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TECHNOLOGIA ADAPTACYJNEJ REDUKCJI INTENSYWNOŚCI BITÓW W SYSTEMIE ŁĄCZNOŚCI

Streszczenie: W pracy omówiono metodę identifikacji makro-fragmentu, który zawiera kluczową informację w zapisie video. Uzasadniono też wybór głównej koncepcji uzyskiwania/dostępności kluczowych informacji poprzez analizę fragmentów (ramek) video. Ponadto, przedstawiono dalsze ulepszenie metody otrzymywania kluczowych informacji z uprzednio przetworzonych zapisów poprzez transformację danych (video frame transformation). Zaproponowana metodologia umożliwia redukcję intensywności sygnału video oraz zwiększenie produktywności systemów informacyjnych w odniesieniu do wymaganego poziomu ich niezawodności.

Słowa kluczowe: przewidywane ramki/klatki video, przepływność (przesył bitów w jednostce czasu), makro-fragment, kwantyzacja, zróżnicowane ujęcia

TECHNOLOGY OF ADAPTIVE BIT INTENSITY REDUCTION IN INFOCOMMUNICATION SYSTEM

Abstract: In this paper, it has developed a method of identifying macro fragment that contain key information video frame. The choice of approach for the formation of core technological concept of differential treatment-based video frame segments availability of key information was grounded. Furthermore, we developed the method of allocation of key information from previous video frame transformation. The method of video coding syntax effectively through their trans-formation was also described. The methodology allows for reduction of video intensity and increasing productivity of information systems in terms of the required level of reliability of the information.

Key words: predicted frames, bit rate, macro fragment, quantization, differentiated treatment

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1. Introduction

The effective functioning of wireless telecommunications systems is determined by the quality of information transmission and processing and is evaluated by such an indicator as productivity. In this case, the components of productivity are time delays (promptness) for the delivery of information and its accuracy in the conditions of protection against unauthorized access.
At the same time, an estimate of the transmission time of uncompressed video data, taking into account the existing performance of wireless infra- communications technologies, including on-board complexes, showed that time delays for the delivery of information reach tens of minutes. That is, we can conclude that it is necessary to improve the performance of existing wireless technologies in order to provide the necessary information intensity of video data according to the given characteristics of video information services.
The main way of solving the formulated scientific problem is to use information technologies to reduce the time of delivery of information by reducing the information intensity.
Thus, the purpose of the research is to develop a method for efficient video coding to improve the performance of information systems.

2. Coding basis

The basis for the effective coding method is to choose a technology based on the elimination of psycho-visual redundancy with the use of pre-transformation and further normalization.
To increase the degree of reduction of information intensity, it is necessary to develop a method of efficient syntactic coding, based on the adaptive processing of the component structure of the transformant, taking into account the availability of key and basic information of the video frame.
In this direction it is proposed to create an approach to adaptive processing of the video frame, which is based on the identification and differential coding of key and basic (background) components of the video frame.
Selection of the key component implies the identification of those fragments of the frame that contain significant information from the point of view of structural saturation at the level of syntactic description. To determine the structural or energy saturation of $S(Y)_{\tau}^{(k;\ell)}$ segments, we introduce the concept of segments of three types:

1. segments with high structural saturation that exhibit sharp transitions in image brightness and contrast;
2. segments with medium structural saturation that contain small differences between pixels, i.e. slow contrast transitions;
3. segments with low structural saturation with uniform image areas.

In view of this, it is suggested to evaluate the video frame by its structural content on the basis of revealing the structural importance of the video frame macrofragment, which, in turn, will be performed on the basis of the structural and semantic saturation of the segments.

As a result of video conferencing typical of videoconferencing systems, it is in the interests of profile organizations using the developed method of detection of key information, on the basis of analysis of integrated information on the low-frequency and high-frequency components of the transformant, practical results were obtained, which showed that due to additional verification for the high-frequency component of the DCT transformant should not be considered as important sections of the video document in which there are homogeneous area with high brightness and contrast, which include small insignificant details (video footage, which depicts textured wallpaper, fence, pieces of furniture, flooring), expressed textural differences that are not significant (video frames that include elements of the roadway, clouds, water surface).

