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METHOD OF REPRESENTATION OF REMOTE SENSING DATA THAT FACILITATES VISUAL INTERPRETATION.

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ABSTRACT

We present a method of visualization of the remote sensing data that allows a quick synthesis of heterogeneous data for its interpretation by a human operator. The method is suitable for processing pictures of one optical band as well as polyzonal and hyperspectral aero pictures. It allows using a priori knowledge for visualization. Different methods of preliminary image processing can also be easily included in the model. As a result a number of alternative visualizations of the same dataset can be obtained depending on the interpretation objectives. The method is particularly efficient at the interpretation of barely visible objects. It makes it possible to reduce the influence of particular conditions of remote probing such as lightening conditions and an optical receiver on the results of visual interpretation.

1. DATA SYNTHESIS AND VISUALIZATION

The existing universal applications packages for cartography (ESRI, ERDAS, LHS, MultiSpec and etc.), allow synthesizing polyzonal and hyperspectral pictures. The known methods, like that are described [1-3], find out multispectral images of objects to display them. These tasks require pixel classification, which is not a simple operation and can be carried out by various methods. It takes much time to do it.

The method presented here does not require preliminary classification. It can thus be used in order to rapidly perform the tasks of visual interpretation. We shall illustrate this method with an example of the synthesis of n-zone aero pictures. We assume that the pictures are superimposed.

Everyone pixel of such set of the images has n the spectral characteristics or attributes. An algorithm of comparison to a standard model is used for visualisation. A pixel with all its attributes is selected as a standard model. Apart from the spectral characteristics some other attributes may be assigned to a pixel. These can be obtained by means of preliminary processing of each spectral image or a set of images. The attributes of the standard model are compared to those of all other pixels. The synthesis of the images is produced based on a principle of similar attributes. The highest brightness is assigned to the pixels that resemble most the standard model.

The brightness value of the rest of the pixels is calculated on the basis of their resemblance with the standard model. Different attributes can be employed as a measure of resemblance, particularly those that are used for classification in the well-known application packages MultiSpec, ESRI, ERDAS.

It can be the Euclidean metric in the n-dimensional space of the attributes or the maximal difference between values of the same attributes. No additional information is needed for this metrics. If the information on the probability distribution of the standard model attributes is known, one can make use of the conditional probabilities (the Bayesian method) to evaluate resemblance. All the characteristics that have been estimated in advance may be involved when creating a resemblance metric. The final synthesized image is presented in grayscale. It contains the information on a degree of similarity of the attributes of every pixel to those of the standard model. The synthesis time of an image depends only on the time needed to calculate the attributes of every pixel. When using only the experimentally measured attributes, such as the spectral values of brightness, the final image is formed in real time, as the calculation of resemblance is carried out instantly.

In addition it is of the importance that this method involves no multiplexing. And throughput of transmitting of information is high.

Note, that the known method “infrared color vision” [3] visualizes initial images in several spectral intervals into one image where each of initial image is submitted by monochromatic color˜ red, green or blue (RGB). But multichannel transfer of the information is necessary in that case.

2. EXAMPLES

We present the results of synthesis of imaging data (aero pictures of a terrestrial surface) that obtained in 9 spectral bands. The Euclidean metric in 9-dimensional space of spectral attributes had been used. Pixels with various coordinates have been selected as standard models. For each standard model a final image is generated. The first column of figure 1 contains the pictures of terrestrial surface in 9 spectral ranges. In the second column we present the results of picture synthesis. The highest brightness level is assigned to pixels with spectral attributes bearing the highest resemblance to its standard model. The others pixels have the brightness setting that corresponds to the level of resemblance of the attributes. The standard model coordinates are marked next to the final images. One can observe that the synthesized images are much more detailed, than the images corresponding to each spectral band. The pixels of the synthesized image, that have a high level of resemblance than a certain threshold value, may be highlighted in colour. The figure 2 presents the synthesis results of the pictures in 4 spectral bands with different threshold values. The standard model is indicated by an arrow in one of the pictures. Note that this image transformation algorithm is also suitable for processing panchromatic images.

