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METHOD OF CODING PREDICTABLE FRAMES WITH THE ACCOUNT OF MANAGEMENT MECHANISMS FOR IMPROVING THE QUALITY OF VIDEO INFORMATION'S SERVICE

Abstract. The main difficulties in working with video are large volumes of transmitted information and sensitivity to delays in the video information transmission. Therefore, in order to eliminate the maximum redundancy amount in the formation of the video sequence, 3 types of frames are used: I, P and B which form a frame group. For a typical low complexity video sequence, the weight of each P-frame in the stream is approximately three times smaller than the I-frame weight. However, taking into account the number of P-frames in the group, they make the main contribution to the total video data amount. Therefore, the possibility of upgrading coding methods for P-frames is considered on preliminary blocks' type identification with the subsequent formation of block code structures. The differential representation of the frame, by using the filtering threshold, makes it possible to identify stationary background regions (stationary component) and regions containing dynamic objects (dynamic component).

Keywords: image, redundancy, coding, quantization, matrix, data.

Introduction

Problem statement. It has been analyzed the predicted frames processing in the MPEG standard and its drawbacks has found during compressing video data. A method for encoding P-frames with the ability to select the type of blocks processing has been developed, where the structural redundancy estimation of the block is used as a decision rule [1-3]. Thus, it has been introduced an additional possibility to control the video bit rate by changing the number of I- and P-type blocks. The method of coding and reconstructing predicted frames has been improved by using block coding, which unlike Huffman codes has more noise immunity and less bit and time costs when processing data blocks.

Research publications. Delays in the processing and transmission of objective video monitoring information lead to the following fact. The temporary standards for the transportation duration by rail are not maintained both under normal conditions and during the liquidation of emergency situations. This leads to delays in the flow of goods on average by 10-15%. Also, this leads to untimely tasks fulfillment for managing rail transport and long delays in assessing the situation and making decisions.

The research aims and objectives. The aim of article is to develop method of coding predictable frames with the account of management mechanisms for improving the quality of video information's service.

The objectives of article are justification of the requirements for video data compression systems in the computer systems and concepts construction on the formation of stationary background's dynamic images compressed representation.

Research bases

Methods with loss of quality provide a greater compression level than methods without loss of quality. However, methods without quality loss, as well as methods with quality loss, must be used to process and transmit video information in the computer systems [4].

This need is explained by the following reasons:

1) for some practical tasks of railway transport management, it is required to provide high quality images. At the same time, methods with quality loss, based on the reduction of psychovisual redundancy, can not guarantee to ensure high quality images;

2) wide use of methods without quality loss in various image formats (TIFF, GIF, BMP, ART, etc.). At the same time, these formats are characterized by an increase in the compressed volume for realistic images heavily saturated with small details;

3) compression methods with quality loss have a longer data encoding time than methods without (dozens of times), and in some cases this leads to a loss and in the total time for processing and data transfer (FMS method);

4) developed a group of methods aimed primarily at compressing color coordinates, while arrays of series lengths are transmitted without additional coding, which reduces the image's degree compression and increases the transmission time on the communication channel;

5) in many complex compression methods, the length methods of the series are used as a subsystem for compressing the service information. Therefore, for further increase the compression ratio, it is required to compress the length of the series [5-7].

At the same time, existing methods without quality loss do not provide the transfer of images in the computer systems in real time. This is due to the following shortcomings of the length methods of the series and the LZW method:

1. The presence of stationary background regions is not taken into account.

2. For the dynamic component [8-10]:

- the amount of the simplest structural redundancy decreases (the lengths of series of the same elements decrease) for realistic images, and consequently, the effectiveness of the RLE and LZW methods decreases;

- there is a problem of the color coordinates processing of the identical images series.

Basing on the analysis of known compression methods, it can be concluded that there is a need to use

methods for processing images in the computer systems without quality loss. At the same time, they do not allow to process and transmit video data in real time.

It will be analyzed the directions of developing compression methods without quality loss in order to improve the processing, transmission and video data's noise immunity in the presence of stationary background images.

