



Magnified Edge Detection using Fuzzy-Canny Logic

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Abstract— In this paper an analytic approach to edge detection with fuzzy in collaboration with canny is explained. Basically, fuzzy is a form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their contexts/appearances. Fuzzy logic provides an alternative way to represent linguistic and subjective attributes of the real world in computing. Edge detection is basically the method to detect the pixels/points where images features or brightness changes abruptly/sharply. Also it works on to detect the boundaries along with the discontinuities in depth of the image.

Keywords— Edge detector, fuzzy image processing, image enhancement, first and second order derivatives, Gaussian membership function.

I. INTRODUCTION

Edge detection is one of the most critical and hot topic for digital images for segmenting images and to improve the quality of the images. As we know, about data abstraction, i.e. it focuses on some of its data but eliminates unwanted data. In the same way, Edge Detection is used to trim down and strain some amount of data and inadequate information, at the same time preserving the important structural(edges) properties in an image. As, edge detection is currently in its developing stage of processing the images for the detection of objects, so it is important to have good understanding of algorithms for edge detection. Edge detection is used to capture the discontinuities in the image brightness where discontinuities can be either at discontinuities in depth, discontinuities in surface orientation or changes in material properties etc. Edge detection algorithms for an image may reduce the quantity of data to be processed and filters out the information that may be less relevant but at the same time preserving the structural properties of the image. For some non-trivial images detected edges are often hampered by image segmentation i.e. some of the edge curves are not so connected. So that some of the edge segments remain missing which may complicates the matter. The edge properties can vary depending upon their viewpoints which can be either viewpoint independent or viewpoint dependent. Edges uses the inherent properties for 3-D objects in case of viewpoint independent edges but in case of viewpoint dependent edges may change as the viewpoint of an image changes which is completely based on the geometry of the scene. Basically edge detection is a non-trivial task because of that most of the edge detection is done using fuzzy logics along with the Gaussian function.

II. EDGE DETECTION METHODS/TYPES

There are various methods for the edge detection in images but they can be broadly categorized under two main categories (i) search based & (ii) zero-crossing based. Search based edge detection uses first order derivatives like gradient magnitude for measuring the edge strength and then searching the local maxima in gradient direction. But, zero-crossing based search techniques uses second order derivative by using Laplacian & Guassian for non linear differential expressions.

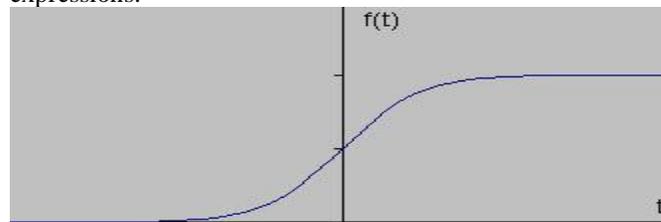


Figure1 (First order derivative)

So basically the edges can be detected with gradient (first order derivative) and Laplacian(second order derivative). Let us suppose that we have the following edge as shown in the Figure1.

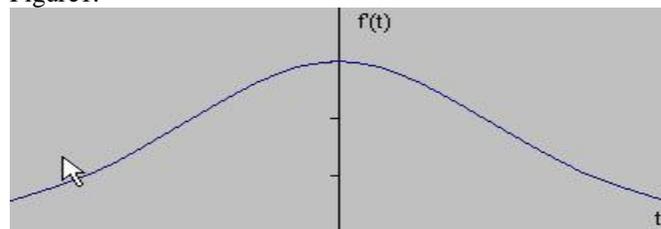


Figure2 (Second order derivative)

If we take the first order derivative (one dimension) with respect to t i.e. the gradient of this signal, we get the following (Figure2). Clearly, the derivative shows a maximum located at the center of the edge in the original signal. But, when detected with the second order derivative i.e. using Laplacian approach following observation is made with respect to t as shown in Figure3.

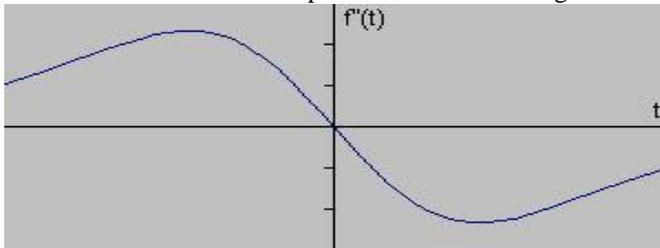


Figure3 (Laplacian approach)

III. REQUIREMENTS FOR EDGE DETECTION

Edge detection is one of the very basic concept used for image processing, image recognition, computer vision techniques as well as for various image analysis. The main requirement behind the edge detection in the images is to improve the quality of the images by focusing on some important points so that the noise intensity can be significantly reduced in digital images. It consists of a wide variety of applications in the area of face recognition, biometrics, eye recognition, finger recognition which requires very clear intensity for the images with noise free content. In past few years, a couple of researches have been done for detecting the edges which mainly differ in types of the smoothing filters which are used for computing the edge strength. The core proposal of most edge detection techniques is based on the local first or second derivative operator, which is used by some techniques to reduce the effects of noise in digital images. Some of the previously developed edge detection methods, such as Prewitt [1, 2], Sobel [3] and Robert's operators used local gradient method for detecting edges for some specified direction. But these were deficient in controlling noise, which results in their degraded performance for blurred or noisy images.