Evaluating the effectiveness of the identification of key segments of the images that describe the objects of interest, shows that more than 90% of key segments, has been identified.

3. Development of a method of reducing the information intensity of the bit stream

It is proposed to differentiate the processing of segments of the video frame. In this case, the processing of the segments containing the key information will be carried out taking into account the preservation of the given reliability.

As a kernel of the concept of differential processing of video frames it is proposed to use the transformation of images based on orthogonal transformations and transfer of the processed data into differential space.

The expression for obtaining a differential description of a one-dimensional transformant is as follows:

$$y'_{k1} = y_{k1} - y_{k+1,1}; \qquad k=\overline{1,q_1}; \qquad 1=\overline{1,q_2}, \tag{1}$$

where y_{k1}, $y_{k+1,1}$ - transformer components in positions k, $k+1$.

As a result, a structural array of differential representation elements is formed, that is, the structure of one-dimensional transformants of discrete-cosine transformations.

The second stage of processing is to form a syntactic representation of the structure of one-dimensional transformants.

The construction of an effective syntax representation for key information segments is defined by the following expressions:

$$P`(R)_\ell = \sum_{k=1}^{q_1} y'_{k,\ell}\, v(R)_k^{(1)} = \sum_{k=1}^{q_1} y'_{k,\ell} \prod_{\xi=k+1}^{q_1} \psi'(R)_{\xi,\ell}; \tag{2}$$

$$h(R)_{q_1}^{(2)} = ([\ell og_2 E'(R)_\ell] + 1) \le h'(R)_{q_1}^{(2)} = ([\sum_{k=1}^{q_1} \ell og_2 \psi'(R)_{\xi,\ell}] + 1); \; \ell = \overline{1, q_2}$$

where $P`(R)$ - vector of code values for 2-dimensional structure of 1-dimensional transformants;

$H'(R)$ - a sequence of codogram lengths of code values $P`(R)_\ell$ in the conditions of use for their codification of the system of bases.

The effective syntactic representation of the entire transform of the base segment of the video frame in the form of codograms of code values of two-dimensional position weighted numbers, taking into account the correction of frequency components, is determined by $h''(R)^{(2)}$.

Thus, a method for generating effective syntactic coding of video frame segments containing key information based on the formation of code values of columns of two-dimensional structure of one-dimensional transformants, which are considered as weighted position numbers taking into account the correction of frequency components and subsequent coding using the system of basics, is developed.
The choice of approach for forming the kernel of technological concept of differentiated processing of segments of the video frame with the availability of key information is substantiated.

4. Comparative estimation of time delays for transmission of encoded video frames for different syntax representation methods

The results of studies on the time delay for the transmission of encoded video frames for different methods of syntax representation are presented in the form of diagrams in Fig. 1 and 2. It was found that the average saturated video frame was taken in the case of percentage of key segments of the information in it more than 65% and not less than 40%.
High-precision video frame - at least 65% of key information segments.

