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Features of implementation of the method for fusion different images by location equipment of on-board systems

S A Nenashev and E K Grigoriev*

Saint-Petersburg State University of Aerospace Instrumentation

E-mail: ev.grig95@gmail.com

Abstract. The paper highlights the features of the implementation of on-board systems for monitoring the earth's surface, based on small aircraft. The problems of fusion of location information from on-board monitoring systems of various types of functioning are considered. The motivation of integrating optical and radar images of the earth's surface is shown. The result of the work is the synthesis of optical and radar images of the earth's surface into a single information field.

The systems for monitoring and collecting information about the earth's surface, based on small aircraft (SA), including unmanned aerial vehicles (UAV), include: digital photo and video equipment; thermal imager; IR camera; small-sized radar stations; Geiger sensor, etc. On-board of such aircraft, the required, location equipment is attached. The choice of such equipment depends on the problem being solved.

To minimize the mass of monitoring systems, decryption of recorded images should carry out in the central ground control unit of SA [1, 2]. When transmitting information, algorithms for masking and compressing images [3, 4], as well as coding the transmitted signal over a wireless communication channel [5-9] should be implemented. The post-processing mode should also be implemented, when the recorded data is saved to a high-speed SD card.

The advantages of using onboard small-sized radars, especially as part of a multi-position complex [10-13], for the tasks of operational monitoring and collecting information about the earth's surface are as follows:

- in a short time interval, it is possible to cover large areas of the observed space;
- it is possible to inform the operator about the state of the location situation and the presence of objects in the area of the monitoring system in real time;
- high efficiency of the monitoring system operation in unfavorable weather conditions and the possibility of operation at any time of the day are realized by using the radar methods of synthesis of the antenna aperture [14-16].

However, considering the modern requirements for on-board monitoring systems, it is rather difficult to build an effective system for collecting and storing information about the earth surface using a single source of location information. In connection with this, they should consider the task of information fusion, in particular, from images from several sources of location information. Since the fusion of information from several sources of location information of different nature, based on SA, forms a more complete and reliable reflection of the location situation about the observed zones and objects on them.

At present, there are several frequently nominated sources of location information that use physical phenomena of a different nature. At the same time, none of the sources of location information is unique and it is special to display on the operator's screen the spectrum of the necessary integral picture of the localization of the underlying surface for the purpose of environmental monitoring.

In works [17, 18], presented studies of compare the main characteristics of sources of location information of different nature - radar, optical, laser and ultrasonic. Based on the data presented in these works, it was found that an effective fusion option is to combine information from high-resolution radar and optical sources in a single complex. It has been found that the information fusion from these location sources makes it possible to detect, determine, and predict the parameters of movement of physical objects, including people. And also, to carry out high-precision mapping of the observed zones with the possibility of classifying both the observed zones and objects on them.

Thus, a feature of the on-board systems is the limited energy and mass resources, which requires the development of specialized algorithms for collecting information about the areas under study and information fusion from several sources of location information located on a small aircraft.

Fusion of images based on optical and radar information has several advantages, which are as follows:

- Revealing visually understandable from the image at different times of the day, regardless of the weather conditions.
- the possibility of geometric transformations from the image, such as scaling, rotation, etc.;
- Formation of a common area of the observed surface from different angles from different sources of location information, etc.;
- in increasing the information content and reliability of the resulting complex image;
- in the formation of an actual database on the earth's surface when combining a complex image with geographic information.

Using the initial images (figure 1), formed on board of SA, we will illustrate the process of synthesis of a complex image [19-21].

a) optical image b) radar image

Figure 1. Initial images of one section of the earth's surface.

As a result of the experiment (figure 2), the initial images were combined into a single complex image using the selection of the most important different components of the initial images.

Figure 2. Complex image.

Such an image is complex because two dissimilar components (radar and optical) complement the other.

Thus, in this work, the options for images fusion from location sources of various natures were identified and implemented. The efficiency of combining optical and radar images into one complex is established. An experiment for the synthesis of a complex image is presented and the advantages of this approach are described in the implementation of on-board monitoring systems of the earth's surface.

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