

PROCESSING OF ASTRONOMICAL IMAGES USING MATLAB IMAGE PROCESSING TOOLBOX

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Abstract: The paper deals with searching for meteors in digital astronomical images. Hough transformation for searching for straight lines was used. Four functions were created on the basis of this method for various types of meteoric snaps. Graphic User Interface (GUI) for handling of functions and the database of snaps was created on the basis of MATLAB. MATLAB tool Image Processing Toolbox was used for image processing as well.

Keywords: meteor detection, Hough transformation, graphic user interface, MATLAB, Image Processing Toolbox

1 Introduction Into Processing of Astronomical Snaps

Astronomical records can be divided into some different groups. We can distinguish static and dynamic records, classical analogue or digital records, professional and amateur astronomical snaps, and of course, astronomical records can be divided by their contents. This work is aimed at processing and analysis of static digital meteoric snaps. The task was to search for meteors in meteoric snaps.

1.1 Hough Transformation

Meteors in astronomical snaps usually have a typical straight-line shape. Hough transformation is the most current method for searching for straight lines in digital images. The principle of Hough transformation for straight lines detection will be explained using the straight line with slope-intercept form. A straight line is defined by two points: $A = (x_1, y_1)$, $B = (x_2, y_2)$, see Figure 1. Slope-intercept forms for straight lines going through the points A and B are given by the equations:

$$y_1 = kx_1 + q \quad (1),$$

$$y_2 = kx_2 + q \quad (2),$$

when k , q are parameters. These equations are interpreted in the parametric space for parameters k , q :

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

$$q = -kx_2 + y_2 \quad (4).$$

The straight lines given by the equations (1) and (2) in the Cartesian coordinated system are given by the equations (3) and (4) in the parametric space. The only common point of both straight lines in the parametric space is the point, which represents the only existing straight line connecting points A and B in the original image space. It is the main principle of Hough transformation for searching for straight lines that all straight lines and their parts in the image space are transformed into the only points in the parametric space.

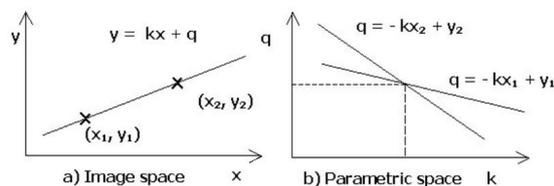


Figure 1 Principle of Hough transformation

All image points are transformed into some points in the parametric space. All values in the parametric space are quantized and the parametric space is divided into elementary cells. Points, which belong to the elements of the straight lines, are accumulated in these cells. At the end of this process the contents of all cells are evaluated. If some cell contains numerous points, it is a big probability that these points lie on the same line. Main steps of the Hough transformation are

shown in Figure 2. Edge detector is usually used as a pre-processing method before Hough transformation. We can see an original image (a), edge image (b), parametric space (c), and detected lines (d).

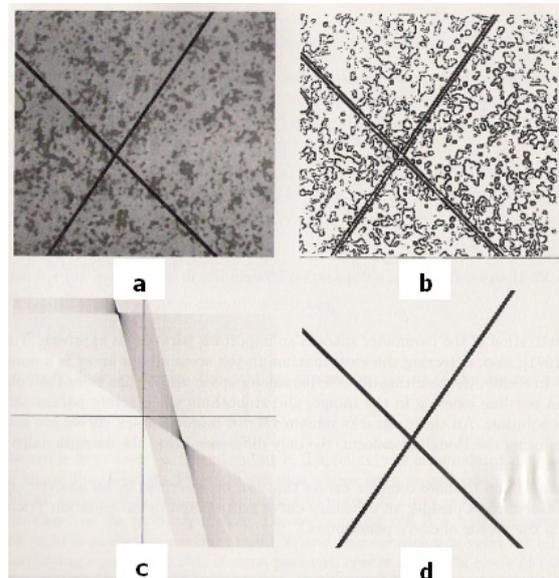


Figure 2 Main steps of Hough transformation by [1]

1.2 Functions for Meteor Searching

Four functions were created to search for meteors in meteoric snaps. It was basic meteoric function, function using median smoothing, function with image rotation, and combined filtration and rotation function. The MATLAB tool Image Processing Toolbox [3] contains many functions to process digital images. Image Processing Toolbox functions were used to create new functions for meteor searching. Detailed description of Image Processing Toolbox functions and new created meteor functions was brought in the paper [2]. We can briefly summarize that main Image Processing Toolbox functions used in meteor searching are the followings: greyscale transformations, geometric transformations, image smoothing (especially median filtering), and edge detector. These functions are further briefly described.