IV. ANALYSIS OF EXISTING ALGORITHMS

Based on the degree of the correlation and the first order gradient in the images Prewitt [1, 2] presented the edge detection in grey scale images where the image pixels are referenced in the eight neighborhoods. It worked significantly to reduce the noise content but is only effective to gray images and also the referencing distance between the pixels is more (i.e. eighth neighbor). Based on the method of image edge detection on gray weighted absolute correlation degree of Gray System theory this paper presents a novel method for image edge detection based on grey weighted absolute correlation degree and the classical Prewitt edge detection operator. As a result of Prewitt operator reflects the first order gradient of the image, and with it as a template to the image spatial

domain filtering, then gain extreme value. And the extreme Prewitt operator as reference sequence, and calculate the grey weighted absolute correlation degree of the image pixels, then the edge is detected according to the grey weighted absolute correlation degree. Simulations show that this method can detect the useful information of the image edge more accurately and has some anti-noise ability value is the edge of the image. But, its effectiveness is only limited to first order gradient it cannot use the Gaussian method for second order derivative of the images and also the effect of noise is not reduced very significantly. Then later on, based on the Gaussian filter Canny [4] proposed a method to answer noise problems, for the images involved with the first order derivatives for smoothing in the local gradient direction which was followed by edge detection by thresholding the images. But with thresholding there arise a problem of over segmentation and sensitivity. So for improving the quality of thresholding Sobel operator [3] is used along with the edge detection. Algorithms were also proposed by Marr and Hildreth [5] for finding edges at the zero-crossings in the image Laplacian. Some other algorithms like SUSAN [6] which were based on Non-linear filtering techniques for edge detection, which works by associating a small area of adjacent pixels with related brightness to each center pixel. Some algorithms were also presented by Torre and Poggio [9] based on the line and edge detection by using differential operators. Edge detection in sampled images may be viewed as a problem of numerical differentiation. In fact, most point edge operators function by estimating the local gradient or Laplacian. Adopting this view, Torre and Poggio [9] apply regularization techniques to the problem of computing derivatives, and arrive at a class of simple linear estimators involving derivatives of a low-pass Gaussian kernel. In this work, they further develop the approach by examining statistical properties of such estimators, and investigate the effectiveness of various combinations of the partial derivative estimates in detecting blurred steps and lines. We also touch briefly on the problem of sensitivity to various types of edge structures, and develop an isotropic operator with reduced sensitivity to isolated spikes. An algorithm was also presented by AZRIEL ROSENFELD [10] for some sort of edge and curve detection. It used some parallel set of operations that detect "texture edges" (abrupt discontinuities in the average values of local picture properties), as well as spots or streaks that are texturally different from their surrounds. But this algorithm was again limited detect the local changes in the image pixels.

Also during recent years, techniques have been proposed that uses edge detection as a fuzzy problem. Some local and global approaches has used morphological edge [7] extraction method using Fuzzy logic. Ho *et al.* [8] used both global and local image information for fuzzy categorization and classification based on edges. In this paper, we have projected a comparative study based edge detection algorithms that works on both global and local

image information. Not all the methods and algorithms are good enough to detect the pixels at the sharp changes with reduced noise content. Here we have tried to combine the concepts of both fuzzy and canny together.

V. MAGNIFIED APPROACH FOR EDGE DETECTION

In the magnified approach, both the concepts of canny and fuzzy can be modified together which will use both global (gray level histogram) and local (membership function for window) information and finally an important step of canny i.e. edge linking. Which consists of the following steps:

1. Initially find out the minimum number of false negatives and false positives.
2. There should be good localization, i.e. edge locations should be at the correct position.
3. There should be only response to every edge.

The combined approach will enhance the quality of the detected edges by almost eliminating the noise factor.

VI. CONCLUSION

The fuzzy – Canny edge detector presented in this paper uses both global (gray level histogram) and local (membership function for window) information and finally an important step of canny i.e. edge linking. The information which appears to be local is fuzzified using a modified Gaussian membership function. Thereafter, the local edge detection operator is applied on the enhanced image using the optimization parameters, which are again obtained from entropy optimization. Then on the resulting image edge thresholding is applied and thereafter canny edge detection is performed. So that the results can be more enhanced by reducing the noise factor. So, in context this type of application can be used for applications such as face recognition and fingerprint identification.

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