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RESEARCH ARTICLE

COMPARATIVE STUDY OF EDGE DETECTION TECHNIQUES FOR STEGANOGRAPHY.

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Abstract

Security of private information is important thing over the internet. So, it is very necessary to hide the data in such a way that attacker cannot access it .There are different algorithms to hide the data into video. In this paper, we describe the different edge detection techniques for finding the edge pixels of image along with their mask.

Introduction:-

In recent times, the need for digital communication has increased dramatically and as a result, the internet has become essentially means more effective and faster communication to digital communication. Steganography is the method for invisible communication between two members or parties. Steganography employs medium such as image, audio, video or text to conceal any information in it, so that does not draw any interest and looks like an innocuous medium [1].Steganography means not to change the composition of the secret message, but cover it inside a cover object. After hiding procedure cover object and stego object are similar [2].

Background for Steganography:-

The word steganography is derived from Greek word which means "covered writing". It has been used in different forms for thousands of years. In ancient times, kings were used skull of slave for sending secret information. The shaved head is used to write secret messages and after his hair grew back, the slave is send with message. At the receiver side, intended recipient remove hair of slave for reading the message [3].

Giovanni Battista Porta narrated how to transfer a message within a hardboiled egg. In this message wrote on the outer shell of egg using a special ink. This special ink is made up of a very small amount of potash alum (nearly 30 grams) and of vinegar (nearly 500 ml). The solution enters the porous covering, leaving no noticeable hint on the shell but the message is marked on the surface of the hardened egg albumen (white part of egg), the recipient can read message after removing shell [6].

Ancient Chinese used to write secret message on small pieces of silk, then packed down it into balls and covered it with wax to be bitten by a messenger and then recipient extract small piece of silk from the messenger's gastrointestinal[4,6].

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Adopted Methodology:-

Edge Detection:-

There are different patterns for hiding the data but among those pattern edge detection is a safe way for hiding the information [8].An edge is defined as the points in an image where brightness changes abruptly. Edge detection preserves the structural properties of an image [9].Edge detection field is developed its own in image processing.

Basically, edge detection used for feature detection and extraction. Practical applications in medical imaging, face recognition, study of astronomical structures and fingerprint recognition [10].Edges are substantial local modification in intensity of an image. They are the boundaries between image segments. Image processing; machine vision and computer vision generally require edge detection mechanism as an important tool, particularly in the field of feature detection and feature extraction as edges are main components for analysis of the most essential contained information in an image. The process of getting meaningful transitions in an image is called edge detection. The points where sharp modification in the brightness takes place generally from the boundaries between distinctly separate objects. An edge is defined by the boundary with which it separates the higher intensity of the image with that of the lower intensity. In image processing, an edge can be used as filter. For identifying sharp edges of image, these filters are used. Edge detection is helpful in image segmentation, image reconstruction etc. Two important aspect of edge pixels are edge strength and edge direction. Many classical edge operators are available in the literature of image processing. Such as:

1. Sobel Edge Detector
2. Prewitt Edge Detector
3. Robert Edge Detector
4. Laplacian of Gausian(Log) Edge Detector
5. Canny Edge Detector

Edge Detection Steps:-

Edge detection has mainly three steps. These are as follows [11]

Filtration:-

Images are often corrupted by noise like salt and pepper, impulse and Gaussian type noise. For the reducing these noise, filtering is carried out.

Enhancement:-

It focuses on pixels where important change in local intensity values. It means the improving image quality. Its main purpose is to produce better and more suitable than original. Apply the filers on image for enhancement.

Edge detection:-

Different methods are used to decide which points are edge points and which edge pixels are removed as noise.

