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Digital analysis of multispectral imagery

SOFTWARE

For the purpose of the multispectral analysis of digitalized images, we developed a simple software package including (see Fig. 1):

1) a simple reproduction of CCT (computer-compatible tape) images on the line printer,

2) merging of different multispectral channels into one CCT (including the rotation and translation of the image if necessary),

3) construction and printing of 2-dimensional histograms (corresponding to 2 selected channels),

4) classification of pixels according to a simple algorithm and printing of thematic maps (the algorithm will be described below).

THEORY AND RESULTS

To test the software, we used 4 METEOR satellite negative transparencies from June 1978. The 4 tranparencies corresponded to 4 spectral channels (500—600, 600—700, 700—800, 800—1100 nm). The material was digitized on a Joyce & Loebl Scandig 3 scanner in „Development and Operational Institute", Běchovice. The magnitude of 1 pixel corresponded to ~300 m on the earth. The quality and contrast of the pictures did not allow to use the method of supervised classification, since no reliable ground truth data were available. Therefore we employed a simple variant of the method of unsupervised classification and applied it to 2 areas, which are interesting, e.g., from the point of view of environmental protection:

1) the region of „Krušné hory" mountains (Fig. 2),

2) Prague and its vicinity (Fig. 3).

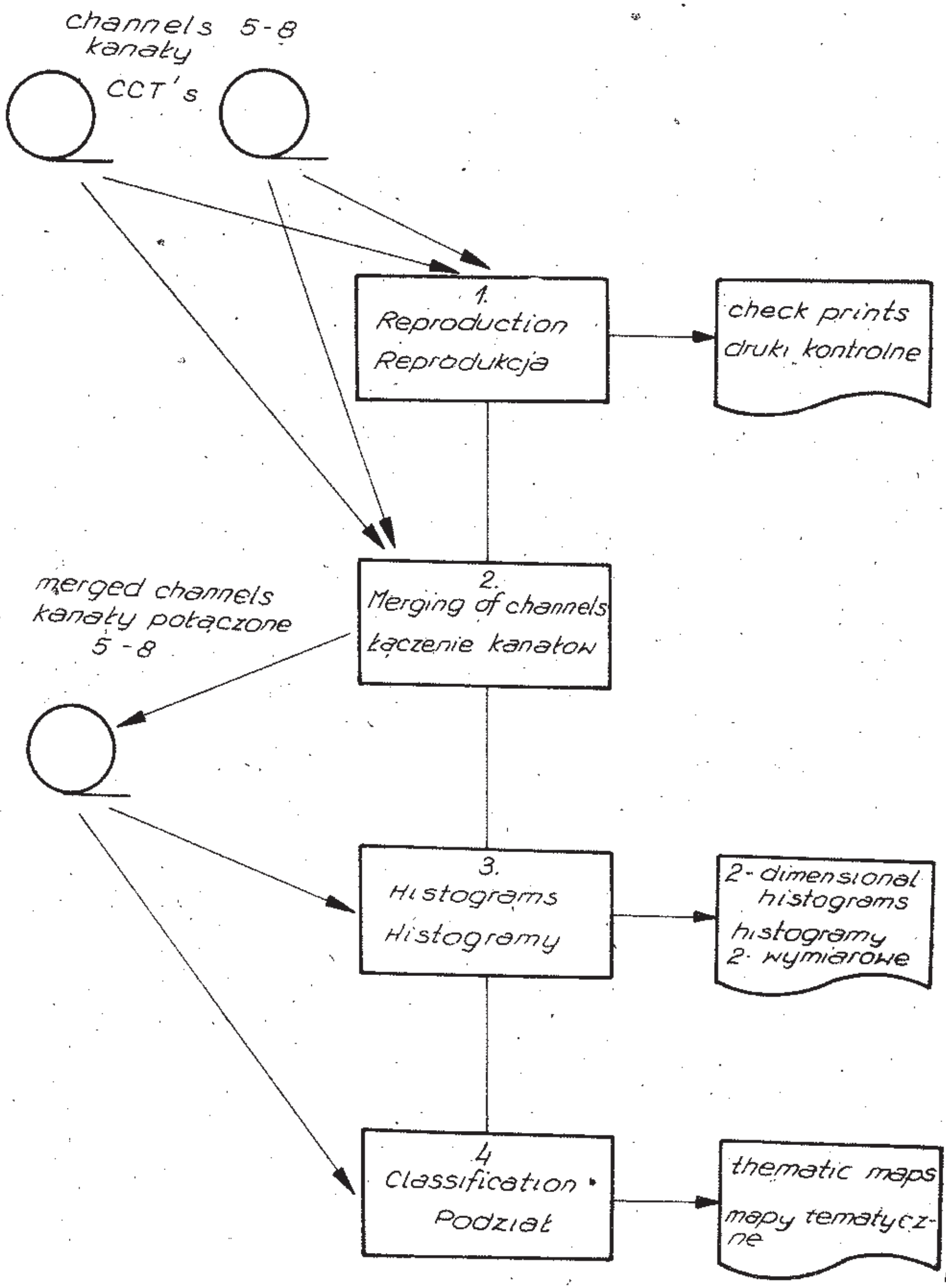

Fig. 1. The flowchart of the analysis of satellite imagery
Ryc. 1. Diagram analizy obrazu satelitarnego

