UDC 621.327:681.5

METHODOLOGY OF INCREASING THE RELIABILITY OF VIDEO INFORMATION IN INFOCOMMUNICATION NETWORKS AEROSEGMENT

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ABSTRACT

Context. The problem of localization of the effect of errors in data transmission channels when using compression and noise-immune coding methods in the conditions of compliance with the speed of data delivery in infocommunication systems of the aerosegment. The object of the study is coding methods for increasing the reliability of video information resources in infocommunication networks using airmobile platforms.

Objective. The goal of the work is to methodology development of increasing the reliability of video information in the infocommunication networks of the aerosegment.

Method. The use of noise-immune coding methods to ensure the required level of reliability of video information transmitted in infocommunication systems of the aerosegment has a number of significant disadvantages: it leads to a significant increase in the bit volume of compactly presented video data; the time delay for the delivery of video information is growing, which is critical in the conditions of using airmobile platforms. An increase in time delays in the process of delivering video information leads to the fact that the video information will not be transmitted in full and, as a consequence, in the conditions of aeromonitoring, to the loss of data reliability; time for processing video data increases. The advantage of using compression coding technologies to solve the problem of increasing the reliability of video information transmitted in infocommunication systems of the aerosegment is to reduce the bit volume of the video information resource. However, the existing video processing technologies are based on the use of statistical coding methods and the identification of a series of identical sequences of repeating elements. But the use of such technologies does not provide the required level of error localization. Restructuring method was developed based on identifying patterns in the internal binary structure of message elements by a quantitative attribute. The sign of the number of series of units in the binary structure of message elements is used as a tool for restructuring. Distinctive features of the method are that the restructuring of the information space is carried out without loss of integrity on the basis of structural features by the number of binary series.

Results. The analysis of existing directions for solving the problem of increasing the level of reliability of video information transmitted in the infocommunication systems of the aerosegment was carried out. A method of internal data restructuring has been developed, which allows obtaining the following results: conditions are provided for additional reduction of structural redundancy of code representation of information due to significant reduction of information space capacity as a result of using internal data restructuring on the basis of the number of series of units; conditions are created for localization of errors in the process of reconstruction of video information resources; conditions are created to reduce the time for data processing, due to the fact that the developed method of data restructuring does not require transformations over the elements of the message.

Conclusions. It is necessary to improve the existing compression coding technologies in the direction of identifying patterns, taking into account which will allow localizing the destructive effect of errors arising in the communication channel.

KEYWORDS: video information resource, coding, reliability, efficiency, communication channel, aerosegment, compression technology.

ABBREVIATIONS

CS is crisis situations;
UAV is unmanned aerial vehicles;
VIR is video information resources;
BCH is Bose-Chowdhury-Hawkingham codes;
SU is series of units.

NOMENCLATURE

f_{cl} is a message clustering functionality $U(\theta)$ of the plural $U(\lambda_i)$ on the basis of λ, $\lambda = \overline{\lambda_1, \lambda_{|\Lambda|}}$;

$f_{cl}(u_\xi, \lambda_i)$ is a element clustering functionality u_ξ video sequences $U(\theta)$ with the same amount λ_i SU;

K' is a number distorted pixels that affect the quality of visual perception, %;

$P(\varepsilon)$ is a probability of bit errors under conditions of interference and interference in the communication channel;

$P(u_\xi)$ is a probability of the appearance of elements u_ξ in video sequence $U(\theta)$;

$PSNR_\varepsilon$ is a peak signal-to-noise ratio under conditions of interference and interference in communication channels, dB;

$PSNR_{\varepsilon nec}$ is a necessary value of peak signal-to-noise ratio;

DOI 10.15588/1607-3274-2022-3-12

$PSNR_{\varepsilon_{dm}}$ is a value of peak signal-to-noise ratio for development method;.

$q_{\alpha-1}$, q_{α} are previous and current binary digits, which specify the internal binary structure of the element u_{ξ} message $U(\theta)$;

T_{del} is a delays time, ms;

T_{tr} is a transmission time, s;

$U(\theta)$ is a video sequence;

u_{ξ} is an element of video sequences;

$U(\lambda_i)$ is a set (cluster) of elements u_{ξ}, the binary representation of which has the same value of the sign λ, i.e. $\lambda = \lambda_i$;

$U(\vartheta)$ is an alphabet of video sequences $U(\theta)$;

V_{tr} is a transmission speed, Mbps;

λ is a quantitative sign;

λ_{α} is a value of quantity λ SU on α-th step, $\alpha = \overline{1, |u_{\xi}|_2}$.

INTRODUCTION

Significant rates of digitalization of society are accompanied by increasing the role of information space at both state and regional levels [1–3]. Especially in the field of security, the main objects of which are the population and the system of critical infrastructure of the city [3–5].

In this direction, video services play an important role as a means to improve the efficiency of departmental bodies and line ministries in terms of timely detection, prompt coordinated response to threats to critical infrastructure of the city, and prompt decision-making on their location [6–8]. In turn, the threats that may arise in modern society and the system of critical infrastructure can lead to crises of man-made, natural, criminogenic, terrorist nature [9–11].

It should be borne in mind that the critical infrastructure system is characterized by such properties as complexity, scale and mobility [12]. In this regard, the use of infocommunication systems of the aerosegment segment has become especially important [13–15]. Thus, unmanned aerial vehicles (complexes, drones) are actively used for mobile monitoring of remote objects and areas [16–18]. This allows for timely detection and prompt response to crisis (emergency) situations.

