A Brief Study of De-Noising an Image and Compression and Decompression Using Huffman Coding Techniques

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Abstract---Digital image processing is a procedure in which the image processing is done on the images. The digital image processing tends to have wider advantage over analog image processing. This paper deals with restoring the original image by de-noising the image. The de-noising can be done based on the noise type in the image .There are many filters used for the removal of noises in the image. In this paper we also deal with a simple and fast lossy compression and decompression of an image . The decompressed image is close to the one in the original image. The strategy does not restrict itself to any form of image , it works well with all type of images .

Key Words:- Lossy image compression, Digital image processing, Image types, Filters

I. INTRODUCTION

Digital Image Processing is a component of digital signal processing .The area of digital image processing refers to dealing with digital images by means of a digital computer. Digital image processing has several advantages above analog image processing; it allows a considerably wider collection of algorithms to be apply to input data and can keep away from problems for instance the build-up of noise and signal deformation during processing. Digital Image Processing involves the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximize the clarity, sharpness of image and details of features of interest towards extraction of information & further analysis. Digital image processing is a very broad subject and it often involves the procedures which can be complex mathematically, but the central idea behind digital image processing is simple. The digital image is given as input into a computer and computer is programmed to change these data with the help of an equation, or with series of equations and then store the values of the computation for each pixel or picture element.

The results form a new digital image that may be display or it can be recorded in pictorial format or it may itself be further changed by additional computer programs. To enhance certain features in the data and to remove noise from image, the digital data is subjected to different image processing operations.

Image processing involve changing the quality of an image in order to:

– Improve the pictorial information of an image for human interpretation,
– Render the image should be more suitable for independent machine perception.

The methods of Image-processing may be grouped into main three functional categories:

A. Image Restoration: compensate for noise, data errors, and the geometric distortions that is introduced while recording, scanning, and the playback operations.

– It restore the periodic line dropouts
– Used for restoring periodic line striping
– Good for filtering of random noise
– Enhance geometric distortions

B. Image Enhancement:Processing an image so that the result is more suitable for a particular application. Such as sharpening or de-blurring an out of focus image, highlighting the edges of image , improving the contrast of image or increase the brightness level of an image, remove the noise from noisy image.

– Used for Contrast Enhancement
– Intensity, saturation and hue transformations
– Edge enhancement
– Producing the synthetic stereo image

*C. Image Analysis**:*** Image analysis is concerned with making a quantitative measurement from an image to produce a description of image. Image analysis techniques extract the certain features that aid in the recognition of an object.

II. IMAGE AND ITS TYPES

An image may be well-defined such as a two-dimensional function F(a, b).Where a and b are spatial (plane) coordinate, and the amplitude of F at any pair of coordinates (a, b) is called the intensity or gray level of the image at that point. When a, b and the amplitude values of are all predetermined discrete quantity, we will call the image as digital image. A digital image is collection of a finite number of elements, in which each element has a certain value and location. These elements of digital image are known as image elements, picture elements, pels, and pixels. Pixel is the word mostly used refer to the elements of a digital image [1].

A. Types of Digital Images

1) *Binary:* In binary image the value of each pixel is either black or white. The image have only two possible values for each pixel either 0 or 1, we need one bit per pixel.

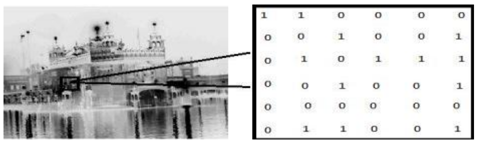

Fig. 1: Example of Binary Image

2) *Grayscale: In* grayscale image each pixel is shade of gray, which have value normally 0 [black] to 255 [white]. This means that each pixel in this image can be shown by eight bits, that is exactly of one byte. Other grayscale ranges can be used, but usually they are also power of 2.

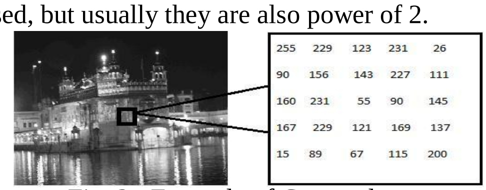

Fig. 2: Example of Grayscale

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3) *True Color or RGB:* Each pixel in the RGB image has a particular color; that color in the image is described by the quantity of red, green and blue value in image. If each of the components has a range from 0–255, this means that this gives a total of 2563 different possible colors values. That means such an image is "stack" of three matrices; that represent the red, green and blue values in the image for each pixel. This way we can say that for every pixel in the RGB image there are corresponding 3 values.