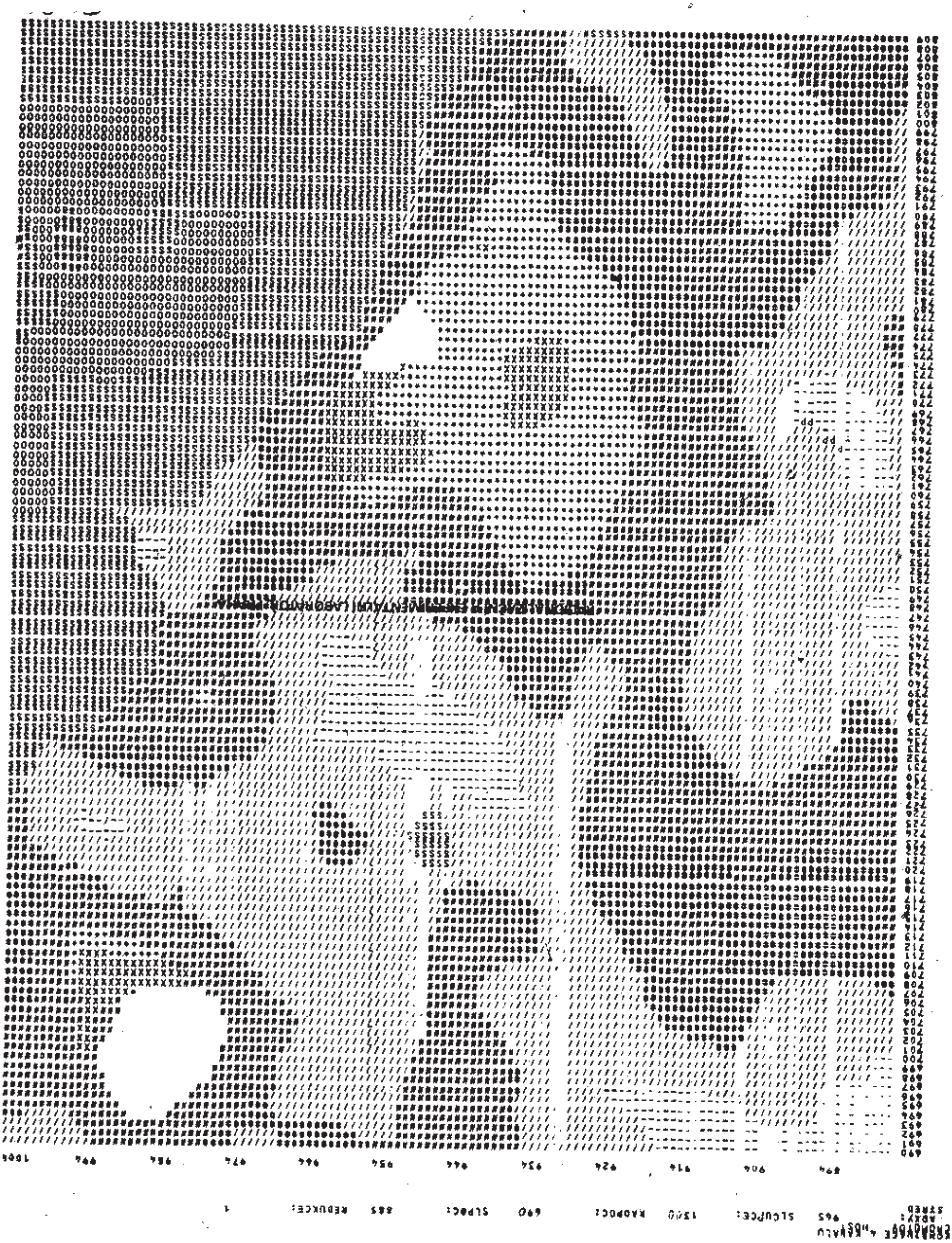

Fig. 2. The classification of the „Krušné hory" region
Ryc. 2. Podział regionu „Krušné hory"