Thus, the use of remote infotainment technologies based on airborne means in order to increase the effectiveness of actions aimed at prevention and timely response to crisis situations (CS) is a very important issue.

Thus, the use of unmanned aerial vehicles provides the following tasks [19–21]:

– obtaining up-to-date information about the object (territory) of observation – video surveillance in real time;

– monitoring of remotely remote objects of observation;

– simultaneous monitoring of a significant number of observation objects;

– monitoring of large areas;

– monitoring of dynamic objects.

For the transmission of video images in the infocommunication systems of the aerosegment, wireless communication channels are used, which are characterized by the presence of a whole range of interference (interference) of natural and artificial nature [22–24]. In this regard, it is necessary to take into account the following problematic aspects of the implementation of wireless technologies [24]:

– low resistance to errors in data transmission channels;

– the need to take into account the electromagnetic compatibility of on-board radio equipment with wireless devices.

This leads to a significant loss of authenticity of video information due to:

– receiving a video information resource with a significant delay;

– loss of relevance of the received video data;

– complete destruction of video information in semantic content;

– Inability to identify image objects.

Thus, the use of unmanned aerial vehicles on the one hand allows increasing the level of informatization of control systems, and on the other is leads to a significant loss of reliability of video information.

The purpose of the work is development of a methodology to increase the reliability of compactly presented video images in infocommunication networks in terms of ensuring the required level of efficiency.

1 PROBLEM STATEMENT

Suppose we have a video sequence $U(\theta)$ consisting of elements u_{ξ} ($\xi = \overline{1, \theta}$) and transmitted over a data channel under error conditions $P(\varepsilon)$. The task is to develop a method of internal data $U(\theta)$ restructuring by identifying patterns in the internal binary structure $[u_{\xi}]_2$ of the elements u_{ξ} of the video sequence $U(\theta)$ on a quantitative sign λ for further clustering.

Restructuring of the information space should provide the required level of reliability of the reconstructed video image, the quantitative assessment of which is the peak signal-to-noise ratio $PSNR_{\varepsilon}$.

For the developed method, the peak signal-to-noise ratio at a given error level ($P(\varepsilon) = 10^{-4}$, $P(\varepsilon) = 10^{-5}$) in the data channel should have the following value:

$$PSNR_{\varepsilon} \geq 15 - 25\,\text{dB}.$$

2 REVIEW OF THE LITERATURE

Analysis of recent scientific publications shows that currently actively used UAVs, which are characterized by

DOI 10.15588/1607-3274-2022-3-12

an increase in maximum flight altitude to 7000 m [25–27]. In this regard, the requirements for the resolution of on-board video surveillance equipment installed on board the UAV are increasing.

To obtain video information using the air segment, airborne means are actively used, which are characterized by the following features [28–30]:

– image resolution – not worse than 4000 × 3000 pixels [28];

– video resolution – not worse than Full HD (1920 × 1080 pixels) [29];

– image format – JPEG / DNG (RAW) [29–30];

– video format – MP4 / MOV (MPEG-4 AVC / H.264, HEVC / H.265) [28–30];

– frame rate per second – 24… 60 [30].

In turn, the increase in the resolution of video images in terms of increasing the height of aerial monitoring leads to the fact that:

– requirements for ensuring the appropriate level of reliability of video information resources (VIR) are increased. This is due to the fact that the number of elements (pixels) that describe the object of observation decreases, resulting in an increase in their semantic load. Accordingly, the loss of the element due to errors in the communication channel leads to a decrease in the level of reliability of the VIR;

– the volume of the video image increases. This leads to an increase in the number of video processing operations. Accordingly, with the same computational complexity and increasing volumes of video information, it is necessary to look for opportunities to reduce the complexity of the processing of VIR to ensure the desired level of efficiency of delivery to the final destination.

So increase the reliability of compactly presented video images in infocommunication networks is **an urgent scientific and applied task**.

3 MATERIALS AND METHODS

Let's break feature space into rectangular regions limiting the range of values of each feature by its minimum and maximum values. Then the partition projections into feature axis allow allocating feature intervals for each of the rectangular block. The intervals can be formed as cluster projections or as a regular grid, or on the basis of class boundaries in sample one-dimensional projections on the feature axes [24].

The use of the aerosegment involves the implementation of a number of requirements for VIR from the standpoint of ensuring the required level of reliability, which are shown in Table 1. The requirements specified in Table 1 are formed taking into account:

– analysis of QoS (quality of service) indicators [31–33];

– requirements for providing video information in critical infrastructure systems [34];

– results of practical research [35–37].

The scheme of formation of these requirements, taking into account the peculiarities of the use of wireless communication channels for the delivery of video information is shown in Fig. 1.

Quantitative indicators of these requirements are given in Table 1.

