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MODEL KONCEPCYJNY STEROWANIA INTENSYWNOŚCIĄ PRZEKAZU VIDEO ZA POMOCĄ MULTIAGENTÓW

Streszczenie: Model koncepcyjny przesyłu i przetwarzania sygnałów video omówiono w artykule. Opracowany system oparto na multiagentach. Zasadą działania tego system są operacyjne zmiany intensywności strumienia video podczas przesyłu sygnału (jego transmisji). Opisano ogólne zasady systemu przetwarzania opartego na multiagentach. Podstawową zasadą funkcjonowania węzłów tego systemu, jest zaimplementowany algorytm MPEG (do dekodowania cyfrowego sygnałów).

Słowa kluczowe: transformata DCT (dyskretna transformacja cosinusowa), intensywność przekazu video, składowa transformacji, system multiagentów

BUILDING A CONCEPTUAL MODEL OF A VIDEO STREAM INTENSITY CONTROL METHOD BASED ON A MULTIAGENT SYSTEM

Summary: A conceptual model of a video processing system at the source level is considered using a multiagent approach. The principle of operation of this system is described in the context of the need to ensure an operational change in the intensity of the video stream during transmission. The general principles of the multiagent processing system are given. The basic principle of functioning of the nodes of this system, implemented on the basis of the basic MPEG algorithm, is considered.

Keywords: DCT transformant, video stream intensity, transformant component, multiagent system of processing

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1. Introduction

The increasing of the volume of transmitted multimedia data (in particular, video), the increase in the number of multimedia services and the increasing quality requirements of video content from users lead to the need to develop coding technologies and devices on the basis of which video data is processed. On the other hand, the lag in the growth rates of network bandwidth and the computing power of end and network devices leads to the fact that network overloads and, as a result, data loss and degradation of service quality are becoming more frequent. All researches conducted in this direction are conditionally divided into 2 groups. The first group includes research, offering solutions to the problem of efficient transmission of video traffic at the level of network nodes.

In turn, the second group proposes to reduce the amount of data entering the network by improving video codec's in general [1-3] and at the coding level of individual frames [4-6]. In this case, the technologies of adapting the intensity of the video stream to the network bandwidth (TAIV) are of scientific interest [7]. One of the main problems that need to be solved in case of developing TAIV is related to the need to process large amounts of data in real time. In this case, a possible solution lies in the plane of application of multiagent schemes [8-10] integrated into the video stream coding system at the end nodes of the network.

2. Principle of operation of multiagent processing scheme

To implement a multiagent video processing scheme, it is proposed to choose the general MPEG algorithm as a basic algorithm. In this case, the video processing system implemented on the basis of TAIV will conditionally combine the MPEG family codec and the control module, which operates on the basis of a multiagent scheme.

In general, in addition to reducing the amount of video data, this processing scheme performs the function of changing the intensity Λ of video data entering the network in real time, ensuring the required level of quality Q , that is:

$$\Lambda = \varphi_{proc}(Q, C, M); \quad (1)$$

$$t \le t_{th},$$

where t_{th} - the permissible value of the processing time;

φ_{proc} - a functional, describing the encoding process and determining the intensity of video data depending on parameters and bandwidth;

C -a set of codec parameters;

M - processing model.

Regardless of the basic processing scheme, the set of codec parameters C will include one or another number of individual agents χ, each of which performs the functions of processing video data at a certain stage of the conversion. In particular, in the case of implementing an MPEG algorithm, the number of agents will be described by the following expression:

$$\chi = \{\alpha_{cs};\alpha_{sd};\alpha_{op};\alpha_q;\alpha_{en};\beta_{gs}\}\ , \qquad (2)$$

where α_{cs} - the color scheme choice agent;
α_{sd} - agents for choosing a model of color subsampling;
α_{op} - the agent responsible for the orthogonal transformation process;
α_q - quantization agent;
α_{en} - coding agent;
β_{gs} - agent for forming groups of frames.

As you can see from the formula (2), the agents are conditionally divided into groups α and β. At the same time, agents belonging to the group α implement the functions of intraframe processing of the stream of individual frames.

In turn, the agent of the group β is responsible for building a group of frames of a certain length at the stage of forming a video stream, in other words, it processes the stream of frames in the time plane. Then the general processing scheme, built on multiagent principles, will look like fig. 1.

