Cluster Coding in System of Multilevel Selective Data Processing

Vladimir Barannik, Dmytro Havrylov, Viktoria Himenko, Oksana Stetsenko

***Abstract* — In the work multilevel selective data processing with the use of the cluster coding depending on bit stream that is produced approach is proposed. Using the developed adaptive algorithms RLE coding and adaptive essentially arithmetic encoding is proposed.**

***Index Terms* – selective processing, adaptive RLE coding, adaptive arithmetical coding, efficiency.**

I. INTRODUCTION

AT departmental and commercial structures are continuously trying to increase efficiency and confidentiality of data transmission by removing the delay. This attempt caused by the fact that in these structures run information which in case of leaking can lead to economic, political and social losses. The required level of confidentiality is achieved through the use of cryptographic algorithms, which usually were certified and is standards. At this time, the territory of Ukraine as a standard algorithm symmetrical encryption-6 "Kalyna", which was adopted by the National standard of Ukraine GSTU 7624:2014 "Information technologies. Cryptographic protection of information. The algorithm of a symmetric block metamorphosis" from July 1, 2015. This document authorizes use algorithm Kalyna in departmental telecommunication systems of Ukraine. As for the operative data transmission data, then it is proposed to use compression algorithm, which will allow avoiding data redundancy, and as a result, reduce the size of data and time for transfer. However, different compression algorithms, depending on the type of input data provide different coefficients compression in some cases even increasing the initial size. Therefore, actual scientific and redefining the objective is to find compression algorithms that were selected depending on incoming data and give maximum zoom ratio compression with providing necessary quality.

Manuscript received October 11, 2016.

Vladimir Barannik is with Kharkiv National Air Force University, Kharkiv, Ukraine (corresponding author to e-mail: barannik_v_v@mail.ru).

Dmytro Havrylov is with Kharkiv National Air Force University, Kharkiv, Ukraine (e-mail: havrylov_d@ukr.net).

Viktoria Himenko is with Cherkasy State Technological University, Cherkasy, Ukraine.

Oksana Stetsenko is Kharkiv National University of Radioelectronics, Kharkiv, Ukraine.

II. ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

It is possible and necessary to use compression algorithms that are based on the characteristics of the data coming will give the largest ratios of compression K_{comp} preservation of the required quality. Through this manipulation may provide operational data measured over $T_{delivery}$ time proof:

$$T_{delivery} = \frac{V}{\delta}, \tag{1}$$

where V – the volume of data that must be transferred; δ – the bandwidth of the communication channel.

Obviously, for operational data transmission performance necessary conditions $T_{delivery} \to \min$ are possible following ways to meet this need:

1) when the amount of data transmitted will be minimal, while maintaining the required quality $(V \to \min)$;

2) when channel capacity is the maximum that would "instantly" transmit data to any size $(\delta \to \max)$;

3) combined, and where $V \to \min$ and $\delta \to \max$.

In this paper, the second way is not considered, such as finding a channel that will satisfy the needs of users without processing algorithms consider impossible.

The goal of the paper is finding the way of meeting the needs $V \to \min$ through the use of compression algorithms that will maximize the coefficient of compression K_{comp} without significant loss of quality (maximum allowable). Compression ratio K_{comp} calculated as the ratio of output size V_{out} to the size of compressed data V_{comp}:

$$K_{comp} = \frac{V_{out}}{V_{comp}}. \tag{2}$$

This approach would satisfy requirements for operational data $T_{delivery} \to \min$ in channel of field center (component of satellite connection) единой departamental digital telecommunication network with bandwidth $\alpha = 5$ Mbit/s (satellite and optical connection channel, which are given by «Datagroup» company) and equipment of videoconference based on personnel computer Intel Pentium Core2Duo 3 GHz, RAM – 3 Gb, IP-camera – 2 Mpx.

III. PRESENTING MAIN MATERIAL

Research is stated the likelihood of different elements depending on the degree of saturation block contour information (Table. I).

TABLE I
THE RESULTS OF EXPERIMENT, THE PROBABILITY OF THE ELEMENT IN TRANSFORMANTS

Block class	Without contour information	With gradual transition	With contour information
Block size	8 x 8	8 x 8	8 x 8
Probability of «1»	0,0059	0,2928	0,4761
Probability of «0»	0,9941	0,7072	0,5239
"1" ratio to "0" (K), %	0,5935	41,4027	90,8761

As a result of the performed experiment (Table I) prompted flowchart selecting the encoding algorithm depending on the probability of occurrence of the element equal to "1" and the probability of occurrence of the element equal to "0" (fig. 1).

