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THE METHOD OF CONTROLLING THE RATIONING COMPONENT OF TRANSFORMANTS BASED ON THE STRUCTURAL RICHNESS OF AERIAL PHOTOGRAPHS FRAGMENTS

V. V. Barannik, doctor of engineering science, professor; ***S. A. Podlesny, S. Yu. Stasev***

Kharkiv University of Air Force

barannik_v_v@mail.ru

The existing methods of application of a video information resource in the state departmental establishments are considered. It is indicated the necessary of reduction of time expenditure by delivery of picture data and maintenance of compliance of restored fragments to the initial aerial photograph. Characteristics of a matrix of rating of components transforms are justified. The quantitative indices of characteristics for image sections with different structural complexity are described. The necessary for control of normalization taking into account structural complexity of aerial photographs is reasoned. The method of the adaptive normalization of components of a segment of the image with class definition of structural complexity is shown. The order of coefficients of rating for image segments with an average level of saturation is defined.

Keywords: video information resource, processing of an aerial photograph, control of compression, saturation of the image.

Розглянуто існуючі способи застосування відеоінформаційного ресурсу в державних відомчих установах. Показано необхідність зменшення часових витрат на доставку даних зображення і підтримки відповідності відновлених фрагментів вихідному аерофотознімку. Обґрунтовано характеристики матриці нормування компонент трасформанти. Описано кількісні показники характеристик для ділянок зображення з різною структурною складністю. Аргументовано необхідність управління нормуванням з урахуванням структурної складності аерофотознімків. Показано спосіб адаптивної нормалізації компонент сегменту зображення з визначенням класу структурної складності. Визначено порядок завдання коефіцієнтів нормування для сегментів зображення із середнім ступенем насиченості.

Ключові слова: інформаційна безпека, відеоінформаційний ресурс, обробка аерофотознімку, управління стисненням, насиченість зображення.

Introduction

One of the mains of the direction of development of information technologies is transmission of a video information resource (VIR) in telecommunication systems. It led to widespread introduction of the bidirectional transmission systems of VIR which are shown in systems of a video conferencing, and unicast systems, respectively, in the form of monitoring systems, in the state departmental institutions, especially in the Ministry of Defence of Ukraine. Improving of quality of management system [1] is result of implementation of a video information resource. When using systems of aero monitoring landscape images are transferred in telecommunication networks. These landscape images (digital images) were formed by aero photography of areas. By reason of importance of solved tasks when contents from the received image were processing there is a problem of reduction of time expenditure on processing and finishing data of an aerial photograph in case of maintenance of necessary level of compliance of the restored image to initial.

For a choice of a candidatolution of the received problem there is a need of the review of the existing technologies of processing of aerial photographs. These technologies (JPEG, JPEG2000) are based on compression when using statistical coding (codes of variable length) [2]. The mathematical process description of processing of aerial photography is represented images as a certain two-dimensional signal which is characteristic some information volume [3]. The effect of reduction of information intensity in

case of implementation of the image processing is shown owing to elimination of psychovisual redundancy as a result of application of orthogonal transform with the next rating.

Starting value of information intensity of a flow of output data is set in processing of aerial photographs after a rating stage. Efficiency of coding is shown in reduction of information intensity of a flow of VIR that physically expresses in lowering of time expenditure on delivery of data of an aerial photography. In case of sharply there is a problem of change of quality of the restored image with big coefficients of rating for saturated images.

Therefore the purpose of work consists in creation of a way of control of rationing a component of the transform on the basis of a structural saturation of fragments of aerial photographs.

Main

For formation of this way it is necessary to consider rationing process in more detail. In digital processing the entrance analog signal of wide and continuous rage of values will be transformed to discrete group with a limited set of output values.

The term "rationing" for processing of images describes operation of approaching of real numbers to integer or transformation of integers in smaller value of integers [4].