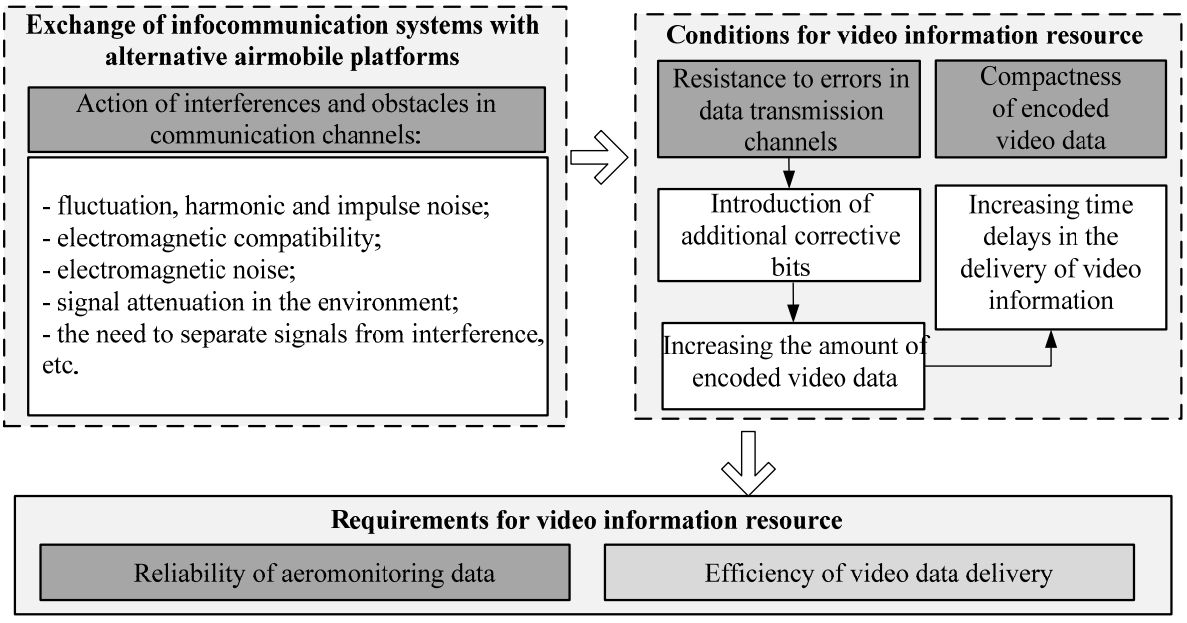

Figure 1 – The scheme of formation of requirements to video information resources in the conditions of use aerosegment

DOI 10.15588/1607-3274-2022-3-12

Table 1 – Requirements for video information resources in the conditions of using the air segment

№ s/n	Indicator	Necessary value
1.	Peak signal-to-noise ratio $PSNR_{\varepsilon}$ under conditions of interference and interference in communication channels, dB	> 15–25
2.	Number K' distorted pixels that affect the quality of visual perception, %	7–8
3.	Probability of bit errors under conditions of interference and interference in the communication channel, $P(\varepsilon)$	10^{-5}… 10^{-4}
4.	Time delays T_{del}, ms	120

Analysis of the data listed in table 1 show that the main requirements for VIR in the use of the aerosegment are the following:

1. Ensuring the reliability of the video information resource in the conditions of errors in the communication channel, which is determined by the following quantitative indicators:

– peak signal-to-noise ratio $PSNR_{\varepsilon}$ under conditions of interference and interference in communication channels, which should not be less than 15–25 dB;

– number K' distorted pixels in the reconstructed video image that affect the quality of visual perception should not exceed 7–8%;

2. Probability of bit errors under conditions of interference and interference in the communication channel, $P(\varepsilon)$.

3. The required level of time delay T_{del} in the process of data delivery of video information resource using wireless communication technologies. Time delays T_{del} should not exceed 120 ms. Otherwise, in the conditions of air monitoring, significant time delays lead to the fact that video information will not be transmitted in full. So this is what will lead to the loss of its credibility.

On the other hand, infocommunication systems using airmobile platforms are characterized by the presence of interference and interference in communication channels due to the following factors [38–40]: electromagnetic compatibility of airborne radio navigation equipment with wireless devices; low resistance of wireless communication technologies to errors; electromagnetic noise; the need to separate signals from interference; mutual electromagnetic interference of devices of one channel (or adjacent frequencies); signal attenuation in the environment.

These factors pose a threat to the loss of information, the destruction of video images, reducing the efficiency of their delivery due to the need to re-record and transmit video data.

There are the following areas of solving the problem of increasing the reliability of video information transmitted in infocommunication networks using airmobile platforms, namely [41–44]:

1) using existing noise-tolerant coding technologies;

2) compression coding technologies with localization of errors that occur in the communication channel.

Estimation of efficiency of use of existing technologies of noise-tolerant coding of video data. One of the ways to solve the problem increase the reliability of video information is the use of existing noise-tolerant coding technologies. The most common are the Bose-Chowdhury-Hawkingham (BCH) codes and the Reed-Solomon codes. The essence of the use of these noise-tolerant coding technologies is the need to introduce additional corrective (verification) bits in the process of forming code structures assigned to the data VIR.

Fig. 2–3 shows estimates of video transmission time in a given level of errors ($P(\varepsilon) = 10^{-4}... 10^{-5}$) at a given baud rate $V_{tr} = 5\ Mbps, V_{tr} = 40\ Mbps$) and pixel depth (8 bits) using standard noise-tolerant encoding methods.