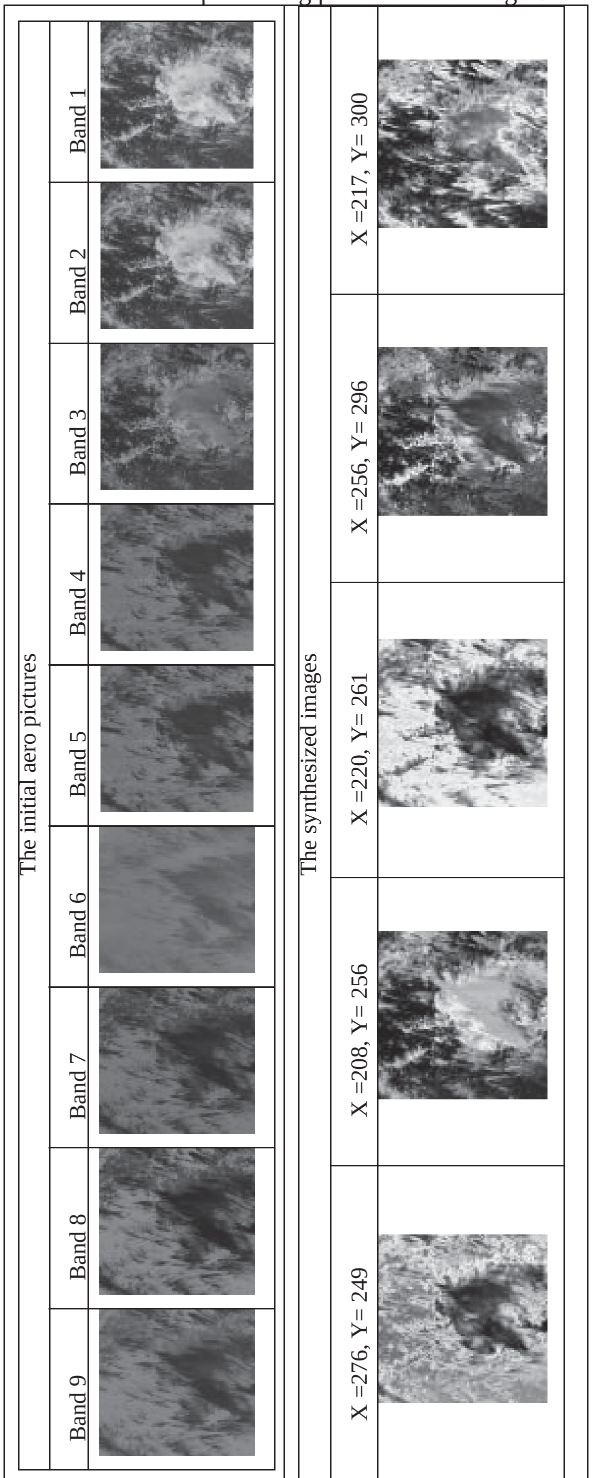

Fig. 1. The synthesis of aero pictures of a terrestrial surface that had been received in 9 spectral bands.

The areas of the picture that are of more interest to the spectator can be emphasised with the highest brightness. It is obvious that this processing method cannot increase the resolution of a panchromatic image unless additional information is used, but it can increase its perceptibility.

The level of intensity in the pictures is determined by the reflective ability of objects and depends on the atmosphere condition, the exposition parameters, etc. The standard model is obtained under the same conditions; therefore the result of the synthesis does not depend on these factors.

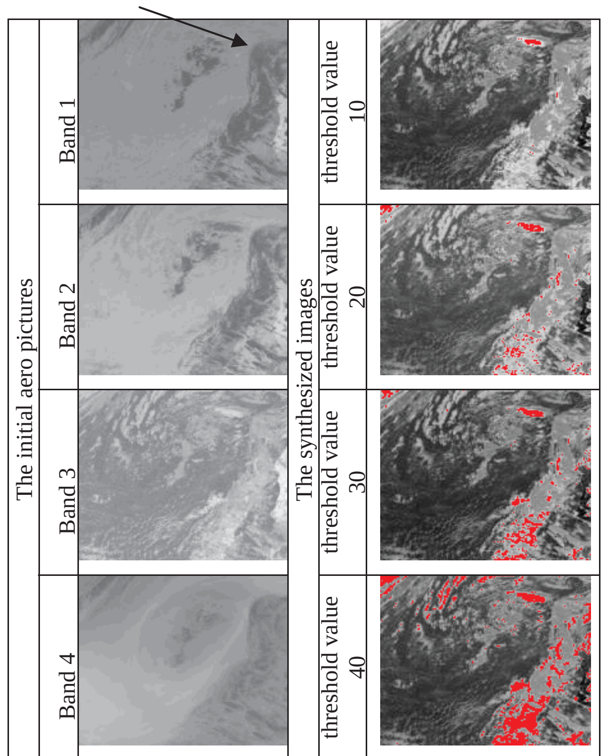

Fig. 2. Results of synthesis with various values of the threshold of the standard.

In the given example only spectral values of brightness were used as attributes. Apart from the measured spectral values of brightness one could use some additional attributes obtained by means of processing the initial data: for example structural, contextual and textural attributes. The choice of the attributes can alter the result significantly.

