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A method of compensating for the brightness of pixels in a block image structure and evaluating its effectiveness

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ABSTRACT: In this paper, we consider a method of compensating for the brightness of pixels in a block image structure. A new algorithm for the brightness conversion of images by searching and subtracting the minimum value of pixel brightness. The algorithm is based on dividing the image into separate blocks. Within each unit block of the image, an analysis of the pixels takes place and their minimum brightness value is individually determined. Further, this value is subtracted from the brightness value of each pixel belonging to this block.

Thus, the processing of images was carried out, which were divided into blocks of different sizes and compressed by a codec according to the JPG standard for various compression parameters. The efficiency of processing frames with this algorithm makes it possible to obtain high uniformity of compensated images and the smallest volume during compression. However, according to the results of the analysis, one of the main drawbacks of the brightness conversion method becomes obvious - this is a file containing metadata. It has a fairly large size, almost equal to the original.

KEY WORDS: luminance conversion, pixel brightness compensation, RLE compressor, JPG codec, pixel, image brightness, metadata, compression coefficient.

I. INTRODUCTION

One of the disadvantages of luminance conversion using pixel division is the occurrence of significant color distortion, due to rounding of the values obtained by dividing the brightness values of pixels.

To eliminate these shortcomings, a method was proposed for finding and subsequently subtracting the minimum brightness indicators of image pixels, divided into blocks. This method is based on the analysis of pixel values located inside some blocks into which the original image is divided. Inside each block, the minimum brightness value is searched, and then the found value is subtracted from each brightness value inside the given block. As a result, due to the fact that the adjacent pixels are not too different in their brightness value, a picture is obtained, the values of the brightness of the pixels in which are much lower than in the original one. Those. application of this method allows reducing the number of bits required for encoding the given image.

II. BACKGROUND OR RELATED WORK

In the development of algorithms for compressing various types of information for their transmission through communication channels, research has been conducted and significant theoretical and practical results have been obtained. The following studies of scientists, in particular, Doctor of Technical Sciences, Professor Yu. B. Zubarev, Doctor of Technical Sciences, should be considered close in essence to the issues being solved and the approaches used. Professor A. A. Gogol, Doctor of Technical Sciences professors V. N. Bezrukov, M. I. Krivosheev, I. N. Krasnoselsky, Yu. A. Semenov, L. Richardson (USA), R. Gonsales (USA), R. Woods (USA), K. Blatter (Germany), S. Winkler (Holland), K. Talukder (India), E. Stolnitz (Poland), K. Lees (France), M. Adler (Great Britain), P. Gubanov (USA), and etc.

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III. METHODOLOGY

The algorithm of work is as follows. Inside each block, each of the pixels is analyzed and the minimum brightness value of these pixels are determined. Then the analysis is transferred to the next block of the image and until the whole image passes. In Fig. 1. The order of the operation in a separate block is presented. The check begins with a zero pixel, sequentially until the end of the line, then the next line is moved. When all the pixels in the block are analyzed, processing of the next block begins.

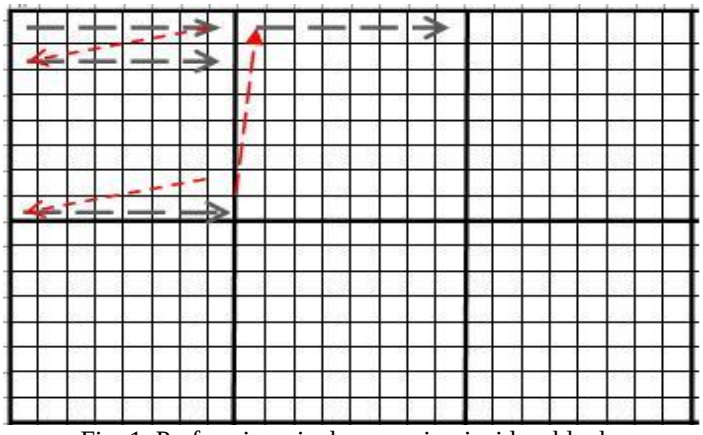

Fig. 1. Performing pixel processing inside a block.

During this analysis, a comparison is made of the brightness values of the pixels and a pixel is determined with the minimum brightness value for this block. During this analysis, a comparison is made of the brightness values of the pixels and a pixel is determined with the minimum brightness value for this block.

The block diagram of this algorithm is presented in Fig. 2.

