Lossy Compression of a Gray Scale Image using Generalized Modified Gray Scale Quantization

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***Abstract*—In this paper we have used generalized modified gray scale quantization method, which is applicable for gray level images. On treating each component image as a gray level image, and adopting the modified gray scale quantization method, lossy compression is achieved. This process leads to a significant compression and reduction in size.**

***IndexTerms*—Image compression, Lossy compression and Modified Gray Scale Quantization**

I. IMAGE COMPRESSION

In today's fast growing life, speedy communication plays an important role. Transmission time is an important factor to be considered. There are lots of multimedia contents over an internet. Sending and sharing these content having large file size is of major concern. Image compression reduces the file size, and in this way these reduced size file takes less interval of time over a communication channel. Image compression address the problem of reducing the amount of data required to represent a digital image in order to be able to store or transmit data in an efficient form. In past bandwidth compression were used, now a day's digital compression is widely used.

II. NEED OF IMAGE COMPRESSION

Everyday enormous amount of information is stored, processed and transmitted digitally. The images contain large amount of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore we need to compress an image by storing only the essential information needed to reconstruct the image [1]. Image compression is useful process to save lots of space while sending images from one place to another. It eliminates the redundant part and functions which can be generated at the time after decompression. An image can be thought of as a matrix of pixel values. In order to compress the image, redundancies must be exploited, for example, areas where there is little or no change between pixel values. When we transmit any image we should convert it into digital form and the information is sent in the form of signals that is wavelets. But there are lot noises or redundancy added into it automatic. So it's very important that when we collect the output information at receiver side it should be in original form. By removing the redundant data, image can be represented in a smaller number of bits, with higher compression ratios and minimum degradation in quality image

III. TYPES OF IMAGE COMPRESSION

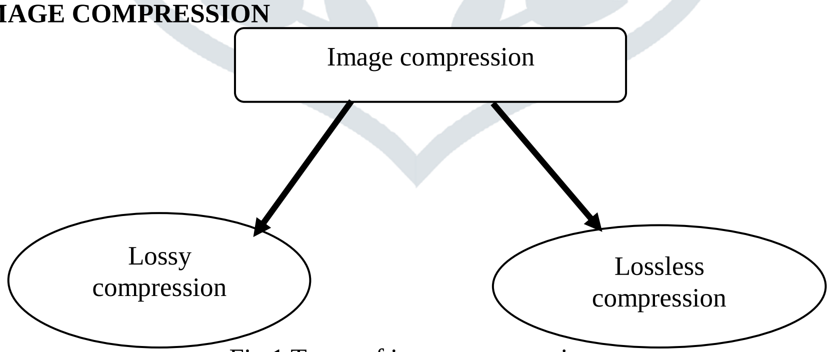

Fig.1 Types of image compression

Image compression techniques can be broadly classified into two categories that is lossless and lossy compression. In lossless compression, the original image can be reconstructed from the compressed image. This technique is widely used in medical imaging since they do not add noise to an image. In lossy compression technique, the reconstructed image contains some degradation as compared to the original one but it is nearly close to it. This technique provides much higher compression ratios than the lossless scheme.

IV. IMPROVED GREY SCALE QUANTIZATION

IGS are used to eliminate false contouring in images and also used for image compression. The pseudo code for performing IGS using matlab is given below.

```
mult = 256 / (2^bits)
mask = 2^(8 - bits) - 1
prev_sum = 0
for x = 1 to width
    for y = 1 to height
        value = img[x, y]
        if value >> bits != mask:
            prev_sum = value + (prev_sum & mask)
        else:
            prev_sum = value
        res[x, y] = (prev_sum >> (8 - bits)) * mult
```

V. DESIGN AND IMPLEMENTATION

TABLE 1 REDUCTION TABLE [2]

Subinterval of the gray level values(G)	Approximate gray level value(G) of any pixel in the interval	Gray level values in Reduced form
[0,7]	0	0
[0,23]	16	1
[24,39]	32	2
[40,55]	48	3
[56,71]	64	4
[72,87]	80	5
[88,103]	96	6
[104,119]	112	7
[120,135]	128	8
136,151]	144	9
152,167]	160	10
[168,183]	176	11
[184,199]	192	12
[200,215]	208	13
[216,231]	224	14
232,247]	240	15
[248,255]	240	15

Algorithm

- Table 1 Representation of gray level values in reduced form (include only col1 and col3)
- Let the component images be represented by the matrices X, Y, and Z where X, Y, and Z correspond to the colors R, G, and B respectively.
- Then take X and say that the first element is 193 which according to the table 1 will become 12.

