Comparison of Digital Image Filtering Techniques

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Abstract

This project explores digital image filtering techniques by comparing the median and frequency filters. By testing the filters with images varying in object type (people, landscapes, or objects) and noise composition, the project determines the advantages and disadvantages of each in specific situations. The median filter implementation is developed as a typical three-by-three median filter. The frequency filter will utilize the Fourier Transformation to process the image in the frequency domain. Noise is introduced manually and is representative of the different kinds of noise experienced in data transmission.

Keywords: digital image, image filter, median filter, frequency filter, frequency domain, Fourier transformation.

Introduction

The field of image processing has wide and important uses. Any field of work that involves images or videos has uses for research in this area. The results of this project will influence how images are processed and enhanced. Applications stemming from the results of this project will be important to image and video enhancement applications because this research project provides insights on the best techniques in filtering and enhancing each kind of image.

This study will involve two filtering techniques: median filtering, and frequency filtering. First of all, algorithms will be developed for each of the two methods. After writing the code implementing these methods and conducting necessary testing, a variety of images will be put through the two filtering techniques to determine which filtering techniques work best for which types of images. The variety of images used will include images of people, objects, and landscapes. The quality, or the amount of noise, of the images used will be another independent variable.

The quality of filtered images will determined in a subjective manner through surveying a pool of people. The effects of human errors and subjectivity does not detract from this study because image filtering is done for subjective aesthetic qualities in the first place.

Background

Digital image processing such as filtering was first developed in the 1960's. As computers became cheaper and faster, real-time image processing became available and its applications boomed. Digital filtering attempts to clear out noise, or useless and distracting information, in pictures. Examples of noise include missing pixels and wrong pixels. Noise is inevitable when converting analog information into a digital form. Such a conversion occurs inside a digital camera, when the camera takes the analog picture from the lens and stores it as a digital file.

To produce high quality images, for both aesthetic and additional high level processing purposes such as edge detection, noise reduction is very helpful and often required. The median and frequency filters are two such filters.

The median filter deals with each pixel and assures it fits with the pixels around it. Therefore, it is very useful in filtering out missing or damaged pixels. The frequency filter implements the Fourier transformation to smooth out images. It is much more demanding in terms of computational complexity and processing time. Because of the sheer volume of data that normally needs to be filtered, the main problem in designing median and frequency filters is efficiency and time consumption.

This project will implement the median and frequency filters and evaluate them for their effectiveness in filtering different kinds of pictures. The results of this project may help determine the best filtering techniques to be used for an image that needs to be processed.

Development

Point one: My project is only in its infantile stages of development so there are not any relevant information to include in this section.

Bibliography

Davies, E. R. (2005). Shifts Introduced by Median Filters. In E. R. Davies (Ed.), *Machine Vision* (3rd ed., pp. 66 - 78). San Francisco, CA: Morgan Kaufmann Publishers.

The median filter is used more often than its counterparts, including the mean and mode filter because the median filter suppresses noise without blurring the image. The median filter, however, may shift the edges of objects in certain situations. Straight edges are not shifted as a result of median filtering, but curved edges are shifted inward (toward the center of the curve) and bumps tend to be smoothed out as a result. The worst case scenario that produces the maximum amount of filtering shift is a circular object.

The median filter may also remove smalls details that the filter mistakes for noise. A line one pixel wide, for example, would be completely wiped out by a one-by-one median filter.

Fourier Transforms & the Frequency Domain. (n.d.). Retrieved January 11, 2007, from University of California at Berkeley Web site: http://grus.berkeley.edu/~jrg/ngst/fft/concepts.html

Signals can be expressed in two different domains, spatial and frequency domains. Considering a graph of a signal in either domain, the horizontal variable in the spatial domain is time; and the vertical variable is amplitude. For a graph in the frequency domain, the horizontal variable

is frequency; and the vertical variable is amplitude. Signals are expressed in either of these domains to make processing and calculations easier. To convert a representation from the spatial to the frequency domain or vice versa, we use the Fourier Transformation. The Fourier Transformation has applications in communications, astrology, geology, and optics. The Fourier Transformation is needed for my project because the frequency filter works on images on the frequency domain, therefore incoming images must be converted from its usual spatial domain representation to the frequency domain.