In block 1 of this block diagram, the block size is entered, then in block 2 the condition is checked: whether all the pixels belong to the blocks, or there are pixels that are not included in the block. The reason for, a simple calculation is performed: if the result of multiplying the number of blocks (image size divided by the block size) by the block size is equal to the image size, then there are no "extra" pixels. If they are still there, then for them it is necessary to provide a value to determine the boundaries of subsequent cycles.

In blocks 3 and 4, the cycle boundaries are set based on the condition fulfilled in block 2. If all the pixels fall into blocks, the values of the boundaries of the cycles are set equal to the number of blocks in the image, if not, the boundaries of the cycles are assigned a value one more larger than the number of blocks, i.e. how would a backup block be created for pixels that did not fall into the blocks.

After this, the opening of two nested loops (blocks 5,6), necessary for the passage of the image through the blocks. The first cycle “rotates” until the cycle counter reaches a pixel value equal to the number of blocks in the image horizontally, the second cycle - until the cycle counter reaches a pixel value equal to the number of blocks in the image vertically. These values correspond to the boundaries of the array into which metadata is written, because for each block, only one minimum value will be found, which is an element of the metadata array.

Inside the loop, the initial pixel brightness values are set to 255 (block 7). This corresponds to the maximum brightness and is necessary so that in the subsequent search for the minimum values, all values are compared with the initial one and do not go beyond this value.

Then two nested loops (blocks 8,9) are opened again, which are necessary for the entire image to go through rows and columns. The first cycle is “spinning” until the cycle counter reaches a pixel value equal to the image width, the second cycle - until the cycle counter reaches a pixel value equal to the image height. Inside the loop, the minimum pixel value is searched (blocks 10-11). In block 10, the condition is checked: whether the current value written to the buffer is less than the initial value (the initial values are specified in block 7). If the matter is done, then the minimum value is the current value of the pixel belonging to this block (block 11), if not, a new pass of the array occurs. Since there cannot be absolutely white images in real video streams, that condition will be fulfilled correctly.

After this, it is necessary to carry out the transformation, i.e. subtract the found minimum value from the brightness values of all pixels inside the block. For this reason, the opening of two nested cycles (blocks 12, 13), necessary for the passage of the image through the blocks. The first cycle "spins" until the cycle counter reaches a pixel

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value equal to the number of blocks in the image horizontally, the second cycle until the cycle counter reaches a pixel equal to the number of blocks in the image vertically. Inside the loop, the found minimum values of the brightness of the pixels are subtracted (blocks 14,15). In block 14, the pixel brightness value is read into the buffer from the current position; in block 15, the found minimum value is subtracted from the current one.

With effective processing of frames by this method, high homogeneity of the obtained compensated images can be expected, which makes it possible to apply long-series compressor coding (RLE) to them. This allows you to increase the compression ratio of the received frames as a result of reducing the amount of memory required to store the same pixel brightness values.

