# Boundary Detection of Objects in Digital Images Using Bit-Planes and Threshold Modified Canny Method

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**Abstract.** Two novel Canny-based boundary detection techniques are presented in this paper. Canny edge detection has gained popularity over the period due to its potential in edge detection. However, the edges detected by Canny are highly superfluous to extract the boundary of the objects in an image. The Modified Canny methods address this issue by modifying the parameter of Canny. The first method namely Threshold Modified Canny (MC-T) uses the Mean of the input image as threshold. MC-T is found to produce the boundaries even on the high-contrast images. The Second method, Bit-planes and Threshold Modified Canny (MC-BT) performs edge detection on the three intensity significant bit-planes using Mean of the input image as Threshold. This technique has also produced promising results in detecting the image boundary. The second method as it works only on three bit planes information of the input image, it reduces insignificant details and yields significant object boundaries. The result of the two proposed techniques, suitably finds place in object recognition, pattern recognition / matching etc. where boundary detection is an important component. These approaches are much promising in terms of clear boundary detection of an object, as boundary detection by conventional methods is very time consuming.

**Keywords:** Edge Detection, Bit-planes, Canny Algorithm, Modified Threshold.

## 1 Introduction

Edge detection is the most essential operation in image analysis. An edge is a manifestation of discontinuity of local characteristics (gray mutation, color mutation, mutation texture, etc), of an image. It defines the boundary between objects and their background. Edge detection is a vital preprocessing technique for image segmentation, object recognition pattern matching and computer vision. There are several algorithms developed for edge detection such as classical methods (Sobel, Prewitt, Kirsh etc) which are simple but sensitive to noise, Zero-Crossing methods (Laplacian, Second directional derivative) which detect

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edges in their orientation with fixed characteristics in all directions though it is also sensitive to noise, Laplacian of Gaussian (Marr-Hildreth) that finds correct places of edges and tests wider area around the pixels, malfunctions at the non-linear features such as corners, curves etc., Gaussian (Canny, Shen-Castan) which uses the probability for finding error rate, Localization and response, improving signal to noise ratio, exhibits better detection in noisy environment, it suffers from computational and time complexity and false zero-crossing [1, 4]. Commonly it is observed that Canny produces better results with the trade-off of time and space complexity [2, 4]. Usually most of the significant details of an object are found in most significant bit planes of any digital image. In this paper, a new approach is presented to detect the object boundary. This exploits those details and thereby produces interesting results. Section 2 discusses the principle of popular edge detection methods and their applications whereas Section 3 presents the methodology of the proposed MC-T and MC-BT. Section 4 presents the experimental results and discussion and the conclusions are drawn in Section 5.

## 2 Conventional Methods of Edge Detection

Typically an edge in an image is a boundary between an object and its background. Mathematically an edge can be represented by First and Second Order differential equations. The first-order derivative (i.e. Gradient) of a 2-D function f(x, y) is given by:

$$\nabla f = \begin{bmatrix} Gx \\ Gy \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \tag{1}$$

where Gx and Gy are the gradients in the x and y coordinates, respectively. The magnitude of the vector is given by:

$$mag(\nabla f) = \sqrt{(Gx) + (Gy)} = \sqrt{(\frac{\partial f}{\partial x})^2 + (\frac{\partial f}{\partial y})^2} \tag{2}$$

Generally, the variance of the gray level is calculated with one of these edge detection operators or kernel operators. The slopes in the x and y directions are combined to give the total value of the edge strength. The edge detection operator fixes a kernel centered on a pixel chosen. If the value of this kernel area is above a given threshold, then the center pixel is classified as an edge [1]. The popular edge-detection methods classified in following categories, based on differential operators:
Gradient Detector (First order derivatives)
Zero crossing (Second order derivatives)
Laplacian of Gaussian (LoG)
Gaussian Edge Detector
Colored Edge Detector