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Image Enhancement and Compression using Edge Detection Technique

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Abstract - *In the recent decades, the consistent improvements are being made in both image and video processing enhancement and compression methods to improvise the storage space and transmission of visual information. The main agenda of image quality enhancement and compression is to minimize the image data that is irrelevant in order to store or convey data in a suitable efficient way. In the last few years, the demand for the development of the multimedia product grows fast resulting in the shortage of bandwidth and storage space of the memory. As a result of which, the concept of image enhancement and data compression is very important to save the memory space and the bandwidth during transmission. In the information theory, source coding used for compression is a method of coding the information using less number of bits. In this proposed framework, the concept of both image enhancement and compression can be achieved simultaneously with the use of edge detection techniques. In this regard, the three important edge detection techniques such as canny edge detection, sobel edge detection and prewitt edge detection techniques are being used to achieve the best possible results in terms of both image quality as well as compression ratio.*

Key Words: Enhancement, Compression, Wavelet, Inpainting, Exemplar selection, Skeletonization

1. INTRODUCTION

Image enhancement and image compression forms the major steps and basic preprocessing steps in the field of image processing. Image enhancement improvises the visual quality of the image. Image compression reduces the storage space required to save an image by retaining the same physical size as that of the original image. The use of the compression techniques helps in the less usage of the space of hard disk. It is a method that employs encoding of original image with less number of bits. The goal is to reduce the number of bytes required to save an image and at the same time restore the quality of the image. The main advantage of doing it is that one can save more number of images in the reasonable amount of memory space available. Thereby it also reduces the time consumption to send the images across the internet and also helpful in downloading the images from the web pages.

There are various to enhance and compress the image files at the same time. The most commonly used formats that is currently in trend is JPEG and GIF formats. The JPEG format is frequently used for saving photographs and the GIF format is best used for line art and to save the geometric shapes that are simple. Other techniques that are being used for compression are fractals and wavelets. PNG format may replace the GIF format eventually over the time.

Any data in the text format or a program can be compressed to some extent without encountering the errors and this technique is called lossless compression. In the data files, it is very important for the compression to be lossless because even a single error can extensively change the mean of the data, or interrupt a program. In this technique the loss in the quality is not evidentiary. There is no particular point called as critical point to which the data can be compressed accurately and beyond of which it is highly impossible.

1.1 Related Work

To start up research on any work, it is very much necessary to go through some of the topic relevant papers and articles to have a better idea. In this regard, few of the related work are as follows:

Amir S. and William[1] developed an image multilevel resolution transformation which is well suited for both the lossless and lossy compression techniques. In this work, the amount of bits that is needed for the transformed output image is adjusted to be small through various computations.

T. Prabhakar, V. Jagan[2] proposed a framework on DCT and wavelet transformations based on image compression The proposed work aims at selecting proper threshold to analyze the compression. Wavelet transforms are used to find the discontinuities, blemishes and patches in an image and fails to find the continuities present in an image.

M. Kumar, S. Loonker[3] developed Huffman coding for the purpose of compression. This technique is used at places where there is tolerance for visual quality as the compression ratio achieved is more in this case.

Samir kumar and Tuhin Utsab[4] developed run length technique for encoding in image compression. In this technique, the data is in a run length of about four to five characters. With the growth of technology in terms of digital media, the need for efficient transmission with accuracy along with the reduced storage space is the main criterion. Hence, with these ideas in mind, the proposed efficient method is edge detection techniques.

2. METHODOLOGY

The proposed framework for edge detection is depicted in Fig.2.1.

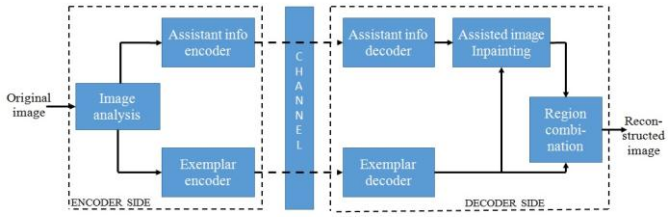

Fig -1: Block diagram of Edge detection

In the proposed methodology, at the encoder side of the block diagram, the input original image is analyzed. This image analysis preserves or retains the regions of partial image as exemplars and sends them to the exemplar encoder for the purpose of compression. The information about the skipped regions is designated as assistant information. Finally, the assistant information which was coded and the coded exemplars are combined together which forms the final compressed output image of the original image.
Correspondingly, at the other side of the decoder, the assistant information and the exemplars are decoded and they are reconstructed. At the final stage, the regions that were skipped out at the encoder side are again restored by the method of edge based image in painting which helps in retaining the visual quality of the image.

Edge detection mainly aims at detecting the points in an image which is digital where its brightness changes or in other terms, the one which has discontinuities. It is the basic tool in the case of image processing and machine learning. An edge in any image represents the change over the intensity of an image. The specific points where brightness rapidly changes are collectively organized into edges.