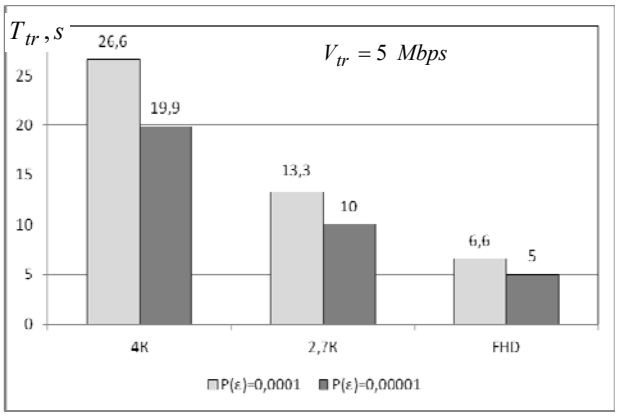

Figure 2 – Diagram of the dependence of the transmission time of the video frame on the resolution at a given transmission speed, $V_{tr} = 5$ Mbps

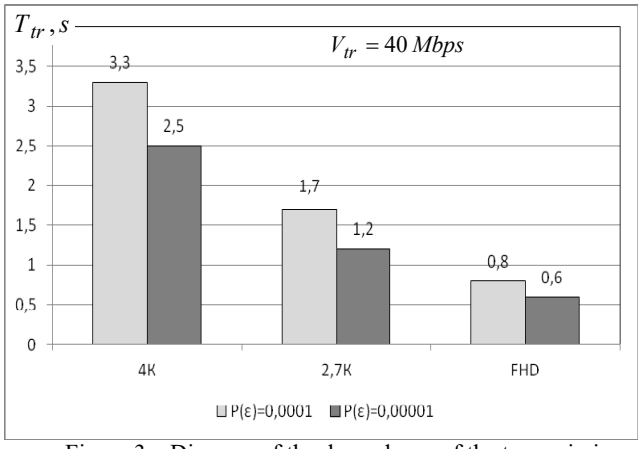

Figure 3 – Diagram of the dependence of the transmission time of the video frame on the resolution at a given transmission speed, $V_{tr} = 40$ Mbps

Analysis of the data shown in Fig. 2–3 shows that:

1. Given the average recording frequency of 30 frames per second, it can be concluded that the on-board equipment for video surveillance and video transmission on the studied airborne means does not provide full registration and transmission of all video information generated per second.

DOI 10.15588/1607-3274-2022-3-12

2. The minimum time for transmitting video information from the UAV is:

– at a video transfer rate of 5 Mbps and error rates in the data channel $P(\varepsilon)=10^{-4}$ – from 3 to 40 minutes;

– at a video data transfer rate of 40 Mbps and a given level of errors in the data channel $P(\varepsilon)=10^{-4}$ – from 24 s to 5 min;

– at a video transfer rate of 5 Mbps and a given level of errors in the data channel $P(\varepsilon)=10^{-5}$ – from 2.5 to 30 minutes;

– at a video data transfer rate of 40 Mbps and a given level of errors in the data channel $P(\varepsilon)=10^{-5}$ – from 18 s to 3.5 minutes

3. Increasing the pixel depth to 24 bits increases the transmission time of video information by 3 times.

Increasing time delays in the process of delivering video information leads to the fact that the video information will not be transmitted in full and, as a consequence, in the conditions of aeromonitoring to the loss of reliability of VIR data.

Thus, we can conclude that the use of existing noise-tolerant coding technologies can increase the resilience of VIR to errors in data channels due to the use of additional corrective digits, but has a number of significant disadvantages:

– leads to a significant increase in the bit size of video data;

– there is a growing delay in the delivery of video information, which is critical in the use of airmobile platforms;

– video processing time is increasing.

In the conditions of aerial monitoring, significant time delays lead to the fact that video information will not be transmitted in full. So this is what will lead to the loss of its credibility.

On the other hand, it is possible to localize the effect of errors on the quality of recoverable images due to the existing psycho visual redundancy. But it is on the elimination of psycho visual redundancy in the existing methods of compression coding is achieved the basic value of the level of compression of video images.

Therefore, it is necessary to increase the reliability of the video information resource based on the study of the possibilities of reducing the negative impact of errors in the process of compression and reconstruction of video frames.

Estimation of efficiency of use of existing technologies of compression coding of video data from a position of maintenance of necessary level of reliability. Analysis of the effectiveness of existing compression video coding technologies from the standpoint of ensuring the required level of reliability in the event of errors in the reconstruction process shows that existing video coding algorithms, built on processing technologies implemented on JPEG platform, have significant shortcomings. This is due to the fact that the action of errors for existing approaches has an avalanche effect, which leads to the destruction of video images in the reconstruction process.

Estimation of reliability of video images in infocommunication systems of an aerosegment on an indicator of a peak ratio signal / noise $PSNR_{\varepsilon}$ at a given error rate ($P(\varepsilon)=10^{-4}...\ 10^{-5}$) in data transmission channels is shown in Fig. 4.