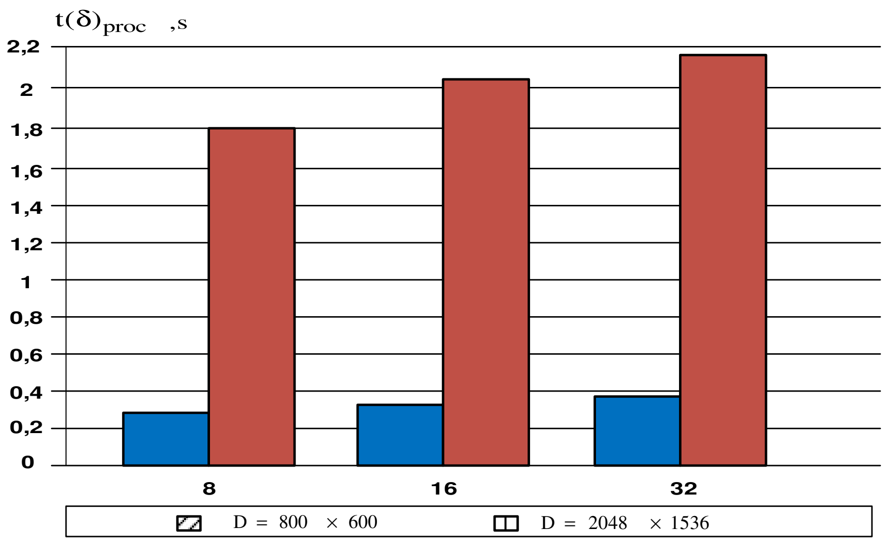

Figure 1. Estimation of time delay for processing of a video frame (average saturated video frame)

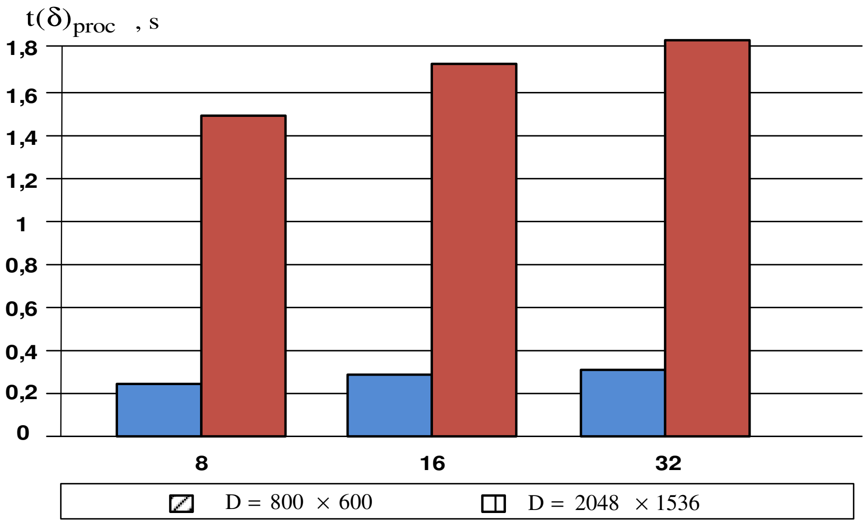

Figure 2. Estimation of time delay for processing of a video frame (high saturated video frame)

A comparative estimate of the processing delay time for different video syntax methods, depending on the percentage of key information segments, is presented in the form of diagrams in Fig. 3, 4.

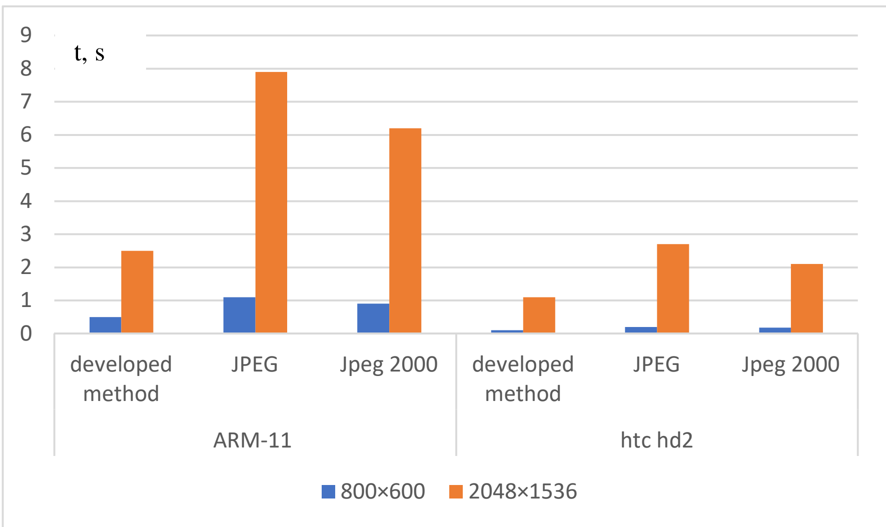

Figure 3. Comparative estimate of delay time $t(\delta)_{proc}$ for processing, for different methods of syntax representation of video frames