Reducing the total processing time and transfer information can be done due to further improvement of existing compression methods [11-18]. From the analysis of known compression methods, there follow such variants of their improvement:

1. Using processing, taking into account the stationary background presence of images. Here are the options:

- identifying motion compensation;
- using three-dimensional discrete cosine transformations.

However, this is a computationally complex processing process.

2. Using additional processing at the individual frames level, i.e. to exclude intraframe redundancy. Here the following options are possible:

1) using the series' lengths encoding. This, on the one hand, makes it possible to improve the identifying structural patterns efficiency. On the other hand, the coding efficiency of the series lengths is sharply reduced in the case of multi-degradation data processing with a high brightness difference probability.

2) as a result of image compression, by using DDS and LZW methods, structural and statistical redundancy is reduced. Therefore, the additional use of methods that reduce statistical redundancy will not significantly affect on the compression ratio. Existing element-wise coding methods, basically, exclude statistical redundancy;

3) the series lengths carry basic information about the shapes and sizes of the image objects, which is crucial for correct image recognition. Even small distortions in the lengths' values of the series lead to a partial or complete image destruction of the objects. Therefore, it is not recommended to use existing methods, which are based on the reduction of psychovisual redundancy to compress the series lengths;

4) increasing the LZW methods effectiveness is associated with an additional increase in the number of operations for coding, spent on:

- statistical characteristics calculation of image elements in each "sliding window";
- large window sizes lead to an increase in the search time of elements in the window.

In addition, the representation of the series' lengths, by uneven codes, slightly increases the compression ratio (not more than 1.5 times). But at the same time additional difficulties appear that make it difficult to implement the compression method in practice:

- additional operations are required to calculate the statistical characteristics of each block (of the order $O(N \log_2 N)$);
- it is necessary to transmit data on statistical characteristics;

-if an error in the codeword, it is impossible to restore the whole message.

It means, that the using of existing methods, which exclude probability-statistical and psychovisual redundancy, to further enhance the effectiveness of methods without quality loss in the process of intraframe processing is inexpedient [11].

Therefore, it came an interest for investigate the possibility of further increasing the compression ratio of stationary background processing images, which are based on the stationary component detection of the frame in the substrate, which will allow:

- to identify the area of stationarity relative to the previous frame;
- to form a binary mask of dynamic areas and thereby provide the potential for reducing structural redundancy as a result of identifying the lengths of binary series;
- to reduce the dimension of the array containing elements of dynamic objects.

Thus, it is proposed to construct a method for compressing images of a stationary background, which is based on the following mechanisms:

1) an identifying area of stationary background, which will allow to take into account the presence of interframe redundancy between neighboring frames;

2) a separated processing of the allocated stationary and dynamic components, using the operation of imposing a binary mask.

Concepts construction on the formation of stationary background's dynamic images compressed representation. The frame of the differential representation is formed on the current and previous frames in the conditions of the video information's stationary formation [12, 19-24]. This process is given by the expression:

$$e_{i,j}^{(\xi+1)} = a_{i,j}^{(\xi)} - a_{i,j}^{(\xi+1)},$$

Here are: $a_{i,j}^{(\xi)}$ - (i; j) -th element of the previous frame;

$e_{i,j}^{(\xi+1)}$ - (i; j) -th element of the current differential-

represented frame; $a_{i,j}^{(\xi+1)}$ - (i; j) -th element of the current frame in the video sequence.

The format of the differentially represented frame allows to distinguish two components, that describe the stationary background and dynamic objects. In order to obtain a stationary background, it is necessary to determine the positions of the elements, which belong to the dynamic component. In this case, it is necessary to take into account that the frame is formed in conditions, when the illumination of railway trains in motion changes, the video camera vibrates, as a result of fluctuations during its fixing, distortions are detected during conversion of the analog signal to digital form [14, 25-28]. In order to take this into account in the process of forming the stationary component of the differential-represented frame, it is proposed to use the filtering threshold ΔP . The filtering essence is to identify the elements of the differential-represented frame, which contain impulsive interference. This will determine whether the element refers to a stationary component or

to a dynamic component. To reduce the number of operations for processing, it is suggested to use scalar threshold filtering. Scalar threshold filtering is performed according to the rule, where each processed element e_{ij} is compared with the threshold value ΔP . If the value of the element is less than the threshold value, i.e. $e_{ij} \leq \Delta P$.