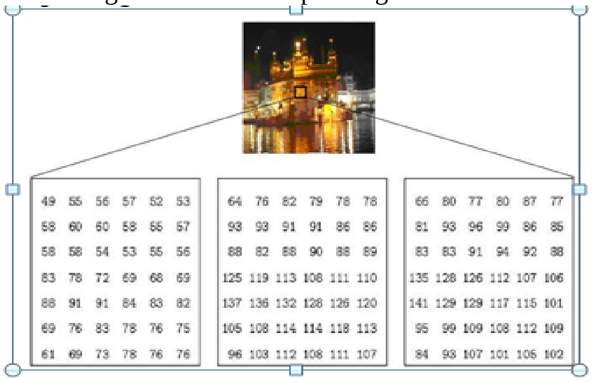


Fig. 3: Example of Color Image

4) *Indexed:* Mostly all the colors images have a subset of more than sixteen million possible colors. For ease of storage and handling of file, the image has an related color map, or we can say the colors palette, that is simply a list of all the colors which can be used in that image. Each pixel has a value associated with it but it does not give its color as for as we see in an RGB image. Instead it give an index to the color in map. It is convenient for an image if it has 256 colors or less. The index values will require only one byte to store each. Some image file formats such as GIF which allow 256 color only.

B. Digital Image File Types

1) *BMP:* Bmp stands for Bitmap. Every picture on a computer appear to be a BMP. In Windows XP the Paint program save its images automatically in bitmap format, however in Windows Vista images are saved now into JPEG format. Bitmap is the basis platform for many other file types.

2) *Benefits*: High quality image, Easy to change and edit, No loss in image through process

3) *Downfalls:* Difficulty while displayable on internet and large in file size.

4) *JPG, JPEG:* JPEG stands for Joint Photographic Experts Group .Jpeg format is mainly used for color photographs. It is not good with sharp edges and it tends to blur the image a bit. This format became trendy with the innovation of the digital camera. Digital cameras mostly download photos to our computer as a Jpeg format. Digital camera manufacturers obviously see the value in high quality images that eventually take up less space.

5) *Benefits:* Small size image, easily viewable from internet, Use millions of colors, and perfect for many type of images

III. NOISE MODELS

The main source of noise in digital images arises during image acquisition (digitization) or during image transmission. The performance of image sensor is affected by variety of reasons such as environmental condition during image acquisition or by the quality of the sensing element themselves. For instance, during acquiring images with CCD camera, sensor temperature and light levels are major factors that affecting the amount of noise in the image after the resulting. Images are corrupted while during transmission of images. The principal reason of noise is due to interfering in the channel which is used for the images transmission [3].We can model a noisy image as follows:

$$C(x,y)=A(x,y)+B(x,y)$$

Where A(x ,y) is the original image pixel value and B(x ,y) is the noise in the image and C(x ,y) is the resulting noise image.

A. Uniform Noise: The uniform noise cause by quantizing the pixels of image to a number of distinct levels is known as quantization noise. It has approximately uniform distribution. In the uniform noise the level of the gray values of the noise are uniformly distributed across a specified range. Uniform noise can be used to generate any different type of noise distribution This noise provides the most neutral or unbiased noise

Fig. 4: Uniform Noise

B. Gaussian Noise or Amplifier Noise: This noise has a probability density function [pdf] of the normal distribution. It is also known as Gaussian distribution. It is a major part of the read noise of an image sensor that is of the constant level of noise in the dark areas of the image.