Figure 3 illustrates an example of some aero pictures synthesis with the use of spectral attributes. The initial aero pictures were obtained in the visual and heatwave ranges. Figure 4 illustrates the synthesis of the same pictures, this time with the use of spectral and gradient value attributes. Note that on the synthesized images the objects that were barely visible are now seen clearly. Moreover, both the objects and the details of the background are visible as compared to the initial images where either the objects or the background were visible. While some of the objects were visible on one initial image, and others on another one, on the synthesised image we can see all of them.

Note also, that on the synthesized image with the use of gradient value attributes small objects are better highlighted.

THE CONCLUSION

When interpreting remote sensing data, the visual expert interpretation is still used very often.

Thus the processing methods preparing the data for visual interpretation are rather important. The present method allows to visualize all the information contained in the numerous data of remote sensing as well as the “a priori” knowledge on a single image. The external factors of the aerial survey conditions, such as atmospheric conditions and exposition parameters, do not influence the visualization result. The method allows to adjust the result according to a specific problem and to use the “a priori” information. This method increases throughput of transmitting of information.

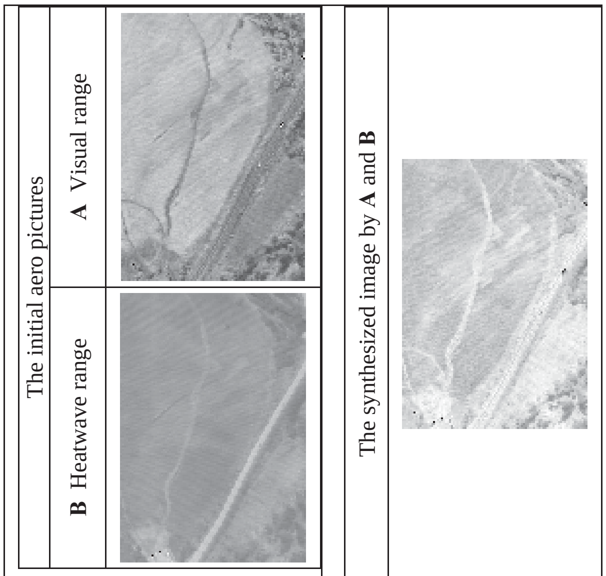

Fig.3. Using of the spectral attributes.

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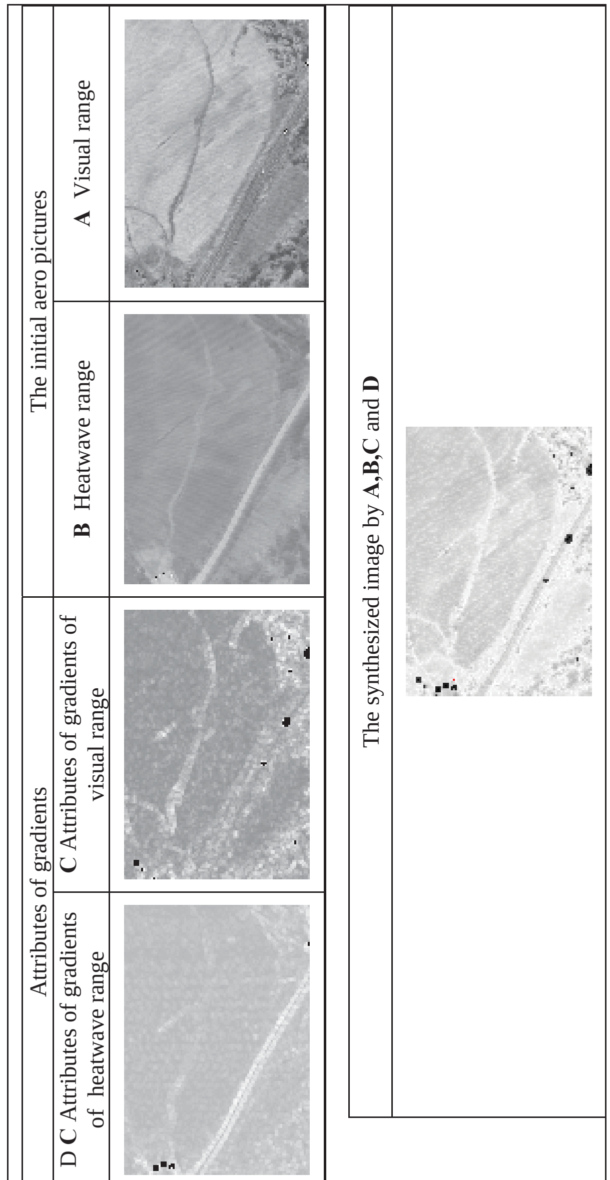

Fig.4. Using the spectral attributes and the attributes of the gradient values