$$X = \begin{bmatrix} 193 & 182 & 175 & 133 & 83 & 44 & 29 & 39 \\ 199 & 177 & 198 & 198 & 162 & 87 & 36 & 41 \\ 216 & 206 & 223 & 224 & 188 & 110 & 50 & 49 \\ 199 & 191 & 205 & 204 & 195 & 151 & 129 & 176 \\ 189 & 203 & 203 & 207 & 228 & 228 & 217 & 231 \\ 190 & 219 & 216 & 194 & 193 & 202 & 222 & 249 \\ 215 & 231 & 255 & 249 & 229 & 205 & 212 & 237 \\ 246 & 239 & 255 & 255 & 255 & 216 & 190 & 199 \end{bmatrix} \quad (1)$$

$$Y = \begin{bmatrix} 163 & 152 & 149 & 108 & 59 & 22 & 11 & 24 \\ 171 & 148 & 169 & 169 & 135 & 63 & 14 & 22 \\ 187 & 177 & 193 & 192 & 157 & 80 & 22 & 25 \\ 167 & 160 & 173 & 170 & 159 & 113 & 91 & 142 \\ 156 & 172 & 169 & 168 & 187 & 186 & 174 & 191 \\ 155 & 186 & 178 & 155 & 152 & 159 & 179 & 209 \\ 180 & 197 & 221 & 206 & 186 & 162 & 169 & 196 \\ 208 & 203 & 213 & 221 & 210 & 171 & 145 & 156 \end{bmatrix} \quad (2)$$

$$Z = \begin{bmatrix} 65 & 56 & 56 & 26 & 0 & 0 & 0 & 19 \\ 71 & 48 & 65 & 75 & 64 & 15 & 0 & 16 \\ 87 & 73 & 83 & 91 & 75 & 18 & 0 & 1 \\ 66 & 54 & 64 & 63 & 62 & 28 & 20 & 81 \\ 53 & 66 & 62 & 63 & 82 & 86 & 80 & 106 \\ 53 & 83 & 79 & 54 & 46 & 54 & 75 & 114 \\ 78 & 97 & 126 & 111 & 81 & 50 & 56 & 91 \\ 109 & 106 & 124 & 128 & 106 & 56 & 26 & 44 \end{bmatrix} \quad (3)$$

- Then take X and say that the first element is 193 which according to the table 1 will become 12

$$X = \begin{bmatrix} 12 & 11 & 11 & 8 & 5 & 3 & 2 & 2 \\ 12 & 11 & 12 & 12 & 10 & 5 & 2 & 3 \\ 14 & 13 & 14 & 14 & 12 & 7 & 3 & 3 \\ 12 & 12 & 13 & 13 & 12 & 9 & 8 & 11 \\ 12 & 13 & 13 & 13 & 14 & 14 & 14 & 14 \\ 12 & 14 & 14 & 12 & 12 & 13 & 14 & 15 \\ 13 & 14 & 15 & 15 & 14 & 13 & 13 & 15 \\ 15 & 15 & 15 & 15 & 15 & 14 & 12 & 12 \end{bmatrix} \quad (4)$$

- Like this all pixels in X will be modified according to table1.

$$X = \begin{bmatrix} 203 & 184 & 83 & 34 \\ 203 & 204 & 165 & 35 \\ 237 & 238 & 199 & 51 \\ 204 & 221 & 201 & 139 \\ 205 & 221 & 238 & 238 \\ 206 & 236 & 205 & 239 \\ 222 & 255 & 237 & 223 \\ 255 & 255 & 254 & 204 \end{bmatrix} \quad (5)$$

- The same procedure is repeated for Y and Z also.

$$Y = \begin{bmatrix} 170 & 151 & 65 & 18 \\ 185 & 187 & 132 & 17 \\ 203 & 204 & 165 & 18 \\ 170 & 187 & 167 & 105 \\ 171 & 187 & 204 & 188 \\ 172 & 186 & 170 & 189 \\ 188 & 237 & 202 & 188 \\ 221 & 222 & 219 & 154 \end{bmatrix} \quad (6)$$

$$Z = \begin{bmatrix} 68 & 66 & 0 & 1 \\ 67 & 69 & 65 & 1 \\ 85 & 86 & 81 & 0 \\ 67 & 68 & 66 & 21 \\ 52 & 68 & 85 & 87 \\ 53 & 83 & 51 & 87 \\ 86 & 135 & 83 & 70 \\ 119 & 136 & 116 & 35 \end{bmatrix} \quad (7)$$

- After this we will try to compress the image column wise. We consider the first row first column element and first row second column element that is values 12 and 11. In binary 12 = 1100 while 11= 1011. Now when we combine these binary, i.e. 11001011, in decimal its value is 203.