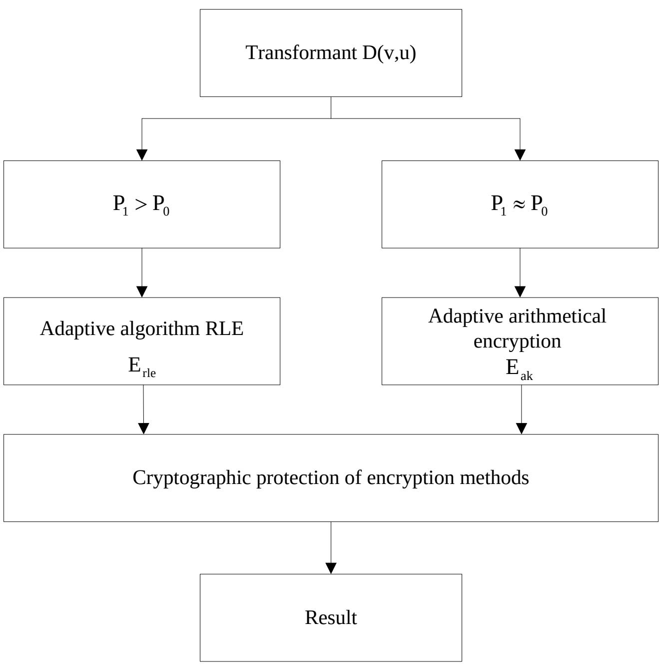

Fig. 1. Flowchart choice of encryption algorithm based on the probability of entering items

For compression n bit stream if $P_1 > P_0$, it is proposed to use adaptive algorithm RLE E_{rle}. The adaptation algorithm is that a standard pair of "number of iterations, the value of the" replaced with 8-bit number in which the most significant bit assigned to the "value elements" (as the input can enter only "0" or "1") and the remaining 7 bits indicate the number of repetitions (long series) (Fig. 2).

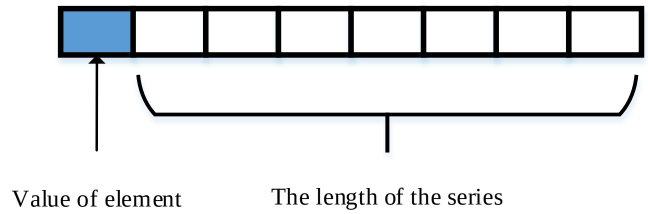

Fig. 2. Adaptive code format after RLE encoding

It is necessary to note that the proposed algorithm using the maximum value of the length of the series can be $2^7 = 127$.

Comparison of developed method of adaptive RLE with standard RLE is presented on Fig. 3.

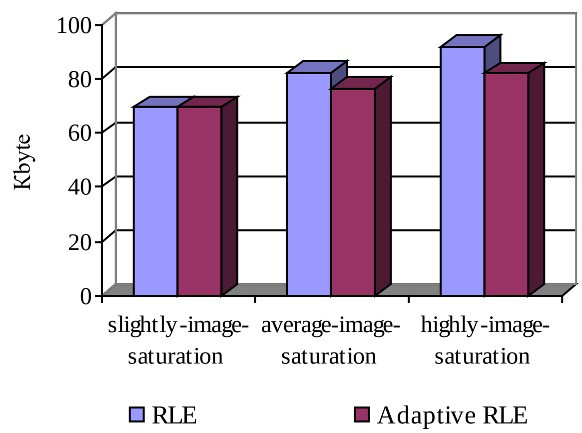

Fig. 3. Research of developed method of adaptive RLE

Example:

Let coded series is next:

$$S = \left| 0_1\ 0_2\ \dots\ 0_{99}\ 0_{100}\ 1_1\ 1_2\ \dots\ 1_{79}\ 1_{80} \right|.$$

Using adaptive algorithm RLE vector code takes the following form:

$$E_{rle}(S) = \left|100; 208\right|.$$

In the binary code will be as follows:

$$E_{rle}(S)_2 = |\ 01100100;\ 11010000|.$$

The volume of the resulting code $V_{ccomp} = 16$. Volume output array transformant is $V_{out} = 180$. Based on this data rate compression for a given array is $K_{comp} = 11{,}25$.