Present psychophysical factors of human sight is expressed in weak sensitivity to change of high-frequency components of the image. For coefficients that correspond to high-frequency components reasonably to use more rough step of quantization. Mathematically rationing is described as division of a matrix of coefficients x on a so-called matrix of rationing W

$$X_{ij} = \left[x_{ij} / w_{ij} \right],$$

where x_{ij} — value of transform component; w_{ij} — value of rationing matrix component; $\lfloor x \rfloor$ — operation of definition of the integer part x.

In the majority of algorithms of the image processing rationing consists in ordinary bit-by-bit division of values a component of a certain working matrix on a rationing matrix. For everyone components of color-difference model (Y, U and V) the matrix of rationing is set $W[\alpha,\beta]$ [5]. Rationing is set by the next formula:

$$x_{i,j}^{(Q)} = \left\lfloor \frac{x_{i,j}}{w_{i,j}} \right\rfloor. \qquad (1)$$

At this stage by change of extent of compression values of an error of quantization of amplitude of output values of the transform component is formed, and, therefore, the level of losses is brought.

At the same time for a rationing matrix with great values of coefficients, the bigger number of zero and, therefore, and bigger value of extent of compression will be created.

It reasons an opportunity to operate extent of compression by a task of size of values of elements of matrixes of rationing at a stage of their formation. That brings reduction of range of values of elements of a rated transform for higher values of elements of a matrix of rationing $X^{(Q)}[\alpha,\beta]$, from this it is possible to use smaller amount of information for coding.

For example, in the JPEG standard the rationing matrixes received in the empirical way are applied. Values of elements of these matrixes for the JPEG standard are received by practical consideration as a result of estimates of visual perception [6].

Control of a compression ratio happens due to multiplication of the initial matrixes on number K.

For the JPEG2000 standard the opportunity of use of own tables of rating is given. However at the same time they are required to be transferred to the decoder together with oblate data that leads to increase in time expenditure at delivery as a result of growth of the general size of coded data.

These standards allow to apply alternative rating matrixes (for stream processing) using one parameter R determined by the user which are created based on value of coordinate of a component in a transform. Value of array elements of rating is defined by the next formula:

$$w_{i,j} = 1 + (i + j)\, R. \qquad (2)$$

Reduction of values of a component of a transform in case of the conditional relocation from the upper left corner in the right lower is characteristic of the given expression. In case of the correct execution of rating the received output transform will contain only several nonzero coefficients with characteristic layout in the matrix upper left corner. Further according to algorithm of JPEG coding will be applied to these received numbers.

As a result of application of rating for algorithm some specific effects in case of great values of compression ratio will be inherent. Losses in the field of low frequency components lead to appearance in the received image of squares 8×8. Losses of high-frequency components cause so-called "Gibbs effect" when some halation appears around aerial photograph elements with sharp overfall of structural saturation. Algorithms of JPEG and JPEG2000 are applied for compression of the image with its subsequent visual acceptability, and the resulted oblate image isn't suitable for future digital processing.