Greyscale transformations are processes, which do not depend on the position of the pixel in the image. Greyscale transformation functions transform the original image with the given brightness into an image with a new brightness. Geometric transformations realize basic geometric operations with the image: rotation, change of the scale and skewing by the angle. Image smoothing is an image pre-processing method, which is used to suppressing of noise in the image. Image smoothing methods, which are not edge preserving, blur sharp edges, which causes lost of information. Median filtering is a non-linear smoothing method that reduces the blurring of edges. The current image point is replaced by the median of the brightnesses in its neighbourhood. Edge detector is a general tool for finding of lines in the image. MATLAB uses edge detector, which is based on the local convolution in the image with convolution kernels, which serve as line patterns. It is used as a line finding operator. All described functions were used in new created functions. The particular realizations of these functions are implemented by the user menu for meteor searching, which is described in the chapter 2.

2 Graphic User Interface for Meteor Searching

The process of meteor searching itself is realized by the Graphic User Interface (GUI), which was created on the basis of the

MATLAB GUI. This tool enables to build an interactive user menu, in which it is possible to insert functions, data, and databases. It is possible to separate two main steps in the user menu building. First step is the choice of buttons from starting menu; see Figure 3. Second step is programming of user functions and creation of the linkage between these functions. Property Inspector serves for setting of technical parameters as a size, fonts, colours, position, etc. Programming of the menu functions, which belong to the buttons, sliders, and other menu items, is realized in M-file Editor (Figure 3). Resulting menu, which was built to search for meteors in meteoric snaps, is in Figure 4. This menu contains push buttons to call meteor functions, pop-up menus to look through the databases of processed images, list box to choose meteoric snap to process, and list box to look over results of the searching. The push button for insertion of a new image to process is placed in the menu as well. It is possible to monitor the whole process of searching for every single meteor, because partial results of meteor detection process are available.

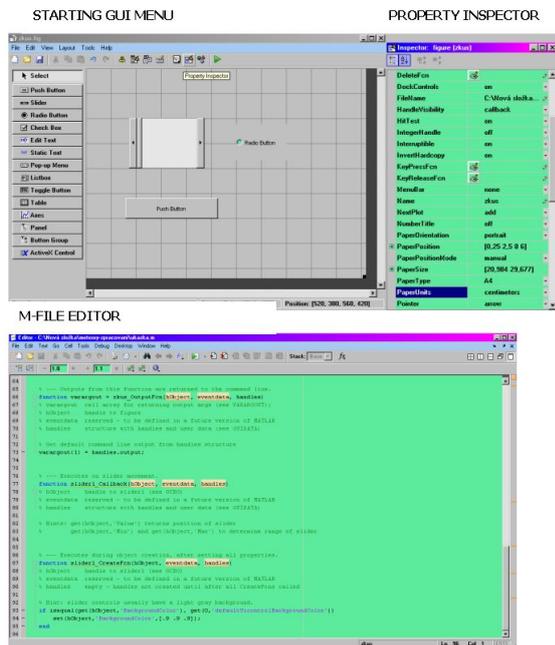


Figure 3 Building of the menu on the basis of MATLAB GUI

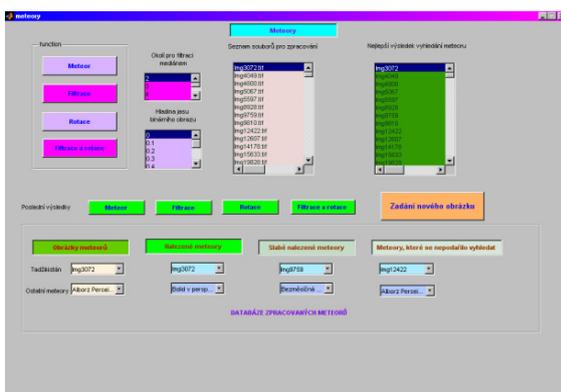


Figure 4 Menu for meteor searching

3 Results of Meteor Searching

This chapter describes some typical results of meteor searching. All used functions are realized on the basis of Hough transformation. The basic meteoric function is based only on this method. Very bright meteors were successfully found using the basic meteor function. But numerous meteoric images do not

contain very bright meteors. The main problems, which arose during searching for meteors, are the followings: feeble meteor on the background with bright stars, meteor on the day sky with the Sun, false lines in the image, earthly objects as buildings, trees, cars, mountains, various pylons. Satellites on the night sky represent a big problem as well. Special case is a very bright meteor named bolid, or fireball, which often has not a typical straight-line shape. These meteors could not be searched for by Hough transformation. A few snaps with meteor showers were processed as well, but processing of snaps with meteor showers was not the goal of this work. It is a more complicated problem demanding different methods. The most common types of meteors were successfully found using combination of basic meteor functions with median filtering or image rotation. The typical meteoric snap and result of the search for meteor is shown in Figure 5.



Figure 5 Example of detected meteor

4 Conclusions

Two hundred meteoric snaps were processed using described functions and created menu. Almost 80% of meteors were successfully found. The main problems mentioned above require new methods of searching for meteors. Improving of the user menu is necessary as well. The next step in meteor searching, after solution of current problems, is to automatize the meteor searching process.

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