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METODA KODOWANIA SYGNAŁU VIDEO OPARTA NA IDENTYFIKACJI ZALEŻNOŚCI STRUKTURALNYCH W KLUCZOWYCH RAMKACH

Streszczenie: W artykule opisano metodę tworzenia kompaktowej reprezentacji obrazów podzielonych na segmenty. Metoda ta opiera się na detekcji 2-składowych wektorów dla n-tek, co umożliwia dokonanie transformacji liniowej. Zależności prędkości przesyłu bitów są porównywane dla różnych wariantów metody. Polegają one na przetworzeniu kluczowych ramek nasyconego sygnału obrazu video dla różnych metod kompresji obrazu. W pracy zidentyfikowano tryby pracy takie, że możliwy jest przekaz sygnału video w czasie rzeczywistym.

Słowa kluczowe: video informacja, porcje (n-tki) wektora kodowanych danych

THE METHOD OF ENCODING VIDEO INFORMATION SYSTEMS BASED ON THE IDENTIFICATION OF STRUCTURAL DEPENDENCIES IN THE KEY FRAMES

Summary: Outlines steps to develop a method of forming a compact representation of the segmented images based on the detection of the two-component vector of tuples for linearized transformant. Dependencies for bit rates are compared in the case of processing the key frames of a saturated image stream using various compression methods. Identified modes that achieved delivery of the video stream in real time.

Keywords: video information, coding vectors tuples

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1. Introduction

In modern conditions of development of the market of services gaining popularity of video information delivery technology video using wireless technologies [1]. It requires resolve problems related to excess relative to the intensity of the video stream bandwidth. Therefore, to reduce the bit rate using frame stream compression technology. One of the main components for the development of such technologies is to increase the compression ratio of key frames with a given level of distortion, which allow the reconstruction of the entire group of frames with a given visual perception [2 - 4]. To do this we need to develop approaches based on the coding of the transformed image with the identification of binary vectors tuples. One effective approach here is a technology vectors encoding binary tuples based on enlarged positional coding [5; 6]. In this connection, the purpose of the research of the article is to create a method of coding video information in information systems based on the identification of structural dependencies in the key frames.

2. Base material

Consider the features of the integration of the developed code representation of the truncated vector of two-component tuples of the linearized transformant into the compression standard on the JPEG platform. Here, on the one hand, it is necessary to take into account the following features of the formation of a compressed representation of a truncated vector of two-component tuples, namely:

- truncated vector P' is formed by eliminating the first tuple containing the value of the low-frequency component of the two-component tuples and the last tuple, which includes the length of the last chain of zero components, i.e. $P' = \{(\ell_2; c_2), \dots, (\ell_\alpha; c_\alpha), \dots, (\ell_{n_{tpl}-1}; c_{n_{tpl}-1})\}$;

- quantity n_{tpl} two-component tuples is a variable whose value is not known in advance, and depends on the image content and factor segment f quality loss during quantization component transformants. This is given by the following dependency: $\phi(f): n_{tpl} = \phi(f) = \text{var}$;

- the value of the code length and truncated overheads two-component tuples vector depends on: statistical, structural properties of the image segments, the mode correction transformant component in the quantization;

- during encoding of two-component tuples recorded patterns of structural and combinatorial nature are specifically identified for the fragment being processed, i.e., treatment is performed adaptively to the structural properties of the linearized transformants. The value code is generated based on positional lexicography numbers. In this case:

- to compute the code value is not required to carry out a preliminary assessment of probabilistic and statistical characteristics of the transformants and using statistical table of codes;

- codewords not use the prefix principle which is peculiar to non-uniform statistical codes;

- distinguishing the service information for the developed code vector representations truncated two-component tuples component system is a base for the emerging chain lengths zero components and important component.

On the other hand in the process of this integration is necessary to consider the requirements for image compression system, namely to ensure reduction of the bit rate of the compressed video in low complexity processing and correction of frequency components. For this is required to provide the following:

- compression mode in limited quality loss factor values;
- avoid the use of additional service data;
- eliminate the need for a significant increase in the number of transactions spent on fulfilment of the conditions of integration of the code representation of a truncated vector two-component tuples in video stream compression system;
- stability codewords compactly represented stream of video frames to errors in the communication channel.