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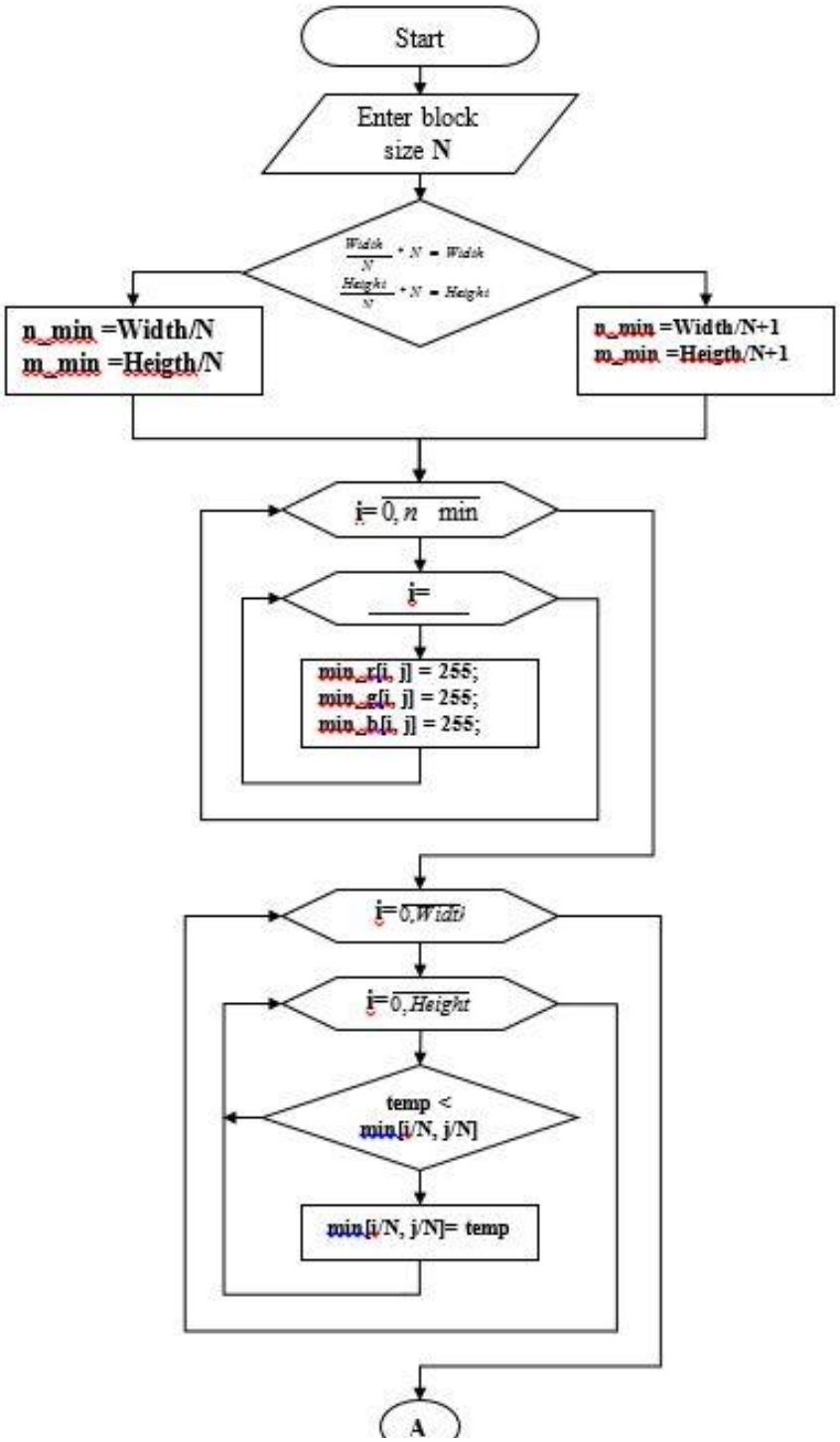

Fig. 2. (a) Block diagram of the algorithm for brightness conversion of images. Search for the minimum pixel brightness.

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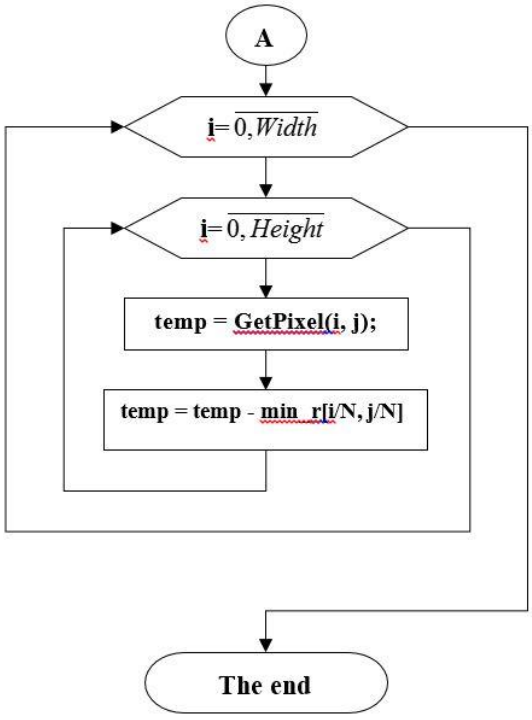


Fig. 2. (b) The block diagram of the image brightness conversion algorithm. Subtraction of the minimum values.

