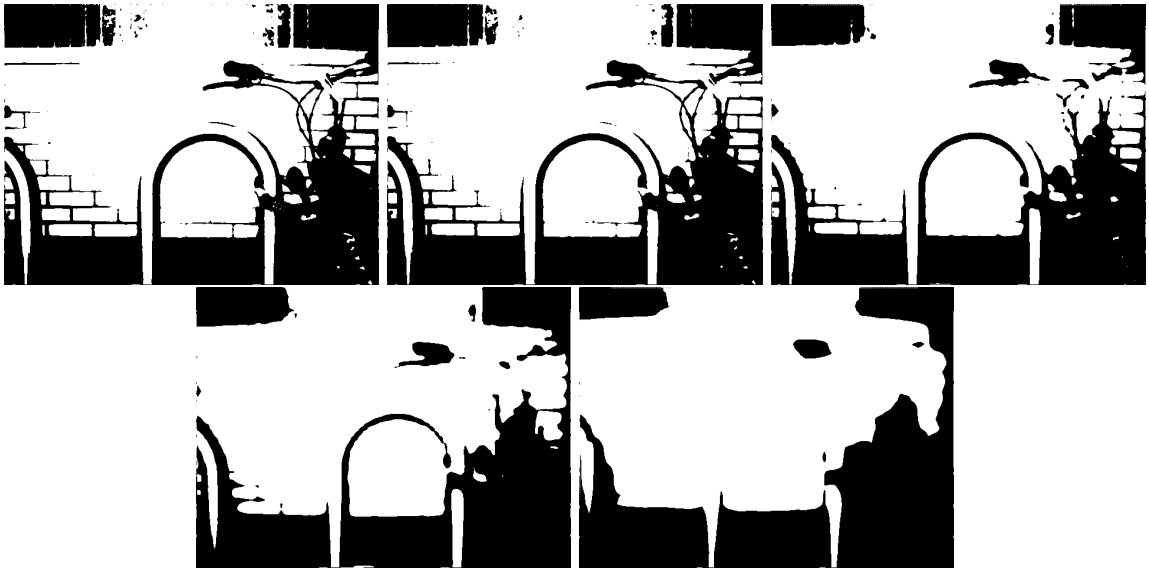

Figure 8: Results from the experiment explained applied on the bike's picture.

at the binary version of the picture. For example, one can clearly see the picture of a woman in all level of the pyramid shown in Figure 7. This tells us that there are valuable information that can help us process the image even in the lowest resolution image.