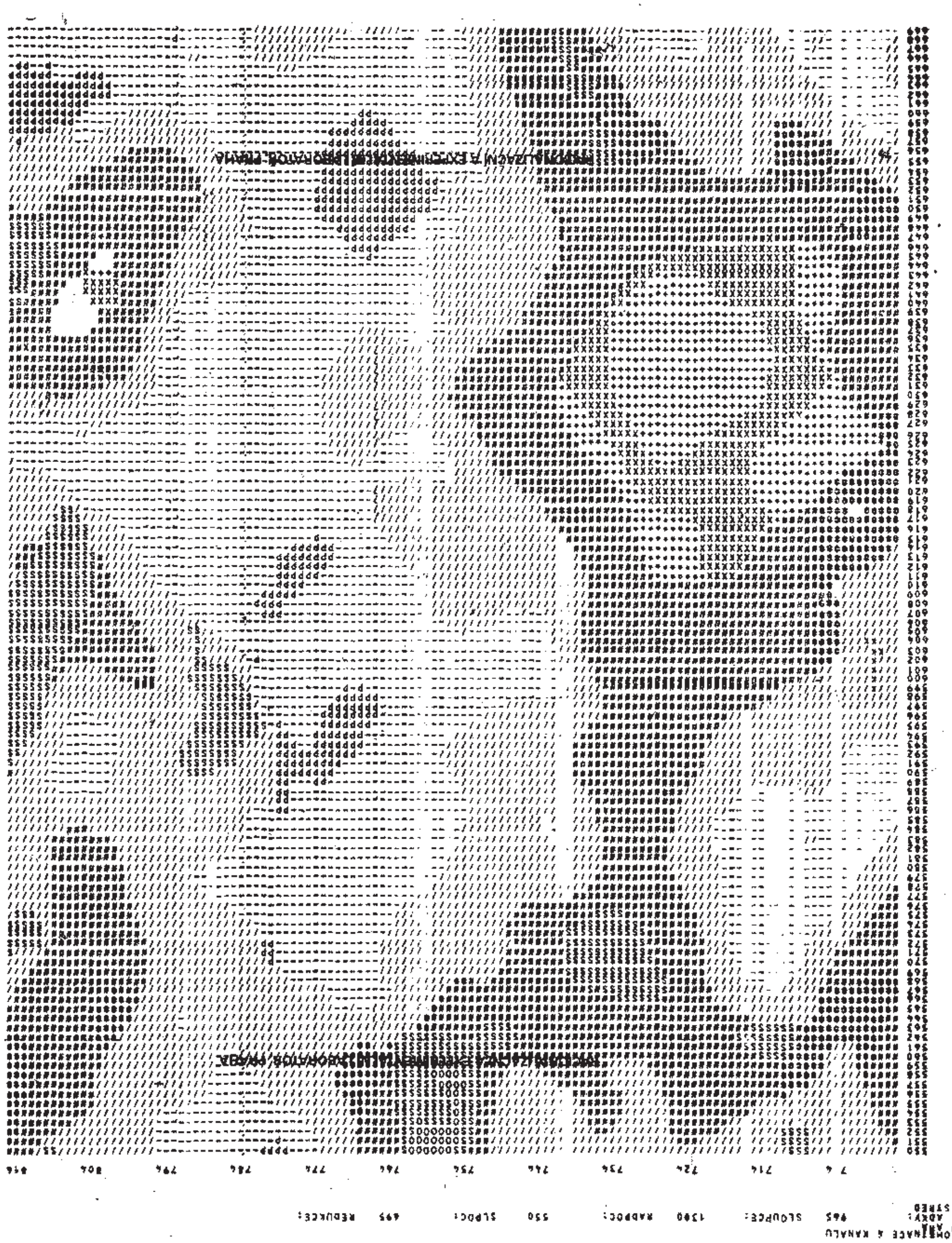

Fig. 3. The classification of Prague and its vicinity
Ryc. 3. Podział Pragi i jej okolic

The computations were performed in our computer centre on an EC 1032 computer (compatible with IBM 360/40). The programs were written in COBOL and FORTRAN languages.

The analysis was performed according to the flowchart outlined in Fig. 1. The histograms were printed in the form illustrated in Fig. 4 (a total of 6 