Driving integration code representation of the truncated binary vector of tuples in the platform on the JPEG compression technique is shown in Fig. 1.

According to the scheme of codec integrating the following basic steps are performed for JPEG platform.

First stage. Translation model RGB three-color image in YUV colour difference space without loss of information.

In this case, as the format of the color representation is used to ensure high-quality video scene mode. This involves the use of a 4: 2: 2 - the horizontal dimensions of the matrices U and V twice smaller than the size of the matrix Y, and the vertical dimensions are identical. Then the macroblock structure is heterogeneous and consist of eight blocks, including four luminance blocks and four chrominance blocks (two blocks U and V) in the following sequence: Y1; Y2; Y3; Y4; U1; V1; U2; V2.

The second stage involves the transfer of space-time representations of segments in the frequency spectral. For this discrete cosine transform is performed image segments.

The third stage consists in carrying transformant correction component in accordance with quality loss factor.

The essence of the fourth basic step consists in obtaining a linearized representation of the transformants, followed by isolation of the vector two-component tuples. Encoding low-frequency DC components is carried out at the fifth stage processing. The low-frequency component is processed separately from the remaining AC components of transformants. This processing is conducted taking into account minor changes coherence between adjacent image segments.

We now consider the steps unit, related to the integration of the codec to a truncated vector two-component tuples. This is the basic unit for encoding the transformed segments in the frequency spectral region by removing psychovisual, structural and statistical redundancies.

To exclude cases when code redundancy is formed, and the length of the codogram of the truncated DC vector exceeds the length of the machine word, it is proposed to impose restrictions on the maximum length of the codogram. As a result, some may be formed Ψ codified, including one or more predetermined length codified V_{max} and a variable length Overhead $V(P')_{\Psi}$.