Different Types of Edge Operators:-

Robert Operator:-

It is the classical operator which is based on gradient. For obtaining the gradient magnitude and directions convolve the input image with default kernels. So it is not compatible to today's technology and more sensitive to noise [10].It is oldest and simplest edge detector in image processing. Due to its restricted functionality, it is not used all over .Its drawback is that it is an asymmetric. Robert edge detector is unable to detect edges which are multiple of 45 degrees [8]. Its mask is as follows.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Fig.1:-Masks for Robert operator

Above mask used to approximate digitally the first derivatives as differences between the adjacent pixels [8, 11].

Prewitt Operator:-

Prewitt filter is rapid method for edge detection. Contrasted noiseless images are used by it. It gives better results than sobel operator. Prewitt edge detector uses following 3×3 total convolution mask is used to approximate digitally the first derivatives Gx and Gy [8, 11].

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

Gx

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

Gy

Fig. 2:-Masks for Prewitt Operator

Above convolution mask is used in x, y, directions to detect gradient [8].

Sobel Operator:-

It gives corresponding gradient or normal vector at each pixel of an image. First order derivatives are approximated digitally by differences between rows and column computes the gradient. This operator consists of above pair 3×3 convolution kernel. These kernels are made to respond maximally to edges running at the 45 degree to the pixel grid. Other kernels are obtained by rotating first kernel at 90^0 degrees [10]. These for getting the measurement of the gradient components in each orientation applied the kernel separately to the input image. After that combined together for getting the absolute magnitude of the gradient at each point and the orientation of that gradient [8].The gradient magnitude is given by

$$|G|=\sqrt{Gx2+Gy2} \quad (1)$$

Approximate magnitude is calculated using

$$|G|=|Gx + Gy| \quad (2)$$

The angle of orientation of the edge giving rise to special gradient is given by

$$\theta=\arctan (Gy / Gx)-3\pi/4 \quad (3)$$

Sobel operator has following mask.

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

Gx

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

Gy

Fig.3:-Masks for Sobel Operator

As compared to Robert operator, sobel operator is less sensitive to noise and also very few computation ability .As having larger mask, errors due to effects of noise are reduced by local averaging within the neighborhood of the mask. [10].

Canny Edge Detector:-

Initially, classical operators are used for edge detection but they did not produce sharp edges and were more sensitive to noise. Laplacian based Marr-Hildreth operators detecting false edges. In 1986, John F. Canny proposed algorithm for edge detection. This algorithm found edges of noisy image. His aim was to find optimal edge detection algorithm for reducing possibilities of false edges and produce sharp edges. Basically, edge detection is the method of identifying points in a computer image at which the image vividness changes suddenly, for example, pixels differing from low intensities to high intensities or vice versa, exhibiting some discontinuities [13].It is widely used with further improvements in today's image processing [10].The plan of edge detection is to detect and confine important procedures and changes in the properties of the image. The best thing about canny edge detector is that it

has three characteristics for which it is mostly employed in machine vision and image processing to find the sharp intensity modification and the object boundaries in an image. They are:

1. All the important edges are preserved, no false edges are considered and at the same time magnitude of error detection should be low.
2. Minimum distance should be maintained between the real and located position of the edge.
3. There is only one response to a single edge.

In case of canny edge operator, a pixel is considered to be an edge pixel, if the gradient magnitude of that particular pixel is more than those of the pixels on either side of it and in the direction of utmost intensity modification. The procedure for canny edge detector implementation is summarized in the following steps:
The canny detector is the strong edge detector in function edge .The method is as follows

1. To reduce noise, the image is smoothed using Gaussian filter with a specified deviation sigma.
2. Find the intensity gradients of the image.
3. Apply non-maximum suppression to get rid of spurious response to edge derivative.
4. Apply double threshold to determine potential edge.
5. Track edge by hysteresis .Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.
6. This edge detection provides good detection, clear response and good localization [10, 14, 15].