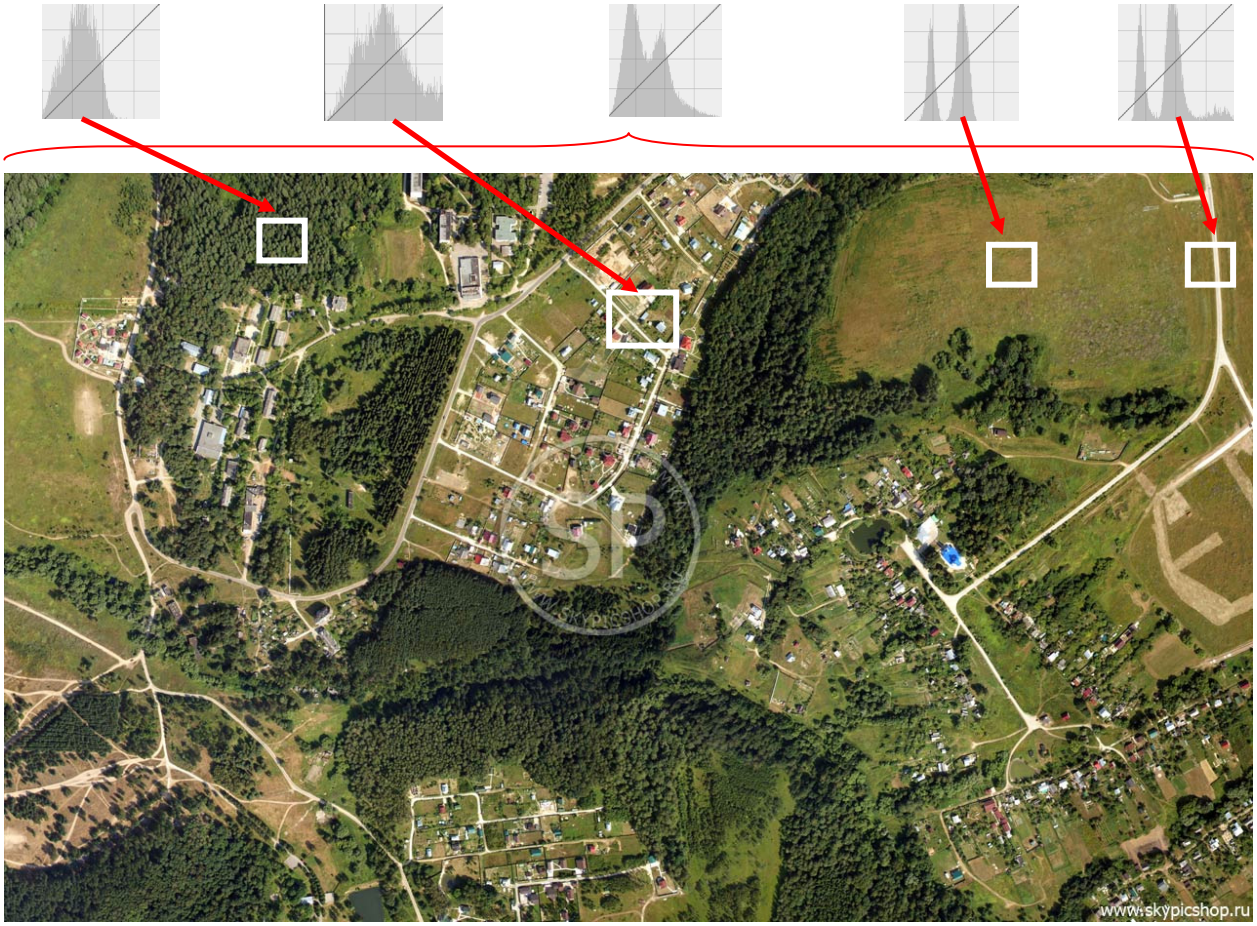
We will analyze the above concerning execution of compression of an aerial photograph.

Change of characteristics of sequences in relation to the subsequent compression results from reduction of quantity of possible options of values, and increase repetitions rate. At the present moment rating is fundamental part of many algorithms of coding with loss of information with value of compression ratio from 3:1 to 100:1.

The entity of the modern methods of compression consists in partition of images on area of a certain value. Normally it is squares with sizes — 8×8, 16×16. At the same time the uneven sections of the image get to some area. Therefore structural complexity of sections of an aerial photograph isn't considered.

On the one hand it leads to reduction of time expenditure by processing at a compression stage, and on the other hand causes the partial (irreversible) loss of information. Therefore there is a need for development of a technique of processing of an aerial photograph taking into account its structural complexity.

For this purpose offered to determine processing parameters taking into account structural complexity of a fragment of an aerial photograph. For what it is required to set the characteristic of processing according to structural complexity of a fragment of an aerial photograph. For this purpose we will analyze some view image with characteristics of value distribution of brightness by its fragments (see Figure).