$$C = \begin{bmatrix} 203 & 184 & 83 & 34 \\ 203 & 204 & 165 & 35 \\ 237 & 238 & 199 & 51 \\ 204 & 221 & 201 & 139 \\ 205 & 221 & 238 & 238 \\ 206 & 236 & 205 & 239 \\ 222 & 255 & 237 & 223 \\ 255 & 255 & 254 & 204 \end{bmatrix} \quad (8)$$

- Now 203 will be the first element of compressed X. we will compress all the elements from column 1 and 2 to new column 1 of compressed X. Like this now we will combine elements of columns 3 and 4, column 5 and 6, and column 7 and 8.

$$X = \begin{bmatrix} 221 & 205 & 90 & 34 \\ 253 & 254 & 205 & 57 \\ 221 & 239 & 253 & 255 \\ 239 & 255 & 255 & 237 \end{bmatrix} \quad (9)$$

- Now show matrix X that is matrix 5 and say that the same procedure is repeated for Y and Z. Now instead of 8 columns we have 4 columns only.

$$Y = \begin{bmatrix} 188 & 156 & 72 & 17 \\ 219 & 220 & 170 & 23 \\ 187 & 204 & 219 & 204 \\ 206 & 254 & 222 & 202 \end{bmatrix} \quad (10)$$

$$Z = \begin{bmatrix} 68 & 68 & 4 & 0 \\ 84 & 84 & 84 & 1 \\ 51 & 69 & 83 & 85 \\ 87 & 137 & 87 & 66 \end{bmatrix} \quad (11)$$

- Now we will try to compress X in matrix 5 equation rows wise also X in matrix 5 is again mapped using table 1. For example, 203 will become 13 and so on.
- Now whatever we did in step 8 will be repeated for rows now. For e.g. First row first element 13 in binary is 1101 and second row first element again 13 in binary would be 1101. So combining them we get 11011101 which is 221 in decimal.
- Like this we will combine all elements of row1 and row2 to get new row in X that is in matrix 9. Same procedure will be followed to combine elements of row3 and row4, then 5 and 6, and finally row 7 and 8.
- Now show matrix X that is in matrix 9 and say that the same procedure is repeated for Y and Z. Now instead of 8rows we have 4 rows only.
- Now we concatenate i.e. combine all X,Y and Z that is the matrices (9), (10) and (11), to get final C that is matrix 12.

$$C = \begin{bmatrix} 221 & 205 & 90 & 34 \\ 253 & 254 & 205 & 57 \\ 221 & 239 & 253 & 255 \\ 239 & 255 & 255 & 237 \end{bmatrix} \quad (12)$$

VI. RESULTS AND DISCUSSION

i. (b)

(c)

Fig.2 Cameraman image reduced to half of its original,(a) Cameraman image (92 x 92),(b) Cameraman image (92x46) and (c) Cameraman image (46x46)

Table 1 Result

Sr. No.	Image	No. of rows	No of columns	Bit depth	File size
1	Inupt.jpg	92	92	8	3.5kb
2	Column wise compressed.jpg	92	46	8	2.6kb
3	Row wise compressed image.jpg	46	46	8	1.97kb

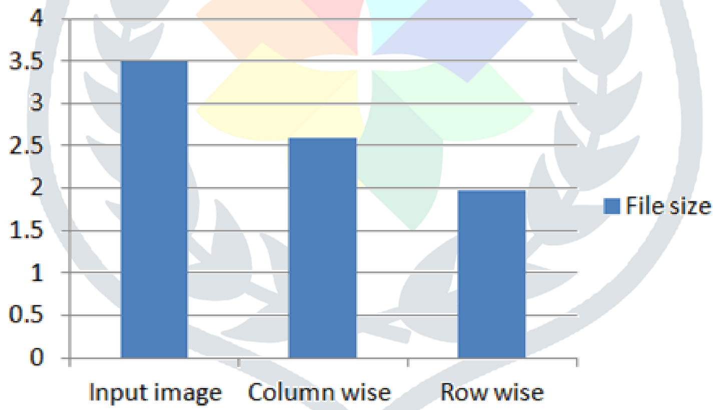

Fig.3 Graph of compressed images

We started with 92 × 92 matrixes and have reduced it to 46 × 46, in general our image will be reduced by half the original size.

CONCLUSION

We have made use of cameraman image which is shown in figure 2. After applying reduction process the image reduce to almost half of their size. We compress the cameraman images column wise and again compress it in the row wise manner, then the resultant images is reduced to one-fourth of their original size which is shown in figure 2. Matlab programming is used for the computations. The size of the original cameraman image is 3.5 KB and ultimately after computation the size is reduced to 1.97 KB, which is shown in figure 3 and table 2. Hence, significant compression is achieved by using generalized modified gray scale quantization method.

REFERENCES

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