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Integration of Heterospectral Infrared Images in the 3–5 and 8–14 μm Bands in Passive Optoelectronic Systems with Matrix Photodetectors

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Abstract—Basic results of the experimental investigation of the correlation between two-dimensional intensity distributions (in two different spectral bands: 3–5 and 8–14 μm) of aerial target and the background on heterospectral infrared (IR) images have been presented. The above images were obtained in the process of comparison tests of trial models of passive optoelectronic systems (OES) with matrix photodetectors (PD) mounted on the antenna of target-tracking radar station (TTRS). A technique for improving the quality of these images was also described. The specified technique was aimed at enhancing the ranges of target detection and recognition under condition of the integration of above images on the basis of the correlation revealed.

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The hypothetical prerequisite of the presence of correlation between two-dimensional intensity distributions in the target region for two data arrays of heterospectral IR images (bands $\Delta\lambda$ = 3–5 and $\Delta\lambda$ = 8–14 μm) implies that the state-of-the-art matrix PD in both bands make it possible to generate on the IR image plane a silhouette of the aerial target similar to the one observed in the visible band. However, the coefficients of the target reflection and radiation as well as those of the background are not the same in different bands. That is why such correlation is not evident a priori and it may be revealed only after receiving and processing of reliable experimental data.

The purpose of this paper is to set forth the peculiarities of experimental investigations on detecting the specified correlation and describe the technique for improving the quality of heterospectral IR images (produced by independent OES) that is based on their joint processing (integration).

The required experimental data were obtained in the course of comparison tests of two trial models (prototypes) of thermal imagers (THI) produced by different companies (technical specifications are presented in Table 1). These tests were performed using the aerial target (aircraft AN-74-200). In this case THI were mounted on the TTRS antenna and were not subjected to any adjustments.

Table 1 presents basic characteristics of passive OES operating in the IR bands.

The tests performed consisted of six approach missions of aircraft AN-74-200 (two missions in the daytime, two at dusk, and two at night). Data from the output of each OES was recorded in the Motion JPEG format in two variants: with and without the overlaying image of the TTRS range display and with common time synchronization. The process of IR image generation on the monitor screen is schematically shown in Fig. 1.

Videorecordings were processed by using the Pinnacle Studio Plus software. From videorecordings of all missions during the target range reducing from 18 to 7 km, each frame was copied in the JPEG format. The total number of images included 5500 IR images for the specified conditions of missions in two spectral bands under investigation.

Sections of the video sequence of one of the target missions at time instants of copying the IR images are schematically shown in Fig. 2.

Since the trial models of THI had somewhat different fields of vision and the PD matrix formats (see Table 1), all images were subjected to normalization: their size was reduced to format 256×380 pixels by using the method of bilinear interpolation.

For the estimation of the target intensity correlation in the 3–5 and 8–14 μm bands on digitized IR images the arrays of equal size belonging primarily to the target region were separated by using masks. At the