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Edge Detection Image Steganography Technique: A Survey

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Abstract: *Cryptography and Steganography are two widely used approaches to provide security to data in transmission. Cryptography scrambles the data to achieve confidentiality, whereas steganography hides the original data in a digital carrier, such as text, audio, video and image. When an image is utilized for this purpose then it is called as Image steganography. To measure the quality and effectiveness of image steganographic techniques parameters like distortion, PSNR, and capacity are used. Image steganography can be achieved various methods such as least significant bit(LSB), pixel value difference (PVD), and edge detection methods etc. Edge detection technique are the most efficient and effective methods to achieve image steganography. In this paper, we have done the survey on various edge detection steganography methods.*

Keywords: Cryptography, Steganography, Pixel value difference(PVD), Least significant bit(LSB), Edge Detection.

1. Introduction

Nowadays, most of the organizations uses digital transmission and electronic data- processing that establishes the communication over an Internet. As consequence, it is inevitable to utilize the sensible method to secure the data. To provide data security, several existing approaches such as Cryptography and Steganography have widely been used [1]. Cryptography uses a specific format to store and transmit the data to achieve confidentiality, whereas steganography hides the original data securely using the cover media, (text, audio, video and image) which may not raise any susceptibility to outsider [2]. In steganography, identification of secure messages is known as Steganalysis. There are various steganography techniques such as text steganography, audio steganography, video steganography and image steganography techniques that use covered media such as text, audio, video, image respectively to secure the transmission.

Lately, the image steganography has attracted the researches attention [20-23]. It uses image as the covered media which is categorized into two types such as spatial and frequency domain respectively [24-25]. In frequency domain, image pixel values are changed into frequency domain using transformation functions like discrete cosine transform, or discrete wavelet transform, or integer wavelet transform before the secret data is embedded in the pixels. Whereas in spatial domain, the secret data is directly embedded in the intensity of pixels [3]. To provide higher embedding capacity, spatial domain is widely used.

In image steganography, there are various techniques such as least significant bit (LSB), pixel value differencing (PVD) and edge detection methods etc. To measure quality and effectiveness of image steganographic technique [26]. The parameters like distortion, Peak Signal Noise- Ratio(PSNR), and capacity are used [27].

Images are divided into two parts: Edges (noisy) and smooth (textured) areas. When data is placed in the edges it is difficult for the Human Visual system to perceive. The reason behind the difficulty in perceiving the data is when comparing to the adjoining pixels it's intensity is high up to a par. As there is a sudden rebuttal change in the coefficient gradient at noisy pixels[3]. Due to these sharp changes in the visual and statistical properties, edges are difficult to model in comparison to pixels in smoother area. Edges give more of an upper hand in the hiding of secret data when compared to any other region of an image which is totally point centric[2]. To hide the data effectively, various edge detection techniques such as canny edge detection, fuzzy edge detection, and sobel edge detection have been proposed. Thus, this paper proposes to study various edge detection techniques to analyses the selective steganographic parameters.

2. Literature survey:

The edge pixels are the better choice to embedded secret data compared to smooth pixels, because they are difficult to perceive by the human visual system (HVS). Intensities of the noisy pixels are either higher or lower than their adjacent. At the edges of pixels due to sudden transformation in the coefficient gradient [4].

Depending on the degree of smoothness, data can be embedding in different locations in the image. gray value pixels are easily noticeable by the human eyes. If the gradient difference between the adjacent pixels is more, then it indicates that those areas are edges. When image is scanned in zigzag manner, if the difference value is close to zero then it indicates that these are smooth area, if the difference is 255 or -255 then it indicates that those are sharp edges [5].

Initially these edges can be detected manually. Later to compute the edges there are some edge detectors are introduced such as canny edge detector, fuzzy edge detector, sobel edge detector and hybrid edge detector [6].

Marr and Hildreth [7] introduced the theory of the edge detection to detect the edges by using zero-crossing of the Laplacian of Gaussian of an image.

Haralick [8] detected the edges by fitting polynomial function to local image intensity to finding the second directional derivatives of the functions. Canny [9] proposed an optimal edge detector on the basics of gradient magnitude of Gaussian-smoothed image. Ulupinar and Medioni [10] proposed that in the process of finding the edges in the images there may be chance of the finding some false edges due to the closer values of gradients. These false edges are identified by Laplacian edge detector. Goshtasby and Shyu [11] was proposed a curve fitting approach to detect the edges. In this high gradient image pixels with weights are proportional to the gradient magnitude of the pixels. Elder and Zucker [12] proposed advanced edge detection to identify the edges at multitudes of scales. Li [13] proposed an adaptive smoothing method, in which without distorting of the image to remove the noisy areas in image.

3. EDGE DETECTORS:

The various edge detectors are discussed below.

3.1 Sobel Edge detector:

Sobel Edge detector computes the gradient by using two 3 x 3 convolution kernels along X and Y directions.

These two kernels are used for edges running for vertically and horizontally relative to pixel grid. The kernels can be applied individually to input image to produce separate the gradient components for each orientation (G_x,G_y)[13].