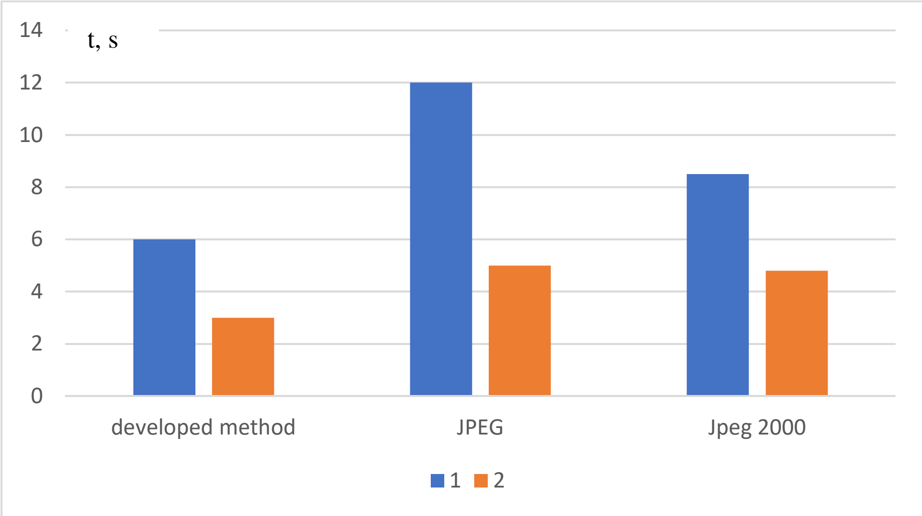

Figure 4. Dependence of magnitude of time delays $t(\delta)_{trans}$ the percentage of key information segments for different processing methods

Analysis of Fig. 3, 4 showed that the reduction of time delays, depending on the percentage of key information segments, decreases from 1.5 to 3 times. Thus, increasing the transmission speed of encoded video frames using the developed method for time delays in the case of standardized approaches is at the level of 30%.

5. Conclusion

A method of extracting key information based on the previous transformation of the video frame is constructed. The peculiarities of the method are that: the identification of fragments is based on the adaptive choice of the number of low-frequency components of the transformants, depending on the gradation of the integrated energy saturation indicator for the high-frequency components. This provides the conditions to maintain the required level of video authenticity and protect it from unauthorized access. Developed an adaptive method for identifying macrofragments based on the analysis of integrated information on low-frequency and high-frequency components of transformants of discrete-cosine transformation, which allows to automatically identify areas of the video frame that have characteristic contrast, structural and bright differences. A method of syntax representation of the base segments that carry information about the background components of video frames was developed. The main practical results of the work are follows:

1. Time delays for video processing based on the developed method vary depending on q for $D = 800 \times 600$ i $D = 2048 \times 1536$ respectively from:
   - 0,09 to 0,012 c. and from 0,6 to 0,8 c when processing middle-saturated segments with key information;
   - from 0,15 to 0,18c. and from 0,9 to 1,2 c when processing middle-saturated segments with key information.
2. The developed method of forming an effective syntactic representation creates the conditions for the processing of video frames with different content of segments of key information in real time using wireless telecommunication technologies.

Among the methods of syntactic representation of video frames using the correction of the frequency components of transformants under the psycho-visual model of visual perception, the coding method has been developed. The reduction in time delays, depending on the percentage of key information segments, ranges from 1.5 to 3 times.

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