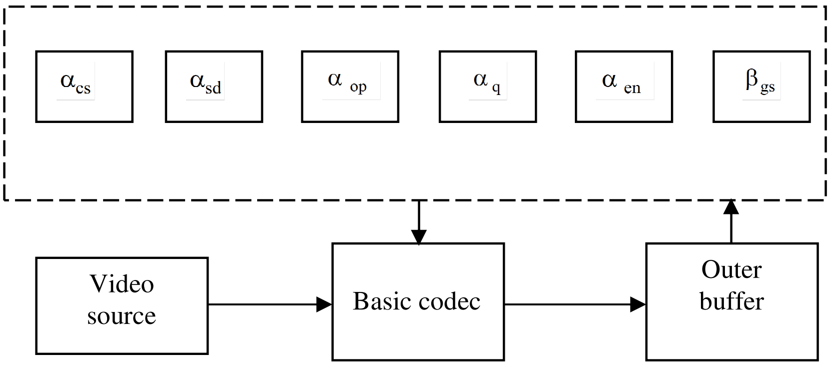

Figure 1. – Scheme of the multi-agent processing

One of the functional differences of this approach from traditional processing methods is the presence of a processing model.

In essence, the processing model is a set of options that will be applied at each of the coding steps. The application of the processing model gives a possibility during the encoding of the video stream, to perform the selection of the relevant parameters that are potentially capable to ensure optimal processing in accordance with conditions (1), and if it necessary, to carry out additional processing [11–13]. In turn, the processing model can be applied to individual structural units of the video stream, in particular, to DCT transformants or their aggregates [14-16]. In this case, also, for realization the possibility of manipulating the step of changing the intensity of the video stream, it is proposed to apply a separate mechanism for choosing the size of the transformants set, within which the processing will be performed. Then the expression (1) can be submitted in the nominal form:

$$\Lambda = \varphi_{pa}(\chi, M)\ , \qquad (3)$$

where φ_{pa} - the functionality for selecting the size of the processing area.

In general, a set of parameters must be added to the processing model, which with a varying degree of approximation can describe the features of the processed video stream fragment, such as:

1. The degree of complexity of the fragment θ_{fr}. This parameter can be calculated as the sum of the differences of the maximum and minimum pixel values for all rows of a frame fragment at the stage preceding the DCT, namely:

$$\theta_{fr} = \sum_{i=1}^{N} (\xi_{max} - \xi_{min})_i \ , \tag{4}$$

where N - the number of lines of the frame fragment;
ξ_{max} and ξ_{min} - the maximum and minimum value of a pixel in a row.

2. Image type. In the general case, the model may include the following types of images, such as computer graphics, photos, or their combinations. At the same time, one of the possible mechanisms for identifying the belonging of a frame to one of the types suggests its analysis for the presence of regions within which the range of changes in the values of components in the brightness and chromatic planes does not exceed a certain threshold [17-20]. In the presence of such areas and their total area within the frame, it is assumed that it is possible to include the frame in one or another type of processing.

3. Structural features of the fragment. These include indicators found in the spectral region, such as the average length of a binary elements series within the DCT transformant.

After the initialization of the control algorithm, on the first processing steps, the system operates in the learning mode [21]. In this case, a gradual formation of the processing model takes place. Thus, a number of processing models are formed, corresponding to different combinations of parameter values. At subsequent processing steps, when one or more fragments of the frame are received for processing, the search for the most appropriate processing model is performed. If, as a result of the application of such a model, an optimal coding is not ensured (according to indications a reduction in the amount of data or the value of the introduced error), the model is adjusted for subsequent similar fragments. Due to this, the processing time is reduced and the computing power requirements of the system hardware are reduced also

3. Conclusions

A conceptual model of the encoding video data method at the source level, based on a multiagent scheme, is proposed. Within the framework of this model, the method is implemented as a combination of a basic video codec and a control module. This module is a set of individual agents, each of which performs a particular function as part of a common video coding scheme using the basic technology.

This scheme provides the following features of video processing in the course of controlling the intensity of a video stream, like:

- implementation of processing functions at the appropriate encoding stage by a separate logic module - agent;
- selection of video intensity control parameters based on the use of processing models;
- dynamically changing the parameters of the processing model in the course of controlling the intensity of video data by refining the parameters of existing models

Such managing video intensity approach, unlike traditional methods, has the potential to ensure the matching of video stream parameters and network bandwidth in the shortest possible time and minimum requirements for the computing power of the hardware platform on which this scheme is implemented.

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