+1	+2	+1
0	0	0
-1	-2	-1

$\boldsymbol{G_x}$

-1	0	+1
-2	0	+2
-1	0	+1

$\boldsymbol{G_y}$

To find the absolute magnitude of gradient of pixel can be calculating by using the following formula.

$$|G|=\sqrt{{G_x}^2 + {G_y}^2} \quad (1)$$

This is approximated by $|G|=|G_x|+|G_y|$.

The angle of direction is measured by using this formula (relative to pixel grid)

$$\theta = \arctan (G_y / G_x) \quad (2)$$

3.2Prewitt's Method:

Prewitt's Method is one of the oldest and best method to compute the edges. It is very similar to the sobel filter. This Prewitt's edge detector can be implemented in following steps. It is fast method for edge detection but it is only suitable for well-contrasted noiseless images [14].

1.In the first step, it is also consisting of two 3 x 3 convolution kernels to identify the gradient in the X and Y directions $\boldsymbol{G_x}$, $\boldsymbol{G_y}$ respectively.

+1	+1	+1
0	0	0
-1	-1	-1

$\boldsymbol{G_x}$

-1	0	+1
-1	0	+1
-1	0	+1

$\boldsymbol{G_y}$

2. To find the absolute magnitude of gradient of pixel can be calculating by using the following formula.

$$|G|=\sqrt{{G_x}^2 + {G_y}^2} \quad (3)$$

This is approximated by $|G|=|G_x|+|G_y|$.

The angle of direction is measured by using this formula (relative to pixel grid) [14]

$$\theta = \arctan (G_y / G_x) \quad (4)$$

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3.3Laplacian of Gaussian(Log) edge detection:

In case of Laplacian edge detector main aim is to reduce the noise in the image and detection of the edges. To reduce the noise by using the Laplacian operator. The image is smoothed by convolution between Log operator and Gaussian shaped kernel [15].

Gaussian function is given by:

$$G\ (x, y) = e^{\frac{-x^2+y^2}{2\sigma^2}} \qquad (5)$$

σ – Standard deviation

Laplacian of Gaussian function is then

$$G(x,\ y) = \frac{\partial^2 G\ (x,y)}{\partial x^2} + \frac{\partial^2 G\ (x,y)}{\partial y^2} = [\ \frac{x^2+y^2-2\sigma^2}{\sigma^4}]e^{\frac{-x^2+y^2}{2\sigma^2}} \qquad (6)$$

The Laplacian L (x, y) of an image with pixel intensity I (x, y) is given by: [16]

$$I\ (x, y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2} \qquad (7)$$

3.4 Robert's cross operator:

The Roberts Cross operator performs a simple, 2-D spatial gradient computation an

Image. (Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point). It is very similar to the sobel operator, consists of two convolution kernels. One is the rotation of 90 degrees of the other.

+1	0
0	-1

$\boldsymbol{G_x}$

0	+1
-1	0

$\boldsymbol{G_y}$

These computations can be done individual to get the $(\boldsymbol{G_x}, \boldsymbol{G_y})$, and combined to get the absolute magnitude of the gradient. Absolute magnitude of gradient of pixel can be calculating by using the following formula.

$$|G|=\sqrt{{G_x}^2 + {G_y}^2} \qquad (8)$$

This is approximated by $|G|=|G_x|+|G_y|$.

The angle of direction is measured by using this formula (relative to pixel grid) [17]

$$\theta = \arctan\ (G_y / \ G_x) - 3\pi/4 \qquad (9)$$

3.5 Canny edge detector:

Among all the edge detection methods canny edge detector is the widely used to identify the edges in the image. the main characteristics of canny detection are good edge detection, good localization and single response on the edges.

Good edge detection: During the detection of real edges there is a low probability to detection of false edges. Since these functions are decreasing functions which makes higher signal-to-noise ratio.

Good localization: The points which are identified as true edges by the canny operator are close to center of the true edges.

Single response on the edges: when multiple response on the same edge, one of them should be considered as the false edge.

In case of canny edge detector, if the gradient magnitude of the pixel is more than adjacent pixels then it can be considered as an edge.

Canny edge detector implemented in following steps.

i. To reduce the noise (ρ), image has to be smoothed by using Gaussian filter with fixed standard deviation.

ii. The gradient magnitude and edge direction has to be computed at each and every point in the image using the formula.

iii. Gradient Magnitude = ${G_x}^2 + {G_y}^2$ (10)

iv. Edge direction = $\tan^{-1}\frac{G_x}{G_y}$ (11)

v. A point whose strength is locally maximum in the direction of gradient is defined as edge [12,13].

vi. Among all the edge detection operators, one edge detection operator needs to be chosen in such a way that which can resolve the problems like missing of true edge, detecting false edges, edge localization and high computational time due to noisy [18]. For these problems are resolved by using Canny edge detection operator.

4. Conclusion:

This paper discusses various edge-based image steganographic techniques in spatial domain. In general edge detector techniques such as: (i) canny edge, (ii) sobel edge, (iii) fuzzy, (iv) Prewitt's, (v) Robert's cross operator are exist in literature. Further, we discussed these edge detection techniques in detail to identify the edges in an image. From our investigation we found that, the canny edge detector is better compared to other edge detection techniques. In future we will develop a hybrid edge detector using the benefits from the existing techniques.

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