combinations for 4 channels). Clusters in the histograms were separated and defined according to the following rules:

— a simple cluster is a rectangle or an ellipse in one 2-dimensional histogram,

— a complex cluster is a conjunction or disjunction of more simple clusters in one or more 2-dimensional histograms.

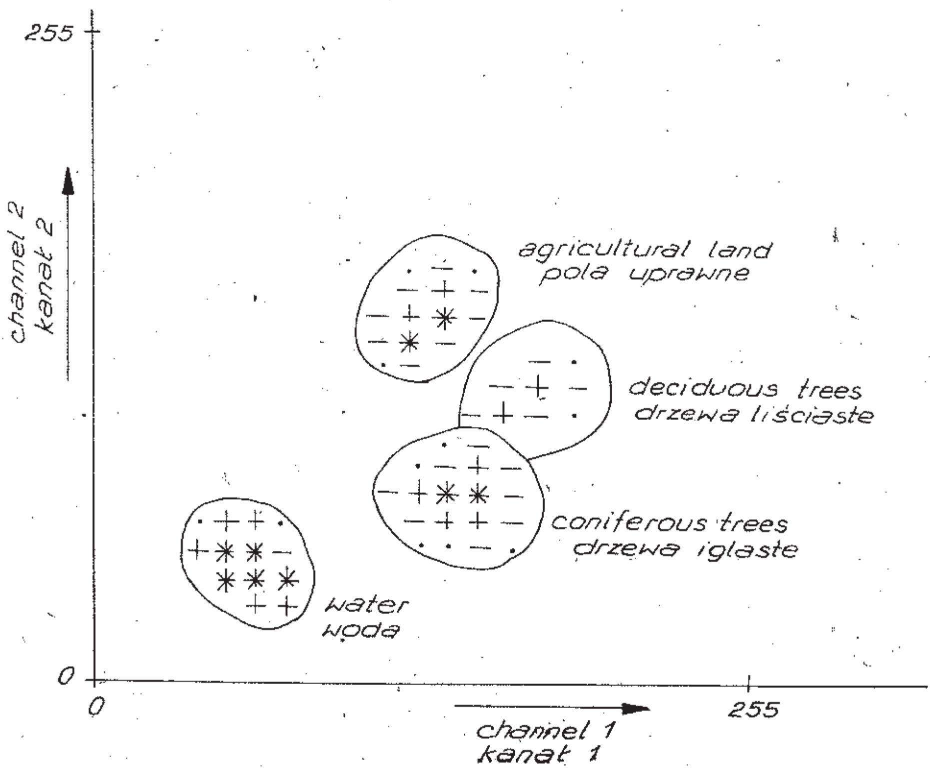

Fig. 4. An example of the 2-dimensional histogram
Ryc. 4. Przykład 2-wymiarowego histogramu

