COMPUTATIONAL MATHEMATICS 1

MATH 357

GROUP 3

**IMAGE DERIVATIVES**

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INTRODUCTION

An image being an array of numerical values called pixels allows us to perform various mathematical operation on it in order to achieve certain effects. One such operation is the image derivatives.

An image derivative is the basically the rate of change of various pixel values. Since pixel values represent the colors on the RGB scale, measuring the changes between these values means measuring the difference between light intensity.

BODY

In our work, we applied three (3) different methods of approximating the derivative of a continuous function on the two (2) images provided (Lena and Barbara). These are the two, three, and five points difference. Under each we considered the forward difference and the backward difference. Since images are 2-D array the derivatives we found were partial derivatives in the x (horizontal) and y (vertical) directions, which detected the horizontal and vertical differences, respectively of the image.

The horizontal and vertical changes were seen more clearly in Barbara, because that image was pattern rich, as compared to Lena, the image which had more edges/ curves, nonetheless, all vertical differences detected by the derivative with respect to y, while the horizontal are detected by derivative with respect to x. Image derivatives as a technique is mainly used in detecting edges and patterns in an image, among other things.

One main hindrance or challenge in the image differentiation process sources from the noise which comes with the images. Noise in images result in pixels that look very different from their neighbors (intuitively, most pixels in images look quite a lot like their neighbors). How to solve this? We applied convolution filters for smoothing of the image in order to reduce the amount of noise present and make our edges more precise and detectable. The smoothening however blurs up the image a little, so we reduce noise and give up our sense of detail.

One thing we noticed, with regards to the different approximations of the derivatives that we used was that, the larger the number of points considered, the larger the amount of noise in our resulting image derivative. We easily linked this observation to the fact that the larger the number of points considered, the more amplified our noise pixels get. The two, three and five point derivatives are actually approximations of the derivative for a continuous function and since our images can be likened to discrete functions, their approximation will not work just as well, instead of giving us a clearer picture of the derivative, we observed the exact opposite effect. The five-point derivative resulted in a picture with more distorted edges, as compared to the three and two point.

There are many uses of image derivatives in many areas.   
Some practical applications are the use of image derivatives in edge detection, pattern recognition and making of sketches.