Then this element is considered an element of the stationary component $e_{ij} \in I_{st}$, and $e_{ij} = 0$.

Conversely, if the value of the element exceeds the threshold value $e_{ij} > \Delta P$, then this element belongs to the dynamic component $e_{ij} \in I_d$.

The filtered structure of the differential-represented frame allows you to extract dynamic and stationary components from it [29, 30].

Taking into account the separate processing for the differential-represented frame, two components are formed (Fig. 1).

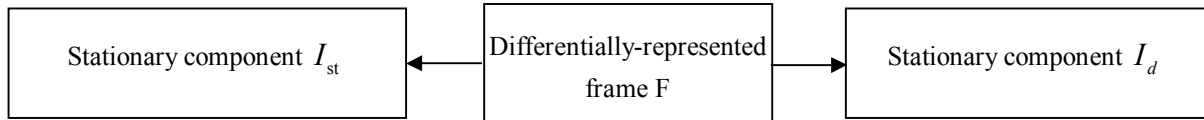


Fig. 1. The scheme for the formation of two differential-represented frame components

The filtered representation of the differential-represented frame is given by the following system of expressions:

$$e'_{i,j} = \begin{cases} 0, & \rightarrow |e_{ij}| \leq \Delta P; \\ e_{i,j} - \Delta P, & |e_{ij}| > \Delta P \ \& \ e_{ij} > 0; \\ e_{i,j} + \Delta P, & |e_{ij}| > \Delta P \ \& \ e_{ij} < 0. \end{cases}$$

Thus, the differential representation of the frame, by using the filtering threshold, makes it possible to identify stationary background regions (stationary component) and regions containing dynamic objects (dynamic component).

Conclusions

1. It has been developed the requirements for video data compression systems in the computer systems.

Proposed to construct a method for compressing images of a stationary background, which is based on the following mechanisms:

- 1) an identifying area of stationary background, which will allow to take into account the presence of interframe redundancy between neighboring frames;
- 2) a separated processing of the allocated stationary and dynamic components, using the operation of imposing a binary mask.

2. It has been developed the concepts on the formation of stationary background's dynamic images compressed representation.

The differential representation of the frame, by using the filtering threshold, makes it possible to identify stationary background regions (stationary component) and regions containing dynamic objects (dynamic component).

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Метод кодування прогнозних кадрів з врахуванням механізмів управління для поліпшення якості надання відеоінформаційних послуг

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Анотація. У статті показано, що основні труднощі в роботі з відео - це великі обсяги переданої інформації та чутливість до затримок при передачі відеоінформації. Отже, щоб усунути максимальну величину надмірності при формуванні відеопослідовності, використовуються 3 типи кадрів: I, P та B, які утворюють групу кадрів. Для типової відеопослідовності низької складності вага кожного P-кадру в потоці приблизно втричі менша, ніж вага I-кадру. Однак, враховуючи кількість P-кадрів у групі, вони вносять основний внесок у загальний обсяг відеоданих. Тому розглядається можливість оновлення методів кодування для P-кадрів при ідентифікації попереднього типу блоків з подальшим формуванням структур блокових кодів. Розроблено вимоги до систем компресії відеоданих в комп'ютерних системах. Запропоновано побудувати метод компресії зображень нерухомого фону, який базується на таких механізмах: 1) ідентифікуюча область стаціонарного фону, яка дозволить врахувати наявність міжкадрової надмірності між сусідніми кадрами; 2) роздільна обробка виділених стаціонарних та динамічних компонентів з використанням операції накладання двійкової маски. Розроблено концепцію формування обробленого подання динамічних зображень нерухомого фону. Диференціальне представлення кадру, використовуючи поріг фільтрації, дозволяє ідентифікувати нерухомі фонові області (стаціонарний компонент) та області, що містять динамічні об'єкти (динамічний компонент).

Ключові слова: зображення, кодування, квантування, матриця, дані.