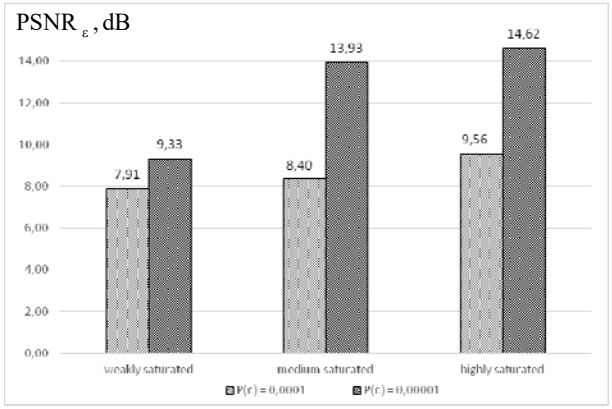

Figure 4 – Diagram of the dependence of the peak signal-to-noise ratio $PSNR_{\varepsilon}$ from mistakes $P(\varepsilon)$ in the communication channel

Analysis of the data shown in Fig. 4 shows that the use of existing compression coding technologies does not provide an appropriate level of reliability of video information for infocommunication systems of the air segment. This is due to the fact that the value of the peak signal-to-noise ratio $PSNR_{\varepsilon}$ at a given level of errors in the process of reconstruction of the video information resource does not meet the required $PSNR_{\varepsilon nec}$, i.e. the following condition is not met:

$$PSNR_{\varepsilon} \le PSNR_{\varepsilon nec},\ PSNR_{\varepsilon} \le 15-25\,\text{dB}.$$

So at the level of errors $P(\varepsilon)$ in the communication channel equal to $P(\varepsilon)=10^{-5}$ the value of the peak signal-to-noise ratio $PSNR_{\varepsilon}$ less than the minimum required value of 3% for high-saturated video to 38% for low-saturated video.

In turn, at the level of errors $P(\varepsilon)$ in the communication channel equal to $P(\varepsilon)=10^{-4}$ the value of the peak signal-to-noise ratio $PSNR_{\varepsilon}$ less than the minimum required value of 36% for high-saturated video to 47% for low-saturated video.

Hence the use of existing compression coding technologies leads to a significant loss of reliability of information, namely the video resource can be obtained with a significant delay and will be in this case irrelevant, or completely destroyed in semantic content, ie not subject to reconstruction. This is due to the fact that existing compression coding technologies are based on the use of sta-

DOI 10.15588/1607-3274-2022-3-12

tistical coding methods and the detection of a series of identical sequences of repeating elements. This situation leads to a number of significant shortcomings, namely:

1. Low resistance to errors in data transmission channels, as statistical coding methods are based on non-uniform code constructions.

2. Due to the formation of non-uniform structural characteristics (lengths of series of transformant components with zero values) to reduce redundancy in transformants, the occurrence of errors in the reconstruction process can lead to a shift in the data of the video information resource.

Therefore, this direction does not provide the required level of localization of errors. Therefore, it is necessary to improve existing compression coding technologies in the direction of identifying patterns, taking into account which will localize the destructive effects of errors that occur in the communication channel.

To solve the problems associated with improving the reliability of VIR data while ensuring the required level of efficiency in the use of compression coding technologies, it is necessary to ensure the following conditions:

1) to ensure the localization of errors to reduce their impact on destructive action in the process of reconstruction of video data;

2) due to the restructuring of the information space, within which unlikely elements will be coded u_ξ ($P(u_\xi) \to 0$), increase the value of probabilities $P(u_\xi)$ by dividing the power of the original alphabet and the length of the video sequence into local sets.

To do this, it is proposed to use a fundamentally new approach – internal restructuring, which takes into account the laws of internal binary structure of the element u_ξ ($u_\xi \in U(\theta)$) on a quantitative sign λ.

Structural and functional scheme of clustering of clustering of elements u_ξ message $U(\theta)$ on a quantitative basis λ presented in Fig. 5.

Video sequence clustering $U(\theta)$ on a quantitative sign λ of the set $U(\lambda_i)$ is given by the following expression:

$$U(\theta) \xrightarrow{f_{cl}} \{U(\lambda_1), ..., U(\lambda_i), ..., U(\lambda_{|\Lambda|})\}. \quad (1)$$

For internal data restructuring as quantitative feature is proposed to use quantity λ series of units (SU) in the binary representation of elements. The advantages of using this quantitative feature are the simplicity of algorithmic implementation (the process of forming a quantitative feature involves the use of only arithmetic and logical operations).

Quantity formation cycle λ SU, in the binary representation of the element u_ξ, is given by the following system of expressions:

$$\lambda_\alpha = \begin{cases} \lambda_\alpha, \to q_{\alpha-1} = q_\alpha; \\ \lambda_\alpha + 1 \to q_{\alpha-1} \neq q_\alpha. \end{cases} \quad (2)$$

Clustering of elements u_ξ video sequences $U(\theta)$ with the same amount of SU is given by the following expression:

$$f_{cl}(u_\xi, \lambda_i) : U(\theta) \xrightarrow{f_{cl}} \{U(\lambda_1); ...; U(\lambda_i); ...; U(\lambda_{|\Lambda|})\}, \quad (3)$$

Alphabet clustering $U(\vartheta)$ video sequences $U(\theta)$ based on the amount of SU in the binary representation of the elements u_ξ is given by the following expression:

$$f_{cl}(u_\xi, \lambda_i) : U(\vartheta) \xrightarrow{f_{cl}} \{U(\lambda_1); ...; U(\lambda_i); ...; U(\lambda_{|\Lambda|})\}. \quad (4)$$

