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SYSTEM FOR ACQUISITION, COMPRESSION AND PROCESSING OF THE TV IMAGES, WITH DIDACTIC AND RESEARCH PURPOSE

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Abstract. The paper presents a system practicallz achieved, using a complete computer IBM-AT for processing of the TV images. In the first part of the paper it is summarily described the theory and achieved architecture.In the second part there are presented the experimental results obtained, concerning the compression of the images. The informational boom in the last decades had a strong impact on image transmission techniques. Generally accepted statistics state that 83% of the information is received visually. That is why the research in video technology is so important. Nowadays, most of the TV networks use analogue transmission of images but the necessity of enhancement of image quality imposed high definition television (HDTV). At the same time the problem of bandwidth for the transmitted signal is important as well. In order to have a narrows transmission bandwidth, several information compression methods are used. Almost all of them utilize numerical methods and digital transmission techniques.

1. Introduction

The TV signal has several particular features that enable the reduction of the bandwidth, without affecting the quality of the received image. The most features are:

a) The neighboring points (pixels) of an image are strongly correlated. That is if a pixel is characterized by a certain brightness and saturation the probability for the neighboring pixels to have the same features is rather high (for example the uniform lightened zones of background, the sky etc.). We can consider, thus, as a waste the transmission of data

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for each pixel and in each moment. In order to reduce the data flow, an image can be divided into NXN pixels quadrate zones. A mathematic transform is applied to each zone resulting a series of coefficients which are transmitted. At the receiving end, the inverse transform is applied, on order to restored the original image. The efficiency of the transform is related to the correlation of the coefficients. Most of the information in the image should be contained in a reduced number of coefficients.

b) The data stream concerning a TV image is very large but the difference between successive images are much less important. It thus interesting to transmit only the differences occurring among images. Many of the differences having particular features (translation, rotation or objects movements) the reduction of transmitted data is obtained using movement estimation algorithms.

The study refers to the DISCRETE COSINE TRANSFORM, adopted in CCITT H261, JPEG and MPEG standards and commonly used in digital transmission equipments using image compression. The direct transform converts the values of each of the pixels in the data bloc from the time domain to the frequency domain. (The transform process takes advantage of the correlation that exist between samples in the block):

$$G_k = \frac{2}{N} C_k \sum_{N=0}^{N-1} X_N \cos\left[\frac{(2N+1)k\pi}{2N}\right], \quad k = 0,1,2,\dots,N-1 \qquad (1)$$

$$C_k = \frac{1}{\sqrt{2}}; \quad \text{for } k = 0$$

$$C_k = 1, \quad \text{for } k = 1,2,\dots,N-1$$

The inverse transform is given by the following relation:

$$X_N = \sum_{N=0}^{N-1} C_k G_k \cos\left[\frac{(2N+1)k\pi}{2N}\right] \qquad (2)$$

This results in a matrix block where the data represents the coefficients of the frequency components. Each coefficient effectively represents the amplitude of a specific pattern within the block.

The real bit rate reduction process takes place when each frequency is quantised and becomes one of a restricted number of integer values. It has been known for many years that the human visual system does not need to be provided with the infinite number of brightness levels that an analogue picture contains, and may be quite content with as few as 256 levels. There is therefore no need to transmit luminance levels to a very high degree of precision.

The quantisation process is not carried out linearly. Different quantisation is applied to each coefficient. It depends upon its position in the matrix that effectively represents the spatial frequency which any particular coefficient is describing.

The eye-brain combination is most tolerant to quantisation errors. These usually take the form of a very fine,noise, pattern at pattern at high spatial frequencies. We are able to quantise the high frequency coefficients relatively coarse, with fewer steps, whilst information about the lower frequencies is carried with greater detail.

The value in the top left hand corner of the matrix, which represents the DC component of the picture information, is sent with the highest level of accuracy.

Since high frequency noise is less visible, larger quantisation errors may be tolerated for the coefficients representing the high frequency components. It is therefore acceptable to quantise these less precisely.

To take account of relative importance of each of the frequency coefficients, the different coefficients are quantised differently. To achieve this a weighting or scaling factor is applied to each coefficient prior to quantisation.

To effect this process, each of the coefficients in the matrix obtained from the discrete cosine transform is then divided by a factor obtained from the weighting matrix (Fig. 1).

8	16	19	22	26	27	29	34
16	16	22	24	27	29	34	37
19	22	26	27	29	34	34	38
22	22	26	27	29	34	37	40
22	26	27	29	32	35	40	48
26	27	29	32	35	40	48	58
26	27	29	34	38	46	56	69
27	29	35	38	46	56	69	83

Fig. 1. Weighting matrix

In practice, the image is divided into $N \times N$ pixels quadrate zones (usually 8×8 or 16×16) and cosine transform is applies on doth dimensions.

The coefficient-scaling process does reult in some loss of information, which can result in a loss of resolution in the decoded image.

2. The system

The obtained card functions well on computers with the frequency of the clock bigger than 33 MHz and contains besides the usually module of conversion A/D, frame memory, collision with ISA buss, one module which achieves the cosines discreet transformation This module is made of SGS-THOMSON STV 3208. The circuit can calculate DCT transformation with on pixel clock of 20 MHz, the obligation of truncate and other processing returns to the host computer.

It was chosen this solution because the respectively change implies many laborious calculation, increasing the speed of the processing of the images for at least thirty times.

The system allows the acquisition of the image in real time.

The other function: the stocking on hard-disc, the compression, the decompression do not happen in real time and they depend on the speed of the computer we use.

The purpose achieving this system is to allow researches in the field of compression of images.

It allows the acquisition and the render in real time and in accordance with the computer we use, it allows very fast processing, almost in real time. So it is possible, besides the study of the static images, some studies of compressing the dynamic images, movement assessment.

The hard structure makes possible the implementation of several methods of image, compressing and processing, being at the same time an useful instrument in education.

There are experimented tillnow methods for static images compression. We started from STANDARD JPEG. This STANDARD requires in the first step the use of DCT transformation and the division of the coefficients following a STANDARD table of division.

Then it is applied a RLE compression and finally a Huffman code, but using an adaptive Huffman code, the best results had been achieved.

3. Practical results

There are presented now some photos:

Photo 1: Original image.

Photo 2: The image has been compressed using the implicit cuantisation matrix (in STANDARD JPEG0. The compression rate is indicated in the superior right side.

Photo 3: The image had been compressed using the DCT transformation, all the coefficients being truncated from 12 to 8 bit. Then it was applied the RLE compression and the Huffman code.

Photo 4: It was used the DCE transformation in addition with RLE compression and adaptive Huffman code. The cuantisation matrix was obtained comparing with a limit determined by the alternative current energy of the coefficients.

Fig. 2. Photo 1

Fig. 3. Photo 2

Fig. 4. Photo 3

Fig. 4. Photo 4

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