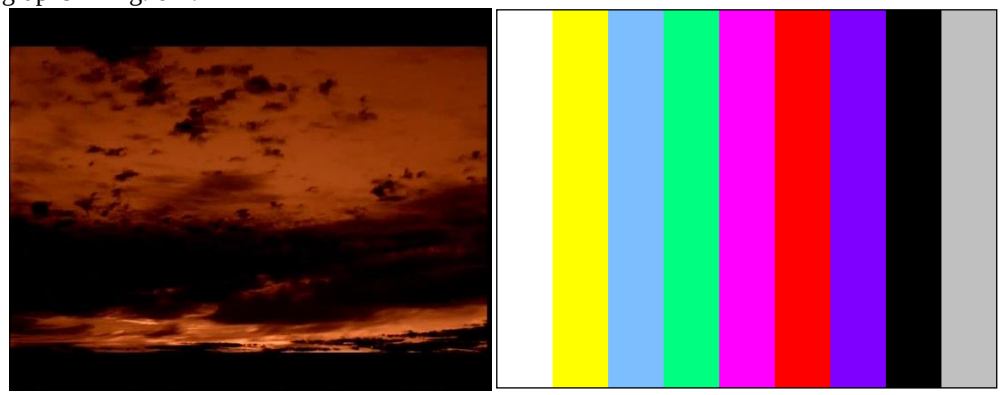
IV. EXPERIMENTAL DATA

To assess the effectiveness of this method of the codec, two different scenes were processed (Fig. 3), which were divided into blocks of 1x1, 4x4, 8x8, 16x16 and 32x32 pixels and were compressed by the JPG codec under various compression parameters.

The results of the analysis of the effectiveness of this method are summarized in the form of graphs in Fig. 4-5.

When working with this method, we are faced with the need to store metadata, i.e. The task of evaluating the effectiveness includes finding the optimal ratio of the size of the compressed image to the size of the compressed file with metadata.

The results of evaluating the effectiveness of this method taking into account metadata are summarized in the form of graphs in Fig. 6-7.



. a) б)

Fig. 3. Test image a) The plot of “Sunset”, b) The plot of “GCB-0” (generation of color bars - an artificial image obtained on a computer).

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As can be seen from the above graphs, the use of pixel brightness compensation for a block structure without metadata gives a fairly high efficiency on all plots when dividing into 1x1 pixel blocks and without using JPG compression. However, when evaluating this effectiveness, the file containing metadata is not taken into account.

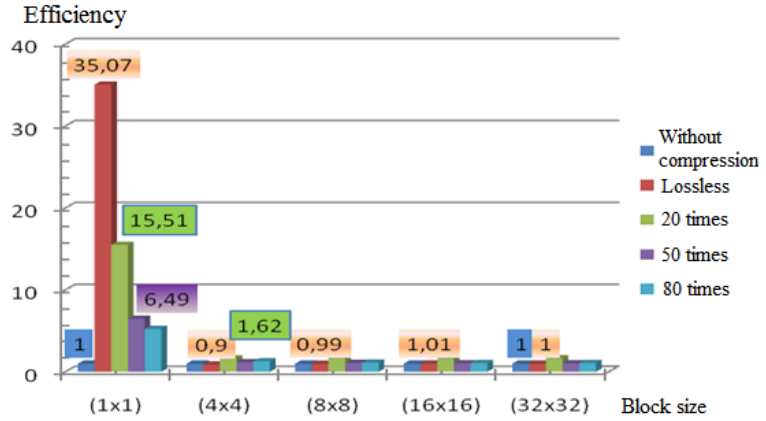

Fig. 4. Evaluation of the effectiveness of processing the plot "Sunset" without metadata

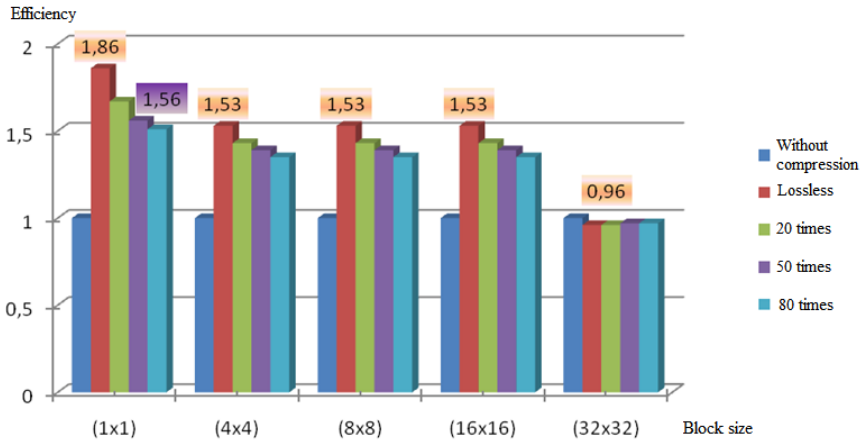

Fig. 5. Evaluation of the effectiveness of processing the plot " GCB-0" without metadata