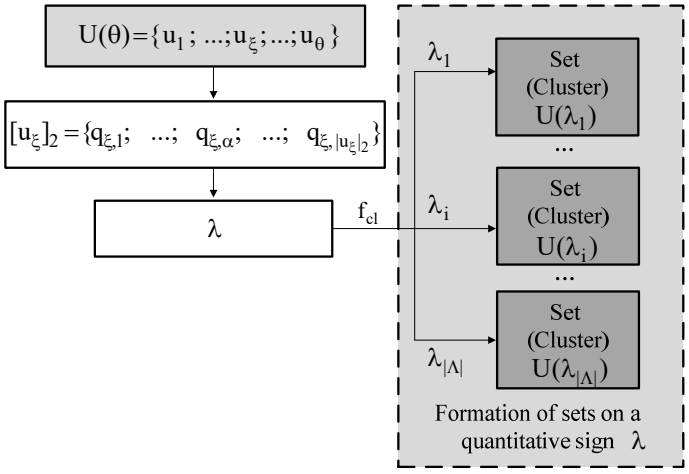

Figure 5 – Structural and functional scheme of clustering of elements u_ξ video sequences $U(\theta)$ on a quantitative basis λ of the set $U(\lambda_i)$

DOI 10.15588/1607-3274-2022-3-12

4 EXPERIMENTS

To assess the effectiveness of the developed method of internal restructuring of video information resource data, a number of experimental studies were conducted.

Test video images of different degrees of saturation were used as source data: low-, medium- and high-saturation.

A discrete symmetric channel without memory was used as the data channel.

The following error probability values were used to assess the effect of errors on the reliability of the reconstructed video image: $P(\varepsilon)=10^{-4}$, $P(\varepsilon)=10^{-5}$.

Modeling of experimental research results was performed using the developed software product.

Comparative assessment of the reliability of video information in infocommunication systems of the aerosegment by the indicator of the peak signal-to-noise ratio $PSNR_{\varepsilon_{dm}}$ at a given error rate ($P(\varepsilon)=10^{-4}...\ 10^{-5}$) in data transmission channels with algorithms of the JPEG family is shown in Fig. 6–7.

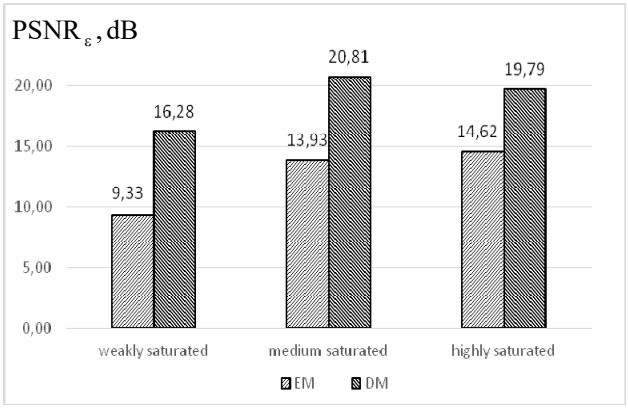

Figure 6 – Diagram of the dependence of the peak signal-to-noise ratio at a given error level $P(\varepsilon)$ from the degree of image saturation for developed and existing methods, $P(\varepsilon)=10^{-5}$

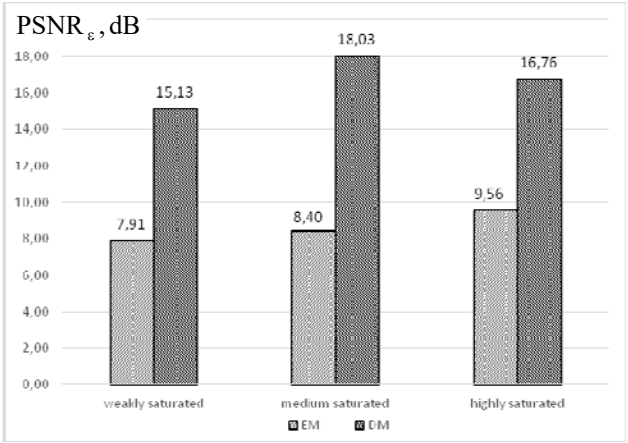

Figure 7 – Diagram of the dependence of the peak signal-to-noise ratio at a given error level $P(\varepsilon)$ from the degree of image saturation for developed and existing methods, $P(\varepsilon)=10^{-4}$

5 RESULTS

Analysis of the results of the reconstruction of VIR data at a given level of errors ($P(\varepsilon)=10^{-4}...\ 10^{-5}$) by the value of the peak signal / noise ratio is presented in Fig. 6–7 indicates that:

1. The use of the developed coding method allows to increase the level of reliability of VIR data at a given level of errors in the reconstruction process. So for the case when the error in the discrete symmetric data channel without memory is set to a value equal to $P(\varepsilon)=10^{-5}$ the use of the developed coding method allows to increase the reliability of video information, which is determined by the quantitative assessment of the peak signal-to-noise ratio, by an average of 53.08% compared to existing methods.

Accordingly, for the second case under study (when $P(\varepsilon)=10^{-4}$) the developed method allows to increase the reliability of video information by an average of 93.8%.

2. The developed method of compression coding of video information solves the scientific problem of increasing the reliability of video information in infocommunication systems of the aerosegment. This means that the following condition is met:

$$PSNR_{\varepsilon} \geq 15-25\,\text{dB}.$$

6 DISCUSSION

Analysis of the effectiveness of modern video coding technologies shows that existing approaches do not provide the required level of reliability in terms of ensuring prompt delivery. Thus, experimental studies of the impact of errors in the data transmission channel show that the use of noise-tolerant coding technologies leads to a significant increase in the amount of coded data. In turn, this leads to time delays in the delivery of video data (Fig. 2–3).

