DETECTION OF METEORS IN ASTRONOMICAL SNAPS

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1 INTRODUCTION

Meteor is light trail, which arises during passage of a meteoric body through the atmosphere. If the trail of the meteoric body (or meteoroid) is known, so it is possible to find meteorites (rests of the meteoric body, which have fallen on the Earth). We get valuable information about origin of meteoroids and their parent bodies as are comet nucleus from meteorites. Theories that terrestrial life comes from the space and especially from comets exist. This paper deals with how we can detect meteors in astronomical snaps, which can help us with questing of meteorites. The most of meteors have a typical line shape and for that reason the best-known method for detection of straight lines in digital images, Hough transformation, was used. The paper contains theoretical introduction into meteor detection, description of the principle of Hough transformation and examples of meteor detection results as well.

2 THEORETICAL BACKGROUND

The straight line in the slope intercept form (see Fig. 1a) can be described by the equations (1) and (2). Each such a straight line can be transformed into parametric form by the equations (3) and (4), see Fig. 1b. The Hough transformation, patented by P.V.C. Hough (1962), transforms all straight lines from the original image space into parametric space. The straight line described by the equations (1) and (2) in the image space is transformed according to equations (3) and (4) into parametric space. Points in the parametric space, in which lines described by the equations (3) and (4) intersect, belong to straight lines (of their segments) in the original image space. Parametric space is divided into elementary cells, in which are accumulated points, which belong to straight lines. At the end of this process the content of all cells is evaluated and in the such case that a lot of points is in the some cell, it is a big probability that these points lie on the same line.

Equations of the straight line in the image space:

$y_1 = kx_1 + q$ (1),

$y_2 = kx_2 + q$ (2),

Parametric equations in the parametric space:

$q = -kx_1 + y_1$ (3),

$q = -kx_2 + y_2$ (4)

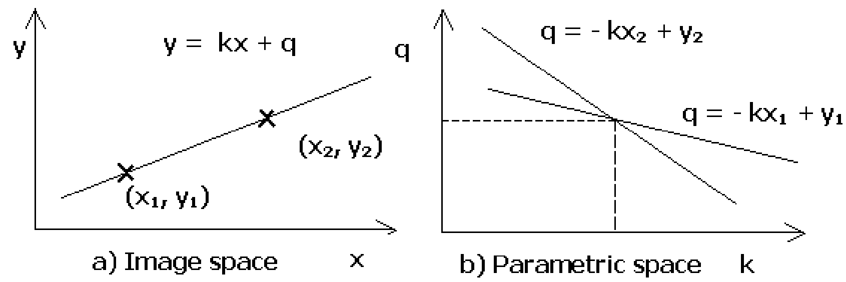

Figure 1: Principle of Hough transformation

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Although Hough transformation is used as a main method for detection of meteors, many other functions were used as pre-processing methods before Hough transformation. Hough transformation is a time-consuming method. For that reason Radon transformation, which enables search for straight lines only in the desirable directions, was used. Some edge detector before use of Radon and Hough transformation is usually applied. Convolution with kernel for four directions was used as an edge detector in this case.

3 PRACTICAL REALISATION OF METEOR DETECTION

Software MATLAB and its tool Image Processing Toolbox were used for practical application of described meteor detection method. This tool contains a lot of useful functions for image processing as grey-scale transformations, geometric transformations or image smoothing. Four new functions for meteor detection were created on the basis of the MATLAB functions. The graphic user interface for processing of the database of meteoric snaps on the basis of MATLAB was designed as well. Two examples of meteor detection are shown in the following figures.

Figure 2: Detection of single meteor

Figure 3: Detection of meteors in meteoric stream

4 CONCLUSIONS

So far two hundred meteoric snaps were processed. Successfulness of meteor detection was from 70 to 80%. Main problems, which arose during meteor detection, were following: too clear background of meteor (typically daily sky), conspicuous false lines in the image (satellites, trees, high voltage pylons), faint brightness of meteor, other bright objects in the image (stars, Milky Way, northern lights).

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REFERENCES

Hlaváč, V. Šonka, M., 1992. *Počítačové vidění.* Grada, Praha.

Hough, P.V.C., 1962. *Methods and Means for Recognizing Complex Patterns. U.S. patent 3069654.*

Klíma, M., Bernas, M., Hozman, J., Dvořák, P., 1996. *Zpracování obrazové informace.* Vydavatelství ČVUT, Praha.