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THE INVESTIGATION OF ALGORITHMIC COMPENSATION METHODS FOR GEOMETRIC CURVATURES OF AEROSPACE IMAGES IN THE AUTOMATED SYSTEMS OF THE EARTH'S SURFACE MONITORING

Taking images of large areas is performed with the methods of photogrammetry. It studies the means and the technology of determination the form, size, position in space, quantitative and qualitative characteristics of objects by their images. Images of area are taken by applying special equipment that is installed on the air planes or satellite carriers. Aerospace shooting is divided into a number of classes and types, depending on the purpose of a carrier, imaging equipment, technologies of shots and the form of the result presentation.

The aerospace shooting uses planes, superlight drones and helicopters. There are several types of aerospace shooting: aero photography, heat infrared, radiolocation and other. Besides, the traditional aero methods include so-called geo physic shooting. They are aeromagnetic, aeroradiometric, etc. These methods allow obtaining the digital information about the researched objects, but not the traditional images.

Space shooting, i.e. shooting from the height of more than 150 km, is performed from a satellite which moves on the set orbit. Therefore, its abilities are limited compared to those done by a plane. Any satellite has to be considered taking into account the parameters of its orbit. Such parameters as the form, the tilt, the height the position of its surface regarding the Sun are really important from the point of view of space shooting.

Camera vibrations or other equipment vibrations can often occur at aerospace shooting. It can cause the image trembling. Mostly, this trembling is the optical axis oscillations. In principle, there may be significant oscillations, reaching a half of a shoot frame, especially when taking an increased image. In addition, there can be more complex cases, for example, when the camera can not only vary, but change its orientation and position in space.

Therefore, the purpose of such oscillation compensation is to obtain the stable images. This task is divided into two sub-tasks.

Firstly, it is recommended to define the parameters of image deformation from shot to shot. The given article focuses on the class of linear deformation. Despite the relative simplicity of the deformation model, it allows describing the typical distortions such as shift, rotation and compression.

Secondly, it is recommended to convert the input shot to the previous coordinate system by the estimation of deformation parameters (deformation compensation). It is necessary to separate the regular deformations caused by deliberate camera movement, from the occasional noise disturbances and compensate only the last ones.

The main task of the algorithm development is to provide of two following conditions.

1. The algorithms have to work with a variety of resistant video sequences. This video sequence can be taken in difficult conditions and can have a very low quality.

2. Data processing algorithms have to provide video streams in real time by modern specialized computer tools.

The task of geometric distortion compensation is divided into two sub-tasks.

The first task is to determine the geometric deformations. Every shot has to obtain its geometric transformation related the previous one, assuming that the image shots are the same for the stationary background. The geometrical transformation implies affine transformation, i.e the transformation of the form:

$$\vec{r}(t+1) = A(t)\vec{r}(t) + \Delta\vec{r}(t)\ , \qquad (1)$$

where $\vec{r}(t)$ - are the coordinates of the background in a shot,

$\vec{r}(t+1)$ - coordinates of the same point on the next scene,

$A(t)$ and $\Delta\vec{r}(t)$ - are geometric distortion parameters to be defined.

The deviations from this mathematical model were taken into account when developing and processing the algorithms:

- a fuzzy image with a low proportion signal - noise;

- the noise is not of Gaussian nature, it is non-stationary, correlated in time and space;

- the additional distortions are blurs, linear geometric distortions, nonlinear changes in brightness and color of a shot etc. ;

- scan distortions;

- the image transience.

Another sub-task is to separate the regular geometric distortion from noise.

It is recommended to compensate only noise component of the geometrical distortion in order to present the video sequence. The regular component (eg, translational displacement chamber) has to obtain the minimum changes. Therefore, the geometric distortions are the following function of time:

$$\begin{cases} \Delta\vec{r}(t) = \Delta\vec{r}_s(t) + \Delta\vec{r}_n(t) \\ A(t) = A_s(t) + A_n(t) \end{cases}, \qquad (2)$$

where $\Delta\vec{r}_s(t)$ and $A_s(t)$ - are the useful components of geometric distortion,

$\Delta\vec{r}_n(t)$ i $A_n(t)$ - are the noise components, which should be compensated.

This problem can not be solved without the initial information about the beneficial components of distortion. But this information is usually little and does not solve the problem. Therefore, this article offers the empirical solutions that cover most of possible situations a.

The following formula is used to determine the conversion of a shot:

$$Q = \arg\min_Q X(\|F(t-1)_{ij}\|, \|T_q(F(t))_{ij}\|)\ , \qquad (3)$$

where Q - is the vector of conversion parameter, which may include both a shift in a shot personnel and the angle and zoom ratio or six affine coefficients,

X - is the function of dissimilarity,

$F(t)_{ij}$ - is a shot at time t,

T_q - is the converting of the shot with the set conversion parameter vector.

There are different methods of estimating the parameters of deformation of the shot, in particular, on the basis of optical flow inside it based on the selection of characteristic points of the image brightness or directly using the input image points.

The algorithmic geometric distortion compensation is usually performed by the reverse design of pixels of the corrected image.

The digital methods of restoring image can be applied to compensate defocus, astigmatism and blur of the image. In this case, it is recommended an attempt to restore an image that has been distorted by using the initial information about the cause of the image problem. That is why; the restoration methods are based on the modeling processes and application procedures for final reproduction of the original image, using such algorithms as the inverse filtering and Winner filtering.

The main purpose of this article is to develop the test algorithms for compensation the geometric distortions of images for their further application software imaging.