For compression bit stream $P_1 \approx P_0$, it is proposed to use adaptive algorithm arithmetic coding E_{ak}. This method is simple to implement and has a high rate of speed by simple calculations, which consist in determining the range in which the encoded element (Fig. 4):

$$E_{ak} = \frac{l_f + h_f}{2},$$

where l_f - the beginning of the working range f-th coded symbol; h_f - the end of the interval f-th coded symbol;

Example:

Let coded series is next:

$$S = |0\ 0\ 1\ 0\ 1\ 1\ 1\ 0|.$$

The amount of weight on the f-th step is determined by the expression:

$$\eta_f = \eta_0 + \eta_1,$$

where η_0 – weight "0"; η_1 – weight "1".

The value of the segment to f-th step can be calculated using the formula:

$$\rho_f = \frac{h_f - l_f}{\eta_f}.$$

When encoding "1" working interval $[l_i; h_i]$ can be found by using the expression:

$$h_f = h_{f-1};$$

$$l_f = h_f - \eta_f^1 \cdot \rho,$$

where η_f^1 - weight "1" to f-th step.

First built Table II.

TABLE II

THE TABLE OF INITIAL DATA FOR ARITHMETIC CODING

№ step	The value of the encoded	Weight η «0»	Weight η «1»	Available value range	Working range $[l_f;h_f]$
		1	1		
1	0	2	1	1	[0; 1]
2	0	3	1	0,5	[0; 0,5]
3	1	3	2	0,33	[0; 0,33]
4	0	4	2	0,163	[0,167; 0,33]
5	1	4	3	0,0815	[0,167; 0,2485]
6	1	4	4	0,0465	[0,2019; 0,2485]
7	1	4	5	0,02913	[0,2194; 0,2485]
8	0	5	5	0,0161	[0,2323; 0,2484]

When encoding "0" working interval $[l_i; h_i]$ can be found by using the expression:

$$l_f = l_{f-1};$$

$$h_f = l_f + \eta_f^0 \cdot \rho_f,$$

where l_{f-1} - the beginning of the working range of the previously coded symbol;

η_f^0 - weight "0" on the f-th step.

As a result of the adaptive arithmetic coding (Fig. 3) obtain a work interval [0.2323; 0.2404] for the interval encoded values will look like:

$$E_{ak} = |1\ 1\ 0\ 0\ 0|.$$

With this value can accurately reproduce the entire sequence encoded thereby, information on the limits of this interval are confidential. After the cluster coding to increase the security of data transmitted is proposed to encryption of data encoding method.

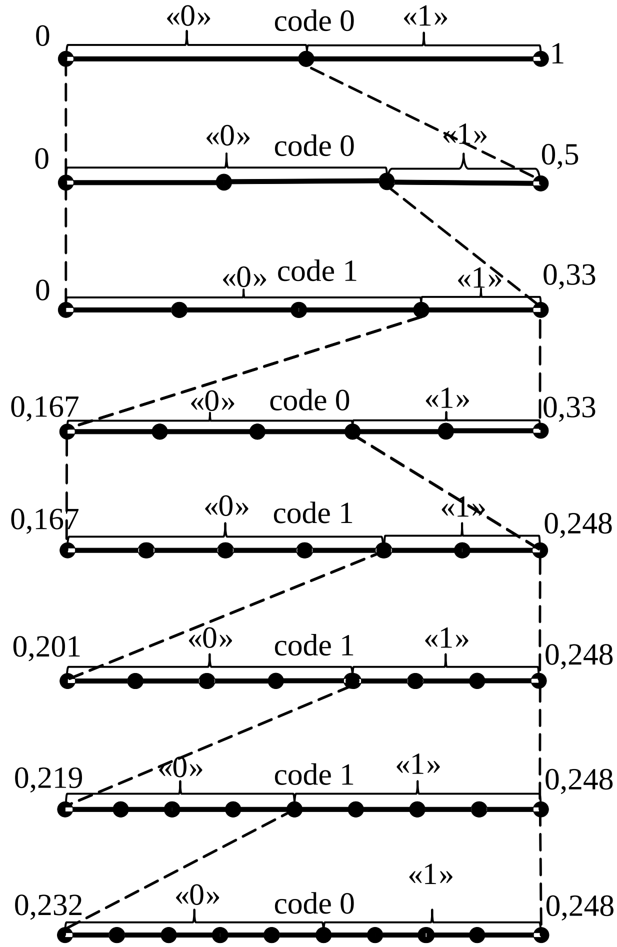

Fig. 4. The process of adaptive arithmetic coding code

Comparison standard JPEG-based method with developed JPEG-based method (Fig. 1) is presented on Fig. 5.