Laplacian of Gaussian or Marr Hildrith operator:-
This function is known as LoG. The laplacian of an image focuses regions which having quick intensity change. Hence it is used for edge detection. Smoothing filter is used for filtering process [8]. The smoothing is carried out by a convolution with a Gaussian function. By applying a convolution with the derivative of the convolution mask getting smooth function on which derivatives applied. Gaussian has its one remarkable characteristics is circular symmetry which is consistent with the implicit anisotropy. The laplacian operator normally takes a single grey level image as input and produces another grey level image as output.The Marr-Hildreth edge detector was a very accepted edge operator previous to Canny proposed his algorithm. It is a gradient based operator which utilizes the Laplacian to get the second derivative of an image. It works on zero crossing method. It uses both Gaussian and laplacian operator so that Gaussian operator decreases the noise and laplacian operator detects the sharp edges.

This operator has two drawbacks:

1. It creates false edge means generates responses which do not correspond to edges.
2. At curved edges produces severe localization errors [10, 14].

-1	2	-1
2	-4	2
-1	2	-1

Gx

1	1	1
1	-8	1
1	1	1

Gy

Fig.5:-Masks for Laplacian of Gaussian

Steps for Canny Edge Detection:-
Noise reduction by smoothing:-
All edge detection results are easily affected by image noise. It is necessary to filter out the noise to avoid detection caused by noise. For smoothing image, a guassian filter is applied to convolve with the image. In this step, slightly image smoothing done to decrease the effect of noise on the edge detector. Mathematically, the smooth resultant image is given by $F(i, j)=G * I(i, j)$ (4)
It is important that the selection of the size of the Gaussian kernel will affect the performance of edge detector. If the larger in size then detector's sensitivity to noise is lower. Generally 5×5 is good size for most cases, but it is vary depending on specific situation [8].

Finding the intensity gradient of the image:-
An edge in an image may point in a variety of directions. Hence, canny algorithm uses four filters to detect edges in the blurred image .It is used to detect horizontal, vertical and diagonal edges in the blurred image. Sobel operator is used to determine the gradient at each pixel of smoothed image. Sobel operators in i and j directions are given as

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

Gx

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

Gy

Fig.4:-Masks for finding the intensity gradient of image

Non maximum suppression:-
Non maximum suppression is passed out to conserve all local maxima in the gradient image, and deleting all else this results in thin edges. For a pixel M (i, j):

Firstly round the gradient direction ɵ nearest 45 °, then compare the gradient magnitude of the pixels in positive and negative gradient directions i.e. If gradient direction is east then compare with gradient of the pixels in east and west directions say E(i,j) and W(i,,j) respectively. If the edge strength of pixel M (i, j) is largest than that of E (i, j) and W (i, j), then preserve the value of gradient and mark M (i, j) as edge pixel, if not then suppress or remove.

Hysteresis Thresholding:-
Generally set threshold too high can drop important information. If we set threshold too small can take irrelevant information e.g. noise. But canny algorithm use two high and small thresholds. Hence canny algorithm provides more flexibility for edge detection. By using this found possible edges [10]. The outputs of non-maxima suppression still include the local maxima formed by noise. Instead choosing a single threshold, for avoiding the problem of streaking two thresholds t_{high} and t_{low} are used. For a pixel M (i, j) having gradient magnitude G following conditions exists to detect pixel as edge:

1. If $G < t_{low}$ then discard the edge.
2. If $G >$ than t_{high} then keep the edge.
3. If $t_{low} < G < t_{high}$ and any of its neighbours in a 3 ×3 region around it have gradient magnitudes greater than t_{high} keep the edge.
4. If none of pixel (x, y)'s neighbours have high gradient magnitudes but at least one falls between t_{low} and, t_{high} search the 5 × 5 region to see if any of these pixels have a magnitude greater than thigh. If so, keep the edge. Else, discard the edge [10].

Conclusion:-
In the era of fast internet communication, video Steganography has become necessary technique for information security. In video, we can hide more data than image. In this paper, we have studied different edge detection techniques with their respective steps. Among these techniques canny edge detector give more edge pixels for hiding the data than other techniques like Prewitt, Sobel, Robert etc.

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