# Video Surveillance for Theft Detection 

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#### Abstract

Surveillance is an essential tool in maintaining security in the premises of organizations, shopping complexes, financial and educational institutions. Security from theft is of critical importance to all organizations. Video surveillance is an effective tool in the prevention or detection of theft. Many techniques are available for surveillance. Techniques like Closed-Circuit television, tripwire, and entry detection sensors are widely used today. But most of these systems are expensive and require human intervention. So there is a need of a system that is cost effective and requires a minimum amount of human intervention. The proposed system video surveillance for theft detection diminishes cost exponentially. It is an accurate and automated system for theft detection.


Keywords- Canny edge detection, Gaussian filter, theft detection, double thresholding

## I. INTRODUCTION

The main purpose of this system is for security purposes. It can be used in places where trespassing is prohibited. It can be used in malls and shopping complexes. The system comes into use when the mall is closed at night and detection of trespassing becomes crucial. Ideally there should be no human movement inside the mall at night. But if human movement is detected it indicates that trespassing has occurred and the system immediately detects this. The system can also be used in banks. The locker rooms in banks need security and are highly prone to theft. This system can be used to secure such vulnerable areas in banks. [1]

In this paper we have presented the study of canny edge detection algorithm, which is used in video surveillance for theft detection. We have showcased the basic theory of the canny edge detection algorithm. The reason behind selecting the Canny edge detection algorithm is that Canny edge is the most accurate edge detection algorithm and it is the least sensitive to noise.

In today's world there is a need for the security in every aspect of life, whether it is shopping malls, bank or any vehicular system. Currently we are using close circuit television (CCTV) for securing the areas we want. Close circuit television (CCTV) will not alert the on-going theft but will only provide the live recording, which will need continuous human monitoring. But video surveillance using canny edge detection algorithm will alert the on-going theft, and the system will be completely independent of any human interaction with the system. Such a system will not only be more secured but also cost effective. Thereby reducing the resources wasted on human monitoring.

## II. Literature Survey

The system Video Surveillance needs to use edge detection.Edge is a basic feature of an image. Edges can be defined as boundary between two different regions in an image. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. Edge detection process significantly reduces the amount of data and filters out useless information, while preserving the essential structural properties in an image. Since computer vision involves the recognition and classification of objects in an image, edge detection is a vital tool.
Different methods are available for edge detection. Some of the methods are given in the table below. [3]

## Comparison of Edge Detection algorithms

$\left.\begin{array}{|l|l|l|}\hline \text { METHODS } & \text { APPROACHES } & \text { DESCRIPTION } \\ \hline \begin{array}{l}\text { First order } \\ \text { derivative } \\ \text { ( Gradient } \\ \text { methods) }\end{array} & \bullet & \begin{array}{l}\text { Roberts Operator } \\ \text { Sobel Operator } \\ \text { Prewitt Operator }\end{array} \\ \hline \begin{array}{l}\text { Second } \\ \text { order } \\ \text { derivative } \\ \text { (Zero } \\ \text { crossing) }\end{array} & \bullet \begin{array}{l}\text { Laplacian of } \\ \text { Gaussian } \\ \text { Difference of } \\ \text { Gaussian }\end{array} & \begin{array}{l}\text { It detects the edges } \\ \text { maximum and } \\ \text { minimum in the } \\ \text { first derivative of } \\ \text { the image. }\end{array} \\ \hline & \begin{array}{l}\text { It detects the edges } \\ \text { by Laplacian } \\ \text { method in which it } \\ \text { search for zero } \\ \text { crossings in the } \\ \text { second derivative } \\ \text { of the image. }\end{array} \\ \hline \begin{array}{l}\text { Optimal }\end{array} & \text { - } \begin{array}{l}\text { Canny Edge } \\ \text { Detgector }\end{array} & \begin{array}{l}\text { It is a method to } \\ \text { find edges by } \\ \text { isolating noise } \\ \text { from } \\ \text { the image without } \\ \text { affecting the } \\ \text { features of the } \\ \text { edges in } \\ \text { the image and then }\end{array} \\ \text { applying the } \\ \text { tendency to find } \\ \text { the edges and the } \\ \text { critical value for } \\ \text { threshold. It first } \\ \text { smoothens the } \\ \text { image to eliminate } \\ \text { noise. }\end{array}\right\}$

Thus we have done a theoretical study of edge based image segmentation methods which provide insight into most widely used edge detection techniques of Gradient-based and Laplacian based Edge Detection. We have described Robert, Prewitt, Sobel, Laplacian of Gaussian, Canny detection methods. Different edge detection methods can be implemented as per the need of segmentation of image. An adaptive edge-detection algorithm is necessary to provide a robust solution that is adaptable to the varying noise levels. Canny edge detection algorithm is less sensitive to noise but is computationally more expensive compared to Robert's operator Sobel, and Prewitt operator. However, canny edge detection approach performs better than all these operators nearly under all scenarios.