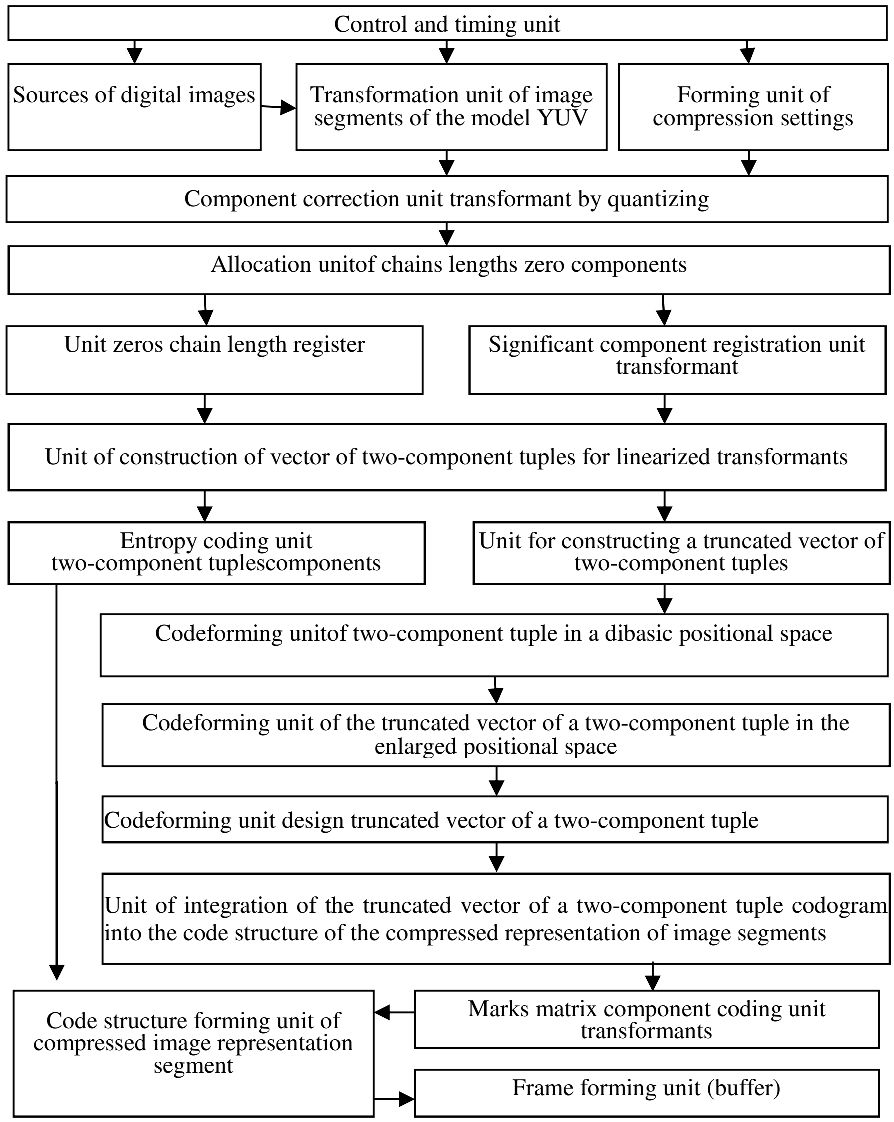

Figure 1. The scheme of integration of the code representation of the truncated vector of two-component tuples into compression technology on the JPEG platform

Here Ψ - number of codified, which are formed to truncated vector two-component tuple. Such principle of the formation will be called codified non-uniform codified with a restriction on the maximum value under uncertainty last chain length LT zero component and a variable-length binary vector tuples.

This principle of coding provides for the use of overhead information, which in the process of decoding determines the number of Ψ codograms and the length of an uneven codogram.. Here is the necessary information for the number of $n_{крт}$ tuples.

Consider the process of calculating the code component $E(A)_{\nu_\psi}$ for the selected variable number of two-component tuples. In the process of coding the enlarged position numbers counted duplex processing principle.
At the first level of two-component tuple vectors encoding truncated carried forming basic codes for individual two-component tuple $\Theta_\alpha^{(2)}$, i.e. $E(\Theta_\alpha^{(2)}) = (\ell_\alpha \lambda(c) + c_\alpha)$. Thereafter carried distribution amount basic number codes (two-component tuples) to generate the code components $E(A)_{\nu_\psi}$ and forming corresponding codified $G(P')_\psi$.

The current value $E(A)_\alpha$ for ψ-th codebook component determined by the following formula:

$$E(A)_\alpha = E(\Theta_\alpha^{(2)}) \cdot W(A^{(\alpha)}) + \sum_{\gamma=2}^{\alpha-1} E(\Theta_\gamma^{(2)})\, W(A^{(\gamma)}) \tag{1}$$

Where
$\sum_{\gamma=2}^{\alpha-1} E(\Theta_\gamma^{(2)})\, W(A^{(\gamma)})$ - the value of the code component obtained for $(\alpha-1)$ tuples;
$E(A)_\alpha$ - code value component with the addition of α-th code $E(\Theta_\alpha^{(2)})$ basic number.

I fon α-th step inequality (1) is not satisfied, then the selection process and the number of tuples calculation code component is considered complete. As a result, the number of tuples for ψ-th codebook component will be equal to $\nu_\psi = \alpha - 1$, and the corresponding value of $E(A)_{\nu_\psi}$.

If the inequality $(\alpha + \sum_{\xi=1}^{\psi} \nu_\xi) > (n_{tpl} - 2)$, the number of tuples not processed offline, and the code value component is determined by the formula (3) for $\psi = \Psi$.

Encoding specified by the expressions (1) - (3) provides no loss of information and without making code redundancy code components for the formation of truncated two-component tuple vectors in the two-level processing conditions and the construction of the combined codified principle.

As a result of the recurrent sequence formed by processing codes for the PN in the mode of construction of the combined codified principle restricted to a maximum value equal to $V_{\max}$, i.e. $\{E(A)_{\nu_1}, \ldots, E(A)_{\nu_\psi}, \ldots, E(A)_{\nu_{\Psi-1}}, E(A)_{\nu_\Psi}\}$. Here $E(A)_{\nu_\psi}$ - code value for ψ-th component of the PN, having the same length ν_ψ.