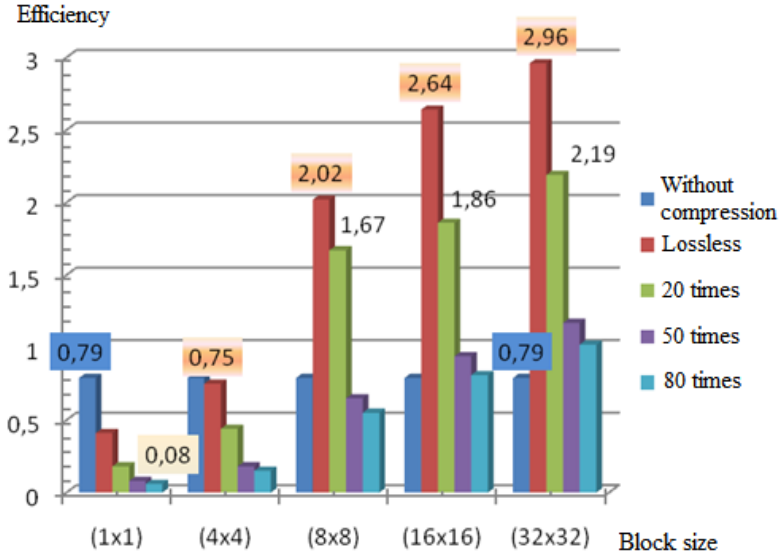

Fig. 6. Evaluation of the effectiveness of processing the plot "Sunset" taking into account metadata.

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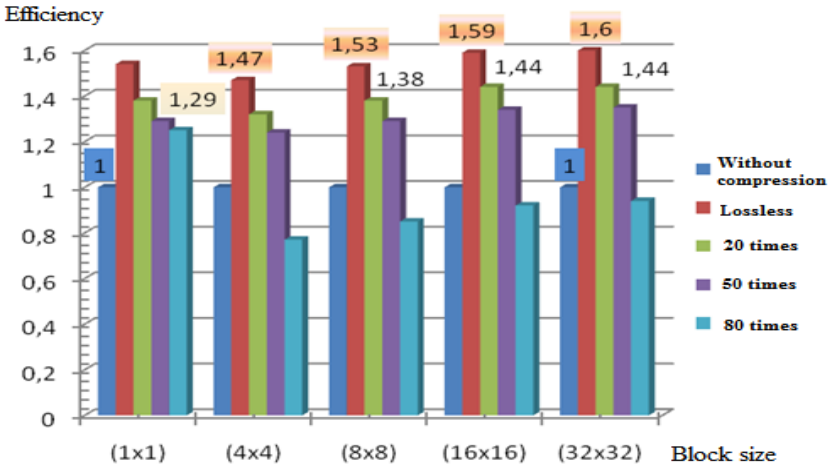

Fig. 7. Evaluation of the effectiveness of processing the plot "GCB-0" taking into account metadata

V. CONCLUSION AND FUTURE WORK

From the analysis of the results obtained (Fig. 6-7), it can be seen that when processing plots divided into smaller blocks (1x1, 4x4 pixels), the smallest image volume is obtained during compression. But at the same time, the received file with metadata is quite large, almost equal to the original file, and further processing and transfer of the compensated file in total with the metadata file is not effective.

An analysis of the effectiveness of this method, taking into account metadata, shows that we achieve the greatest efficiency when processing images divided into blocks 32x32 pixels in size and without applying subsequent compression. That is, at a given block size, the necessary balance is achieved between the size of the compensated image and the file size with metadata

According to the results of the analysis, contrary to expectations, the processing of the image of the GCB-0 plot obtained on a computer is not quite effective, despite the fact that when dividing even into large blocks (16x16 pixels), a completely uniform frame with a zero brightness value is obtained. This is due to the inefficient operation of the standard RLE compressor, not designed to compress large amounts of video data. Therefore, to increase the compression efficiency of compensated images, it is necessary to adapt the RLE compressor algorithm to compress large series of data.

Thus, the use of the brightness conversion method allows to increase the compression coefficient of the codec by 1.5-2 times, but only with small compression ratios (10-20 times). With large compression ratios, the effectiveness of this method decreases due to a rather large amount of metadata. Therefore, it is necessary to develop methods for effectively minimizing the amount of metadata, for example, based on the use of blocks of variable size, the dimensions of which are determined by the plot structure of the processed image.

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