Basically, there are three types of edge detection techniques such as Canny edge detection technique, Sobel edge detection technique and Prewitt edge detection technique.
The Flowchart of the overall process is as shown in Fig 2.

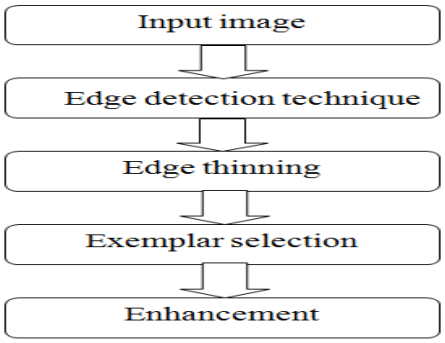

Fig -2: Flowchart of the overall framework

2.1 Canny Edge Detection

The canny edge detector was developed by John Canny and is regarded as the multistage algorithm. Canny edge operator is applied to wide range of edges. The canny edge detector is also termed as optimal edge detector. The main goal of canny edge detector is to achieve both enhancement and compression without the loss of any important edge. The second criterion of canny edge detector is to have all the edges well localized. It is obtained by convolving at each point of the two images Gx and Gy with the values given below

$$G_x = \begin{bmatrix} -1 & 1 \\ -1 & 1 \end{bmatrix} \qquad G_y = \begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix}$$

The magnitude and the orientation of the gradient is computed as shown below

$$M[i,j] = \sqrt{P[i,j]^2 + Q[i,j]^2}$$

$$\theta[i,j] = \tan^{-1}(Q[i,j], P[i,j])$$

Where P and Q are the two images and I,j are values of the pixel in horizontal and vertical directions.
The canny edge detector algorithm mainly follows the five important steps:
i. Guassian filter is used to filter out the noise which inturn smoothens the image of interest.
ii. It is necessary to find the intensity of the image.
iii. To apply a non-suppression algorithm in order to get rid of the false edges in an image.
iv. A particular threshold is applied on the obtained image.

2.2 Sobel Edge Detection

The Sobel edge detector is sometimes called as a sobel filter which is used in image processing and also in computer vision. It was developed by Irwin Sobel. The sobel edge detector is basically a discrete and differentiation operator.

The sobel operator is mainly based on convolving an image with the filter or a kernel both in horizontal and vertical directions. The gradient approximations on the other hand helps in having relatively crude and hgh frequency of the image. Another operator called Kayyali operator which is used for edge detection is developed from the sobel edge operator. The output of the sobel edge operator is 2- dimensional map with the gradient at every point. It is processed and can be viewed as an image itself with the edges as white lines.
The sobel edge detection operator is a 3X3 convolution mask given by

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

Gx

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

Gy

Where Gx and Gy are the gradients of the two image.

2.3 Prewitt Edge Detection

The prewitt edge operator is similar to sobel edge operator with the different values in the convolution. As a result of which the accuracy in terms of compression ratio is more with respect to prewitt edge operator than sobel and canny edge operator. Prewitt edge operator discrete differentiation operator which computes the intensity of the gradients of an image. Prewitt edge detector is 3X3 convolution operator with the change in values from the sobel edge operator which makes it more accurate.

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

Gx

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

Gy

Where Gx and Gy are gradients of the intensity of an image.

2.4 Edge Thinning

Edge thinning is performed to remove the unwanted falsely detected points in an image. The process of edge thinning is carried out after the image is filtered from the noise using guassian filter or median filter. The process of edge thinning follows the simple process.

i. Choose a type of connectivity, maybe 8,4 or 2 connectivity.
ii. The 8 connectivity is preferred the most as it covers all the directions of the target pixel.
iii. Remove the points in North, South, East and West directions.
iv. Do this in multiple passes and remove a point if the point is isolated, if it is not present at the end of the line or if it is not surrounded by the neighboring pixels.

Therefore, edge thinning plays a vital role to reduce the redundancy data in an image by retaining the physical size of the image and helps to achieve increased compression ratio. The method of edge thinning is mainly used for skeletonization.

2.5 Exemplar Selection

Exemplar selection is performed once all the edges are available. In order to make it simple, the exemplar selection is performed at the block level. In the case of exemplar selection, an input image is divided into non-overlapping 8X8 blocks. Depending on the distance from the edges, the regions are classified as structural and textural regions. The blocks at the encoder which are not selected as exemplars are removed or skipped at the encoding. The exemplars are classified as necessary ones and additional ones. In general, an image can never be restored properly with the only necessary ones. Instead they make use of additional ones which also results in improved visual quality.