## Canny Edge detection

Canny edge detection algorithm has 5 steps:

1. Noise reduction
2. Finding gradients
3. Non-maximum suppression
4. Double thresholding
5. Edge tracking by hysteresis [4]

## A. Noise reduction

All images taken from a camera will contain some amount of noise. The noise should not be mistaken for edges, hence the noise must be reduced. Generally noise reduction implies some sort of blurring operation. A Gaussian filter is used to do this. The kernel of a Gaussian filter with a standard deviation of 1.4 is shown in equation (1). The effect of noise reduction on the test image with this filter is shown in the figure below.

$$
B=\frac{1}{159} \cdot\left[\begin{array}{ccccc}
2 & 4 & 5 & 4 & 2  \tag{1}\\
4 & 9 & 12 & 9 & 4 \\
5 & 12 & 15 & 12 & 5 \\
4 & 9 & 12 & 9 & 4 \\
2 & 4 & 5 & 4 & 2
\end{array}\right]
$$

Given below is an example of an image before and after noise reduction.


Fig 1: Original Image


Fig 2: Noise reduced Image

## B. Finding gradients

The Canny edge detection algorithm finds edges where the grayscale intensity of the image changes the maximum. These areas are found by determining gradients of the image. Gradients at each pixel in the noise reduced image are determined by applying the Sobel operator. The first step is to approximate the gradient in the $x$ - and $y$-direction respectively by applying the kernels shown in Equation (2).

$$
\begin{align*}
& K_{\mathrm{GX}}=\left[\begin{array}{ccc}
-1 & 0 & 1 \\
-2 & 0 & 2 \\
-1 & 0 & 1
\end{array}\right] \\
& K_{\mathrm{GY}}=\left[\begin{array}{ccc}
1 & 2 & 1 \\
0 & 0 & 0 \\
-1 & -2 & -1
\end{array}\right] \tag{2}
\end{align*}
$$

To compute the gradient magnitude:

$$
\begin{equation*}
|G|=\sqrt{G_{\mathrm{x}}^{2}+G_{\mathrm{y}}^{2}} \tag{3}
\end{equation*}
$$

To compute the angle of the gradient:

$$
\begin{equation*}
\theta=\arctan \left(\frac{\left|G_{\mathrm{y}}\right|}{\left|G_{\mathrm{x}}\right|}\right) \tag{4}
\end{equation*}
$$

## C. Non Maximum Suppression

Non Maximum Suppression is the conversion of the blurred edges in the image of the gradient magnitudes to sharp edges. This can be done by preserving all the local maxima in the gradient image and removing everything else. The algorithm is for each pixel in the gradient image:

1. The gradient direction is rounded to the nearest $45^{\circ}$, corresponding to the use of an 8-connected neighbourhood.
2. The edge strength of the current pixel is compared to the edge strength of the pixel in the positive and negative gradient direction.
3. If the edge strength of the current pixel is largest then that value of the edge strength must be preserved.

## D. Double thresholding

The edge-pixels that are remaining after the non-maximum suppression are marked with their strength each pixel at a time. Some edge pixels may be caused by noise or colour variations for instance due to rough surfaces. The easiest way to distinguish between these would be to use a threshold value, so that only edges stronger that a certain value would be retained. The Canny edge detection algorithm uses double thresholding. Edge pixels stronger than the high threshold are marked as strong. Edge pixels weaker than the low threshold are suppressed and edge pixels between the two thresholds are marked as weak.

Given below are the images before and after double thresholding.


Fig 3: After Non Maximum Suppression


Fig 4: After Double thresholding

## E. Edge tracking by hysteresis

Strong edges can immediately be included in the final edge image. The weak edges are included if and only if they are connected to strong edges. Strong edges will only be due to true edges in the original image. The weak edges can either be due to true edges or noise and colour variations. The weak edges will probably be distributed independently of edges on the entire image, and thus only a small amount will be located adjacent to strong edges. The weak edges due to true edges are much more likely to be connected directly to strong edges. Edge tracking can be implemented by BLOB-analysis (Binary Large Object). The edge pixels are divided into connected BLOB's using 8 -connected neighbourhood [7]. The BLOB's containing at least one strong edge pixel are preserved, while other BLOB's are
suppressed. The effect of edge tracking on the test image is shown on the figures below.


Fig 5: Double thresholding


Fig 6: Edge tracking by hysteresis


Fig 7: Final output

## III. CONCLUSION

Thus we have observed that there is a critical need for Video Surveillance in all types of organizations. The proposed system reduces cost exponentially as compared to other existing surveillance systems. It requires minimum human intervention and still maintains accuracy in theft detection. The system is an Image Processing software of which edge detection is an integral part. We have studied different algorithms for edge detection. Canny edge detection algorithm proves to be the optimal edge detection algorithm for the proposed system. We have examined the steps of Canny edge detection algorithm. The proposed system if implemented will be very useful for theft detection in different scenarios.

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