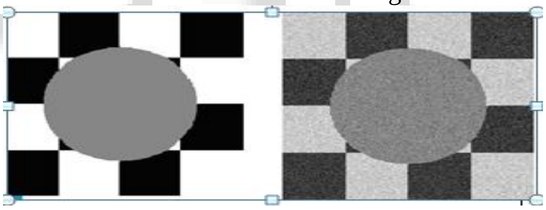


Fig. 5: Gaussian image

C. Salt and Pepper Noise: The salt-and-pepper noise are also called shot noise, impulse noise or spike noise that is usually caused by faulty memory locations ,malfunctioning pixel elements in the camera sensors, or there can be timing errors in the process of digitization .In the salt and pepper noise there are only two possible values exists that is a and b and the probability of each is less than 0.2.If the numbers greater than this numbers the noise will swamp out image. For 8-bit image the typical value for 255 for salt-noise and pepper noise is 0

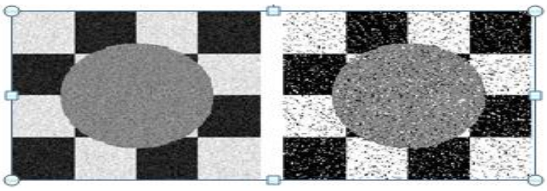
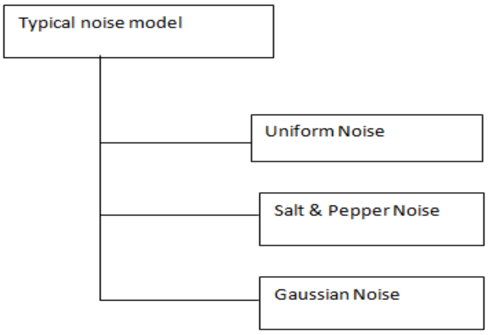


Fig. 6: .Salt & Pepper Noise

D. Reasons for Salt and Pepper Noise

- By memory cell failure.
- By malfunctioning of camera's sensor cells.

– By synchronization errors in image digitizing or transmission.



IV. FILTERS

A. Gaussian Filter: Gaussian filters square measure supposed to offer no overrun to a step operate input by reducing the increase and fall time,by that minimum cluster delay is caused. Mathematically, a Gaussian filter modifies the input by convolving with a Gaussian operate. The Gaussian filter is square measure used as a power tool.

Wiener Filter: By evaluating the estimation of the specified quiet signal, it's wont to scale back the noises within the signal. The Wiener filtering could be a linear estimation of the first image . The approach relies on a random framework. Wiener filters square measure categorised by the following: one. Assumption: signal and (additive) noise square measure stationary linear with identified spectral characteristics a pair of. Requirement: the filter should be physically realizable/causal system. 3. Performance criterion: minimum MMSE.

B. Average Filter: Mean filter, or average filter is windowed filter of linear category, that smoothes signal (image). The filter works as low-pass one. the essential plan behind filter is for any part of the signal (image) take a median across its neighbourhood.

V. COMPRESSON AND DECOMPRESSION

Storage and transmission of digital images has become more of a necessity than luxury these days. Hence the importance of image compression. It involves minimization of the number of information carrying units, pixels. This means that an image where adjacent pixels have almost the same val- ues leads to spatial redundancy. Any lossy compression technique has to achieve high compression ratios while maintaining high visual quality of the decompressed image [7].

During the last two decades, various lossy and lossless image compression tech- niques have been developed as discussed in [2]. Lossy coding methods provide high compression ratios but do not recover the ex- act data. While lossless methods recover the exact original data but do not compress the image to such extent as the former method. So, high compression ratios can be achieved for images where some loss of data does not matter. When a compressed image is de- compressed to the original one, some distor- tion/loss is acceptable provided image qual- ity is not compromised. This is because HVS (Human Visual System) does not de tect slight changes in the image. The same has been elaborated in [2]. Therefore, pixel values may differ slightly in the original and decompressed images and HVS will not de- tect the difference between them [3]. One method as in [4] gives good results but is hardware dependent. Recently neural net- works have also been used [5] for compress- ing images, but they have low compression rates.

Our purpose in this paper will be to discuss possible algorithm for compressing a still digital image and then acquiring back the original image from the compressed one. We use Huffman code procedure to re- construct the original image from the compressed one. The proposed decompression algorithm can also be universally used to enlarge any given image.