2.6 Inpainting Technique

Inpainting is a method of restoring the lost parts of the images. Inpainting technique is also termed as image interpolation in the digital world. The inpainting technique not just help in restoring an image but also helps in the removal of undesired objects and unwanted writings in an image. The main concern of inpainting technique is to fill-in the regions to be inpainted as and when they are selected. The main advantage of image inpainting is that it helps to enhance the visual quality of the image and makes it look good for human perception.

3. EXPERIMENTAL RESULTS

The following are the results of each stage carried out.

3.1 Input Images

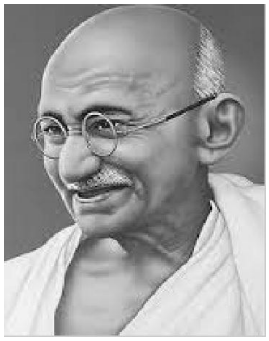

Fig -3: Mahatma Gandhiji

Fig -4: National Flag

Fig -5: Computer

3.2 Edge Detected Images

The input images are edge detected using the edge detection algorithm.

Fig -6: Canny edge detected Mahatma Gandhiji

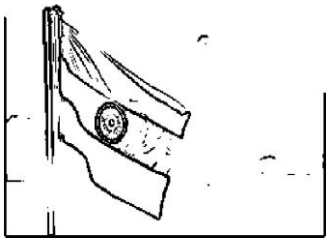

Fig -7: Sobel edge detected National Flag

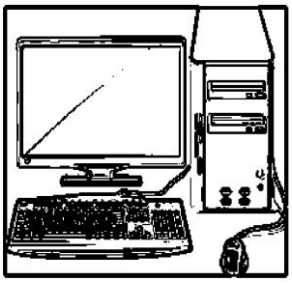

Fig -8: Prewitt edge detected Computer

3.3 Edge Thinned Images

The edge detected images are thinned in order to achieve accuracy at the time of reconstruction.

Fig -9: Edge thinned Mahatma Gandhiji

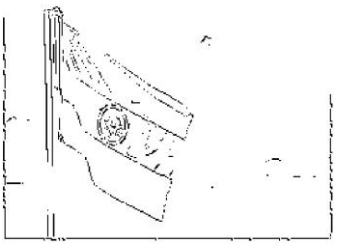

Fig -10: Edge thinned National Flag

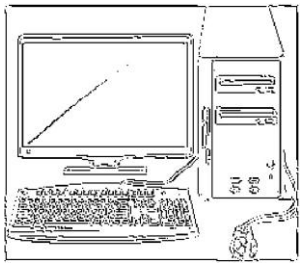

Fig -11: Edge thinned Computer

3.4 Exemplar Selected Images

After edge thinning of an image, the wanted information are selected using exemplar selection.

Fig -12: Exemplar selected Mahatma Gandhiji

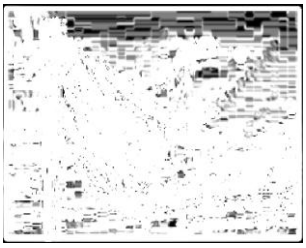

Fig -13: Exemplar selected National Flag

Fig -14: Exemplar selected Computer

3.5 Inpainted images

The image is reconstructed using edge based inpainting once all the wanted portions of the image is obtained.

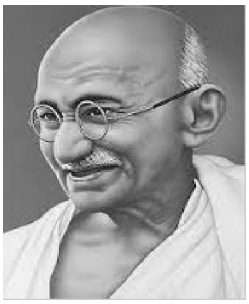

Fig -15: Inpainted Mahatma Gandhiji

Fig -16: Inpainted National Flag

Fig -17: Inpainted Computer

3.6 Comparision Results

The comparision of all the three techniques in terms of the compression ratio is mentioned as follows:

INPUT IMAGE	TECHNIQUE USED	ORIGINAL IMAGE SIZE	OUTPUT IMAGE SIZE	COMPRESSION ACHEIVED
MAHATMA GANDHIJI	Canny	299 KB	249 KB	16.72%
NATIONAL FLAG	Sobel	90.7 KB	66.8 KB	22.35%
COMPUTER	Prewitt	83.9 KB	64.7 KB	26.88%

Table -1: Comparision Results

4. CONCLUSION AND FUTURE WORK

The compression framework when it adapts inpainting techniques remove the visual redundancy in the original natural images. The adapted techniques extracts the distinctive features in the images. The skipped regions at the encoder side during the exemplar selection are recovered back at the decoder side. With the edge detection techniques proposed, it is possible to obtain a compressed image without any loss or degradation of the original data.

4.1 Future Work

In the current scheme, the further improvement are still promising. Firstly, the selected exemplars and the assisted information can be compressed in bit-stream with more compaction. Secondly, the extraction of the distinct features can be improved with their adaptability and flexibility. Besides all this, the technique of image inpainting is a challenging work when different assisted information are given and it is necessary to put more efforts to tackle this problem in the future.

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BIOGRAPHIES

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