The resulting number of distinctly recognizable clusters was ~10 in all cases. Symbols — for the following output of thematic maps on the line printer (see Table) and priorities were then assigned to all clusters. Each pixel in the image was classified according to the simple algorithm:

— the pixel is classified as belonging to a cluster whose definition region encompasses this pixel provided that the clusters are run through in the order given by their priorities.

Table

Assignment of classification symbols to ground objects:

symbol	object
S O 8	— forest,
d	— dark green areas (warm),
– /	— grass, agricultural land (light green),
÷ #	— other green areas (unidentified) water,
* X +	— urban areas, smog (in the order corresponding to the increasing degree of pollution),
.	— unassigned.

Results of 2 such classifications are in Figs. 2—3 for clusters determined from multispectral images corresponding to Fig. 2 (Krušné hory). With the aid of maps of „Krušné hory" we attempted to assign the cluster symbols to ground objects; this assignment is obvious from Table. The classification in Fig. 2 reveals apparently in its upper middle part an enormous cloud of smog (symbols * and X), which covers entirely the town Most; at its west edge we can see the dam „Dřínov" (spaces). The town Chomutov is depicted as five symbols „*" in the lower left middle part. The forest-meadows boundary at the bottom of the Krušné hory mountains passes from the centre of the uppermost line to the lower left part. The classification of Prague and its vicinity is presented in Fig. 3. The capital is located at the upper right quarter of the figure and it is distinctly separated into several classes corresponding most probably to different pollution zones.

As a next step we tried to improve the separation of clusters with the help of an exponential function, which would:

1) eliminate the inhomogeneity in the illumination of the scene,

2) employ rather the radiation intensity than the optical density.

However, the results were not too encouraging and we did not pursuit this line of research any further.

CONCLUSIONS

It was confirmed that multispectral images of the earth can be employed for a rapid classification of ground objects. The following conclusions should be emphasized:

1. The most laborious and expensive part of our work was the visual search for pass points on the individual monochromatic images and the following merging of the images into a single file. To minimize the re-

sulting number of computer operations, individual monochromatic components of a multispectral imagery must be oriented as precisely as possible before the digitalization.

2. Any practical utilization of imagery from meteorological satellites for other purposes than for the investigation of atmospheric phenomena is questionable. For a more accurate tracing of smog or its possible differentiation from clouds or common urban turbidity, the classification must be verified on ground truth data.

3. Our simple method of unsupervised classification, which is based on a visual determination of clusters in the 2- or more dimensional feature space, yielded expected results. In all verified cases, the clusters corresponded to the objective situation on the earth (if we take into account the quality of the original material). A more thorough evaluation of possibilities of our method will be possible after it will have been tested on more accurate images in an experiment including a verification of its results on the earth surface.

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CYFROWA ANALIZA OBRAZU WIELOSPEKTRALNEGO

Streszczenie

Program opracowany w REL dla wielospektralnej analizy danych teledetekcyjnych jest opisany i zilustrowany na podstawie obrazu satelitarnego uzyskanego dzięki satelicie METEOR. Podano dwa przykłady klasyfikacji.

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L'ANALYSE NUMÉRIQUE DE L'IMAGE MULTISPECTRALE

Résumé

On traite les programmes développés en REL pour l'analyse multispectrale des dates conquises par des recherches télémetriques. L'application des programmes est illustrée sur les vues prises du satellite METEOR. On indique deux exemples de la classification.

Traduit par
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