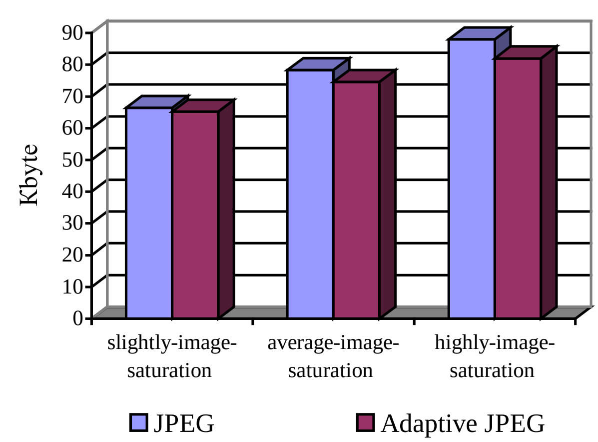

Fig. 5. Research of developed method of adaptive RLE

IV. Conclusion

The developed system multilevel approach will provide selective protection efficiency of data transmission by using compression algorithms and privacy protection by type of coding (see Fig. 5).

Scientific innovation is the first developed adaptive algorithm RLE-encoding, which is operating with an input bitstream will achieve a significant coefficient of compression while maintaining quality.

References

[1] V.V. Barannik, V.V. Larin, S.A. Sidchenko, "The model of avalanche-relating effect in the process of images reconstruction in the combined crypto semantic systems on the polyadic presentation", *Knowledge-based technology*, vol. 5, no. 1, pp.68 – 70, 2010.

[2] D. Havrulov "The analysis of template method of video processing.", Proc. IEEE-2015 (AICT'2015), pp. 87 – 89, Oct – Nov , 2015

[3] V.V. Barannik, J.N. Ryabukha " The method of improving information security in video monitoring systems for crisis situations ", Cherkassy, pp.143 c., 2015.

[4] V. Barannik, I. Tupitsya, S. Shulgin, S. Sidchenko, V. Larin The application for internal restructuring the data in the entropy coding process to enhance the information resource security / 2016 IEEE East-West Design & Test Symposium (EWDTS), Yerevan, 2016, pp. 1-4.

[5] V.V Barannik, A.V Vlasov, S.A Sydchenko, A.E. Bekir " Substantiation of significant security threats to the video information resource of video conferencing systems of profile management systems", *Information control systems on railway transport*, no.3, pp.24 – 31, 2014

[6] Barannik, V.V., Komolov, D. , Musienko, A.P., Tarnopolov, R.V. Methodological basis for determining the energy significance of the structural unit of a video frame based on the estimation of low-frequency components of the matrices of the DCT blocks of the luminance component / 13th International Conference on Modern Problems of Radio Engineering, Telecommunications and Computer Science, TCSET 2016; Lviv-Slavsko; Ukraine; 23 February 2016 - 26 February 2016; pp. 739-741

[7] V.V Barannik, J.N Ryabukha, A.A Krasnorutskyy, V.J. Yaschenok " Methodology of improving the processing of video information, to improve the efficiency of the service of providing remote video services, in managing in crisis situations ", *Automated control systems and devices*, no.170, pp.12–20, 2015.

[8] Barannik, V., Shulgin, S.S. The method of increasing accessibility of the dynamic video information resource / 13th International Conference on Modern Problems of Radio Engineering, Telecommunications and Computer Science, TCSET 2016; Lviv-Slavsko; Ukraine; 23 February 2016 - 26 February 2016; pp. 621-623.

Vladimir Barannik is with Department of combat use automatic control system, Kharkiv National Air Force University, Kharkiv, Ukraine (corresponding author to e-mail: barannik_v_v@mail.ru).

Dmytro Havrylov is with Department of combat use automatic control system, Kharkiv National Air Force University, Kharkiv, Ukraine (e-mail: havrylov_d@ukr.net).

Viktoria Himenko is with Department of Information Security and Computer Engineering, Cherkasy State Technological University, Cherkasy, Ukraine (e-mail: barannik_v_v@mail.ru).

Denys Tarasenko is with Department of Information Security and Computer Engineering, Cherkasy State Technological University, Cherkasy, Ukraine (e-mail: barannik_v_v@mail.ru).