Length V_c code construction compressed representation of the segment is determined by the following relationship:

$$V_c = V(\tilde{P}')_{comp} + V(n_{tpl}) + V(\lambda) + V(f) + V_{DC} + V_{ms} \tag{2}$$

where $V(\tilde{P}')_{comp}$ - the length of the information part of the codogram of the compressed representation of the truncated vector of two-component tuples; $V(n_{\text{крт}})$ - code length containing information a bout the number of tuples formed linearized for transformants; $V(\lambda)$ - number of bits to represent the base $\lambda(\ell)$ and $\lambda(c)$ tuple component; $V(f)$ - number of bits to represent the value of the factor f loss of quality; V_{DC} - length statistical code the low frequency two-component tuple -components; V_{ms} - compressed representation of the signs of the matrix.

Accordingly, the length $V(P')_{comp}$ information part code construction compressed representation truncated vector of two-component tuples is defined as the tuple $V(P')_{comp} = (\Psi - 1) \cdot V_{max} + V(P')_{\Psi}$ (bit).

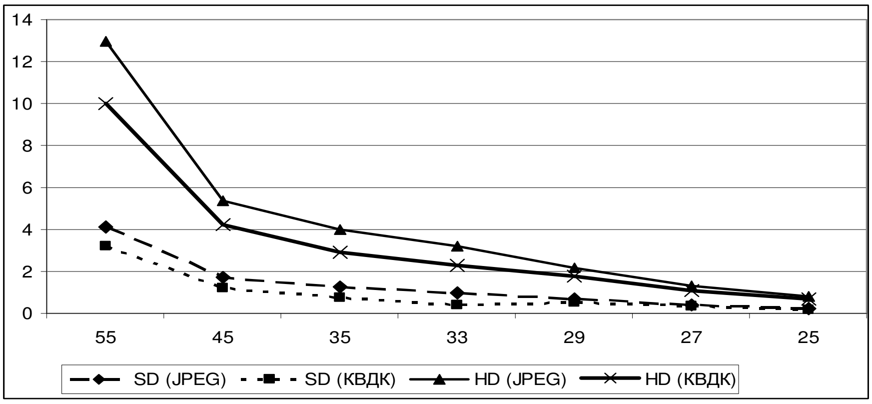

Figure 2. The graphs of bit rate of frame PSNR for different spatial resolution

In this Figure 2 are constructed according to the magnitude V_c the degree of saturation of images and ensurePSNR (peak signal-to-noise ratio) regime, namely $25 \le \delta \le 55$ dB

Bit rate estimation V_c is performed for the developed method of compression and a compression method based on the JPEG technology. Uses the averaged estimates per key frame stream saturated detail image formats such as: HD quality with a spatial resolution of 1280 × 720, SD quality and with a spatial resolution of 640 × 480.

Shown in Fig. 2 comparative analysis of the bit rate in the case of processing the base saturated picture stream frames leads to the conclusion that the developed method provides gain for PSNR level of 25 to 55 dB on the average between 18% - for highPSNR(55 дБ), value (55 dB), and 23% for medium PSNR(33 dB). For PSNR low levels (25 dB) is observed alignment bit rates compared to compressed streams technologies.

3. Conclusions

A method of forming a compact representation of the segmented images based on the detection vector of two-component tuples for linearized transformant. Under the conditions where: the number of binary tuples is a variable value not previously known, and generally depends on the content of the image segment and quality loss during quantization factor component transformants; the code value and the length of the codogram for the truncated vector of two-component tuples depends on: statistical, structural properties of the image segments and the mode correction transformant component during quantization.

In the case of a telecommunications network with a bandwidth of 10 Mbits / s is allowed to use the developed method transfer to HD video quality real-time with high quality (PSNR at 55 dB), but for bandwidth at 2 Mbit / s - with sufficient quality (PSNR at 33 dB). In the case of a telecommunications network with bandwidth at 2 Mbit / s is allowed to use the developed method pass video SD quality real-time with a good quality visual perception (PSNR at 50 - 45 dB), and for the bandwidth at 512 Kbps / s with sufficient quality (PSNR at 33 dB).

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