The use of existing compression coding technologies based on the JPEG platform allows more compact presentation of coded data [32, 33]. This allows ensuring compliance with the requirements for the efficiency of delivery of video information resources by eliminating psychovisual redundancy [11, 13]. However, it should be borne in mind that at the coding stage, the algorithms of this family use a statistical approach [1–4, 6]. This means that the result of statistical coding is the formation of non-uniform codes assigned to the elements of the video sequence [7–9]. In turn, the results of experimental studies presented in Fig. 4, indicate that the use of this approach in the process of forming code structures does not allow localizing the effect of errors in communication channels.

The use of the proposed method (Fig. 5), which is based on the restructuring of the information space in quantitative terms, allows without loss of integrity to provide additional reduction of the structural redundancy of the code representation of the video sequence. This is due to the fact that further coding of video sequence elements occurs in the statistical space of clusters. In turn, this allows to increase the level of reliability of video data due to the localization of errors within the sequence of code constructs assigned to one cluster (Fig. 6–7). Comparative

DOI 10.15588/1607-3274-2022-3-12

analysis of the developed method with the existing ones shows that the proposed approach allows providing the required level of reliability (Fig. 6–7).

CONCLUSIONS

1. For infocommunication systems using airmobile platforms are characterized by the presence of interference and interference in communication channels. This poses a threat to the loss of information, the destruction of video images, reducing the efficiency of their delivery due to the need to re-capture and transmit video data. In this connection the problem of increase needs to be solved reliability of video information transmitted in infocommunication networks using airmobile platforms. There are the following ways to solve this problem: use existing noise-tolerant coding technologies; compression coding technologies with localization of errors that occur in the communication channel.

2. A study of the use of noise-tolerant coding methods to ensure the required level of reliability of video information transmitted in infocommunication systems of the air segment shows that this direction increases the resistance of VIR to errors in data channels through the use of additional correction bits. But it has a number of significant disadvantages:

– leads to a significant increase in the bit size of compactly presented video data;

– there is a growing delay in the delivery of video information, which is critical in the use of airmobile platforms. Increasing time delays in the process of delivery of video information leads to the fact that video information will not be transmitted in full and, as a consequence, in the conditions of aerial monitoring to the loss of reliability of VIR data;

– video processing time is increasing.

3. The advantage of using compression coding technologies to solve the problem of increasing the reliability of video information transmitted in the infocommunication systems of the air segment is to reduce the bit size of the video information resource. However, existing video processing technologies are based on the use of statistical coding methods and the detection of a series of identical sequences of repeating elements. But the use of such technologies leads to a number of significant disadvantages, namely:

– low resistance to errors in data transmission channels, as statistical coding methods are based on non-uniform code constructions. This is due to the fact that the action of errors that occur in the communication channel leads to an avalanche effect;

– due to the formation of uneven structural characteristics (lengths of series of transformant components with zero values), to reduce redundancy in transformants, the occurrence of errors in the reconstruction process can lead to a shift in the data of the video information resource.

Therefore, this direction does not provide the required level of localization of errors.

4. It is substantiated that it is necessary to improve the existing compression coding technologies in the direction of identifying patterns, taking into account which will allow localizing the destructive effect of errors that occur in the communication channel.

5. Thus, for the first time a method of restructuring based on the detection of patterns in the internal binary structure of the message elements was developed. Distinctive features of the method are that the restructuring of the information space is carried out without loss of integrity on the basis of structural features by the number of binary series. This allows you to get the following results:

1) conditions are provided for additional reduction of structural redundancy of code representation of information due to significant reduction of information space capacity as a result of using internal data restructuring on the basis of the number of series of units.

2) conditions are created for localization of errors in the process of reconstruction of video information resources;

3) conditions are created to reduce the time for data processing, due to the fact that the developed method of data restructuring does not require transformations over the elements of the message.

ACKNOWLEDGEMENTS

The work was supported by Kharkiv National Air Force University named after Ivan Kozhedub, Kharkiv, Ukraine.

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Received 20.04.2022.
Accepted 26.08.2022.

УДК 621.327:681.5

МЕТОДОЛОГІЯ ПІДВИЩЕННЯ ДОСТОВІРНОСТІ ВІДЕОІНФОРМАЦІЇ В ІНФОКОМУНІКАЦІЙНИХ МЕРЕЖАХ АЕРОСЕГМЕНТУ

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АНОТАЦІЯ

Актуальність. Проблема локалізації впливу помилок у каналах передачі даних при використанні методів компресійного та завадостійкого кодування в умовах дотримання швидкості доставки даних в інфокомунікаційних системах аеросегменту. Об'єктом дослідження є методи кодування для підвищення надійності відеоінформаційних ресурсів в інфокомунікаційних мережах з використанням аеромобільних платформ.