VI. COMPRESSION

Huffman code procedure is based on the two observations [9]. a. More frequently occurred symbols will have shorter code words than symbol that occur less frequently. b. The two symbols that occur least frequently will have the same length. The Huffman code is designed by merging the lowest probable symbols and this process is repeated until only two probabilities of two compound symbols are left and thus a code tree is generated and Huffman codes are obtained from labelling of the code tree. This is illustrated with an example shown in table

Original Source			**Source Reduction**		
S	**P**	**1**	**2**	**3**	**4**
a_2	0.4	0.4	0.4	0.4	0.6
a_6	0.3	0.3	0.3	0.3	0.4
a_1	0.1	0.1	0.2	0.3	
a_4	0.1	0.1	0.1		
a_3	0.06	0.1			
a_5	0.04				

S-source, P-probability

At the far left of the table I the symbols are listed and corresponding symbol probabilities are arranged in decreasing order and now the least t probabilities are merged as here 0.06 and 0.04 are merged, this gives a compound symbol with probability 0.1, and the compound symbol probability is placed in source reduction column1 such that again the probabilities should be in decreasing order. so this process is continued until only two probabilities are left at the far right shown in the above table as 0.6 and 0.4. The second step in Huffman's procedure is to code each reduced source, starting with the smallest source and working back to its original source [9]. The minimal length binary code for a two-symbol source, of course, is the symbols 0 and 1. As shown in table these symbols are assigned to the two symbols on the right (the assignment is arbitrary; reversing the order of the 0 and would work just and well). As the reduced source symbol with probabilities 0.6 was generated by combining two symbols in the reduced source to its left, the 0 used to code it is now assigned to both of these symbols, and a 0 and 1 are arbitrary appended to each to distinguish them from each other. This operation is then repeated for each reduced source until the original course is reached. The final code appears at the far-left in table 1.8. The average length of the code is given by the average of the product of probability of the symbol and number of bits used to encode it. This is calculated below: Lavg = (0.4)(1) + (0.3)(2) + (0.1)(3) + (0.1)(4) + (0.06)(5) + (0.04)(5) = 2.2 bits/ symbol and the entropy of the source is 2.14

bits/symbol, the resulting Huffman code efficiency is 2.14/2.2 = 0.973. Entropy, H=- j)

– Huffman's procedure creates the optimal code for a set of symbols and probabilities subject to the constraint that the symbols be coded one at a time.

VII. DECOMPRESSION

Huffman decoding

Original Source Reduction					Source Reduction					
S	P	Code	1		2		3		4	
a_2	0.4	1	0	1	0	1	0	1	1	0
a_6	0.3	0	0	0	0	0	0	0	0	1
a_1	0.1	11	0	11	0	10	0	1		
a_4	0.1	100	0	100	0	11				
a_3	0.1	1010	0	1010						
a_5	0	1011								

After the code has been created, coding and/or decoding is accomplished in a simple look-up table manner[16]. The code itself is an instantaneous uniquely decodable block code. It is called a block code, because each source symbol is mapped into a fixed sequence of code symbols. It is instantaneous, because each code word in a string of code symbols can be decoded without referencing succeeding symbols. It is uniquely decodable, because any string of code symbols can be decoded in only one way. Thus, any string of Huffman encoded symbols can be decoded by examining the individual symbols of the string in a left to right manner. For the binary code of table 3.2, a left-to-right scan of the encoded string 010100111100 reveals that the first valid code word is 01010, which is the code for symbol a3. The next valid code is 011, which corresponds to symbol a1. Valid code for the symbol a2 is 1,valid code for the symbols a6 is 00,valid code for the symbol a6 is Continuing in this manner reveals the completely decoded message a5 a2 a6 a4 a3 a1 , so in this manner the original image or data can be decompressed using Huffman decoding as explained above . At first we have as much as the compressor does a probability distribution. The compressor made a code table. The decompressor doesn't use this method though. It instead keeps the whole Huffman binary tree, and of course a pointer to the root to do the recursion process. In our implementation we'll make the tree as usual and then you'll store a pointer to last node in the list, which is the root. Then the process can start. We'll navigate the tree by using the pointers to the children that each node has. This process is done by a recursive function which accepts as a parameter a pointer to the current node, and returns the symbol.

Fig. 7: Original Image

Fig. 8: Decompressed Image

VIII. CONCLUSION

Enhancement of an noisy image is necessary task in digital image processing. Filters are used best for removing noise from the images. In this paper we describe various type of noise models and filters techniques. We also implement compression and decompression of an image. One area to improve is de-noising along the edges as the method we used did not perform so well along the edges. The future work of research would be to implement Wiener Filter in Wavelet Domain.

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