Sample of picture and distribution of probability of its fragments brightness

On a class of structural complexity fragments of the image are subdivided on “low saturation” to which correspond uniform intensity of brightness (one local maximum of distribution), “middle saturation” to which there correspond planimetric images (two local a distribution maximum), and “high saturation” to which there correspond textural images (wide distribution of brightness).

After performance of orthogonal transformations there is a distribution of energy of the image on frequency area. At the same time in a fragment of aerial photograph which corresponds to the class “low saturation” all energy is concentrated in low-frequency area, sizes of values for high-frequency part are going to zero. For an image fragment with the class “high saturation” all energy, respectively, is located in high-frequency area, sizes of values for low-frequency part aspire to zero that leads to reduction of combinatory redundancy in the transform. Intermediate values of elements transform are characteristic of fragments of images with the class “middle saturation”.

At the existing tendency of suppression of high-frequency components of the image that follows from (2), when rationing of data the component is performing on a formula (1), the essential error of quantization will bring for image fragments with the class "high saturation". It is unacceptable from a position of mission of aero monitoring which important objects of supervision correspond to these fragments.

It results in necessity for control of value of size of a matrix of rationing at implementation of orthogonal transformation with the subsequent coding when processing an aerial photograph (its fragments). In result of it an opportunity to make fast processing of an aerial photograph taking into account its features and local communications between fragments is given. For what, it is offered to apply the next way of a setting of sizes of coefficients of a matrix of rationing W :

– for fragments of aerial photographs which correspond to the class "low saturated" to set great values of coefficients of a matrix of rationing $w_{i,j}$;

– for fragments of aerial photographs which correspond to the class "high saturated" to set small values of coefficients $w_{i,j}$;

– for fragments of aerial photographs which correspond to the class "middle saturated", values of coefficients $w_{i,j}$ to define depending on values of dynamic ranges for each transform.

At the same time the class of structural complexity of a fragment of an aerial photograph is offered to be defined according to characteristics of distribution of brightness.

Values of coefficients $w_{i,j}$ rationing matrixes W are defined by practical consideration, is based on the data obtained during experiment for types of images with various values of structural complexity (as well as for the JPEG2000 standard it is necessary to create matrixes).

As a result of the created technology an opportunity to operate parameters of rationing of values a component transform on the basis of parameters of structural complexity of a fragment of the image is given.

It is led to reduction of time expenditure by finishing for the low saturation fragments of the image, and for the high saturation fragments of the image degree of compliance of the restored image to initial increases.

Conclusions

1. The way of control of time expenditure on finishing data of an aerial photograph by application of adaptive normalization an image segment component is created. Adaptive normalization consists in determination of sizes of values of coefficients of rationing depending on values of dynamic ranges for each transform taking into account an image segment saturation.

2. The constructed technology allows to lower time expenditure on delivery of data the low saturated of segments of an aerial photograph due to increase in values of a matrix of rationing.

3. The created technology considers structural complexity of segments of the image that leads to increase in compliance of the restored aerial photograph to initial.

4. The constructed way allows to save memory of specialized devices and to operate degree and respectively a level of losses.

LITERATURE

1. *Barannik V.* Analysis of the action of cyber-attacks in the video-information's resources in the information-telecommunications networks / V. Barannik, S. Podlesny // Management Information System and Devices, 2014. — N 169. — P. 16–22.

2. *Gonzales R. C. and Woods R .E.* "Digital image processing" in Prentice Hall, edition. II, 2002. — 1072 p.

3. *Salomon D.* Compression of data, images and sound / D. Salomon. — M. : Technosphere, 2004. — 368 p.

4. *Krasilnikov N. N.* Digital processing of images / N. N. Krasilnikov. — M. : High school book, 2011. — 320 p.

5. *Pratt U.* Digital processing of images: in 2 t., the lane with English / U. Pratt. — M. : World, 1985. — 736 p.

6. *William B. Pennebaker, Joan L. Mitchell*. JPEG: Still Image Data Compression Digital Multimedia Standards Series. Springer Science & Business Media, 1992. — 638 p.

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