Метод. Використання методів завадостійкого кодування для забезпечення необхідного рівня достовірності відеоінформації, що передається в інфокомунікаційних системах аеросегменту, має ряд істотних недоліків – призводить до значного збільшення бітового об'єму компактно представлених відеозображень; зростає часова затримка на доставку відеоінформації, що в умовах використання аеромобільних платформ є критичним. Підвищення часових затримок у процесі доставки відеоінформації призводить до того, що: відеоінформацію буде передано не в повному обсязі і, як наслідок, в умовах аеромоніторингу до втрати достовірності даних; збільшується час на обробку відеоданих. Перевагою використання технологій компресійного кодування для вирішення задачі підвищення достовірності відеозображень, що передаються в інфокомунікаційних системах аеросегменту, є зниження бітового об'єму відеоінформаційного ресурсу. Однак існуючі технології обробки відеоданих базуються на використанні методів статистичного кодування і виявленні серій однакових послідовностей елементів, що повторюються. Але використання таких технологій не забезпечує необхідного рівня локалізації дії помилок. Розроблений метод реструктуризації на основі виявлення закономірностей у внутрішній двійковій структурі елементів повідомлення за кількісною ознакою. Інструментом для реструктуризації є ознака кількості серій одиниць у двійковій структурі елементів повідомлення. Відмінні характеристики методу полягають у тому, що реструктуризація інформаційного простору здійснюється без втрати цілісності на основі структурної ознаки за кількістю двійкових серій.

Результати. Проведено аналіз існуючих напрямків вирішення проблеми підвищення рівня достовірності відеоінформації, що передається в інфокомунікаційних системах аеросегменту. Розроблений метод внутрішньої реструктуризації даних дозволяє отримати наступні результати: забезпечуються умови додаткового скорочення структурної надмірності кодового представлення інформації зарахунок суттєвого скорочення потужності інформаційного простору в результаті використання внутрішньої реструктуризації даних за ознакою кількості серій одиниць; створюються умови для локалізації дії помилок в процесі реконструкції відеоінформаційних ресурсів; створюються умови для скорочення часу на

DOI 10.15588/1607-3274-2022-3-12

обробку даних, в зв'язку з тим, що розроблений метод реструктуризації даних не вимагає проведення перетворень над елементами повідомлення.

Висновки. Необхідно вдосконалювати існуючі технології компресійного кодування у напрямі виявлення закономірностей, облік яких дозволить локалізувати руйнівну дію помилок, що виникають у каналі зв'язку.

КЛЮЧОВІ СЛОВА: відеоінформаційний ресурс, кодування, достовірність, оперативність, канал зв'язку, аеросегмент, технології стиснення.

УДК 621.327:681.5

МЕТОДОЛОГИЯ ПОВЫШЕНИЯ ДОСТОВЕРНОСТИ ВИДЕОИНФОРМАЦИИ В ИНФОКОМУНИКАЦИОННЫХ СЕТЯХ АЕРОСЕГМЕНТА

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АННОТАЦИЯ

Актуальность. Проблема локализации влияния ошибок в каналах передачи данных при использовании методов компрессионного и помехоустойчивого кодирования в условиях соблюдения оперативности доставки данных в инфокоммуникационных системах аеросегмента. Объектом исследования являются методы кодирования для повышения достоверности видеоинформационных ресурсов в инфокоммуникационных сетях с использованием аеромобильных платформ.

Метод. Использование методов помехоустойчивого кодирования для обеспечения необходимого уровня достоверности видеоинформации, передаваемой в инфокоммуникационных системах аеросегмента, имеет ряд существенных недостатков: приводит к значительному увеличению битового объема компактно представленных видеоданных; растет временная задержка на доставку видеоинформации, что в условиях использования аеромобильных платформ является критическим.
Повышение временных задержек в процессе доставки видеоинформации приводит к тому, что: видеоинформация будет передана не в полном объеме и, как следствие, в условиях аеромониторинга к потере достоверности данных; увеличивается время на обработку видеоданных. Преимуществом использования технологий компрессионного кодирования для решения задачи повышения достоверности видеоинформации, передаваемой в инфокоммуникационных системах аеросегмента, является снижение битового объема видеоинформационного ресурса. Однако существующие технологии обработки видеоданных базируются на использовании методов статистического кодирования и выявлении серий одинаковых последовательностей повторяющихся элементов. Но использование таких технологий не обеспечивает необходимый уровень локализации действия ошибок. Разработан метод реструктуризации на основе выявления закономерностей во внутренней двоичной структуре элементов сообщения по количественному признаку. Инструментом для реструктуризации является признак количества серий единиц в двоичной структуре элементов сообщения. Отличительные характеристики метода состоят в том, что реструктуризация информационного пространства осуществляется без потери целостности на основе структурного признака по количеству серий единиц.

Результаты. Проведен анализ существующих направлений решения проблемы повышения уровня достоверности передаваемой в инфокоммуникационных системах аеросегмента видеоинформации. Разработанный метод внутренней реструктуризации данных позволяет получить следующие результаты: обеспечиваются условия дополнительного сокращения структурной избыточности кодового представления информации за счет существенного сокращения мощности информационного пространства в результате использования внутренней реструктуризации данных по признаку количества серий единиц; создаются условия для локализации действия ошибок в процессе реконструкции видеоинформационных ресурсов; создаются условия для сокращения времени на обработку данных в связи с тем, что разработанный метод реструктуризации данных не требует проведения преобразований над элементами сообщения.

Выводы. Необходимо совершенствовать существующие технологии компрессионного кодирования в направлении выявления закономерностей, учет которых позволит локализовать разрушительное действие ошибок, возникающих в канале связи.

КЛЮЧЕВЫЕ СЛОВА: видеоинформационный ресурс, кодирование, достоверность, оперативность, канал связи, аеросегмент, технологии сжатия.

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