Detection of Meteors Using Cluster Analysis

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1 Introduction

Detection of meteors in digital astronomical photographs represents finding of a suitable mathematical method for detection of meteoric light curve in the image. Various methods were used for detection of meteors in video records. The problem solving of searching of meteors in static digital photographs is a new task in meteor detection. One of methods, which were successfully applied in processing of meteor video records, is cluster analysis. Here this method is used for detection of meteors in meteoric digital photographs.

2 Introduction into Cluster Analysis

Cluster analysis (or clustering) represents a large group of methods, which try to separate objects from a given dataset into individual groups on the basis of similarity and dissimilarity among those objects. Cluster analysis methods can be divided from various points of view. The most common division of clustering methods is shown in Figure 1.

Mathematical definition of clustering is realised via definition of the cluster, which is the following:

Definition: Let $X = \{x_1, x_2,...,x_n\}$ is a set of items. Let D is a dissimilarity coefficient. Then cluster is a subset A of the set D, which complies the following inequality:

$$\max D(x_i, x_j) < \min D(x_k, x_l), \text{ where } x_i, x_j, x_l \in A, x_k \notin A. \quad (1)$$

Clustering is the process, which divides given set X into clusters.

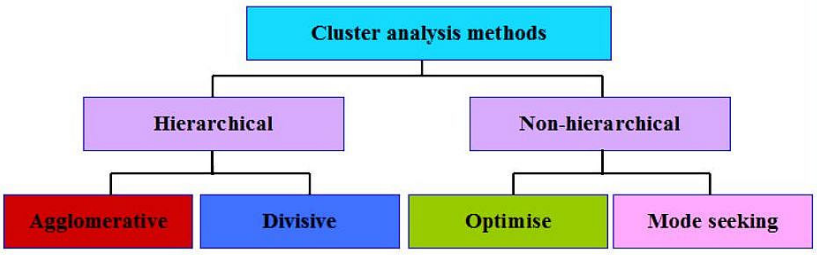

Figure 1: Division of clustering techniques by Lukasová, Šarmanová (1985)

3 Meteor Detection and Discussion of Results

One hierarchical clustering algorithm named single linkage and one non-hierarchical (partitional) algorithm named K-means were used for detection of meteors in astronomical snaps. Statistics MATLAB Toolbox contains functions *clusterdata* for single linkage clustering algorithm and function *kmeans*, which performs partitional clustering technique k-means. Results of meteor detection using the mentioned methods are shown in Figure 2 and 3. We can see that the both of the used methods give similar results. Clustering is often used for image segmentation and it is obvious that it performs this task very well. However, we can

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see that clustering is not generally a suitable method for meteor detection. Very bright meteors (bolides) were successfully detected, whereas faint or scattered meteors were not ever detected. Comparison of the use of cluster analysis and Hough transformation for meteor detection is shown in Figure 4.

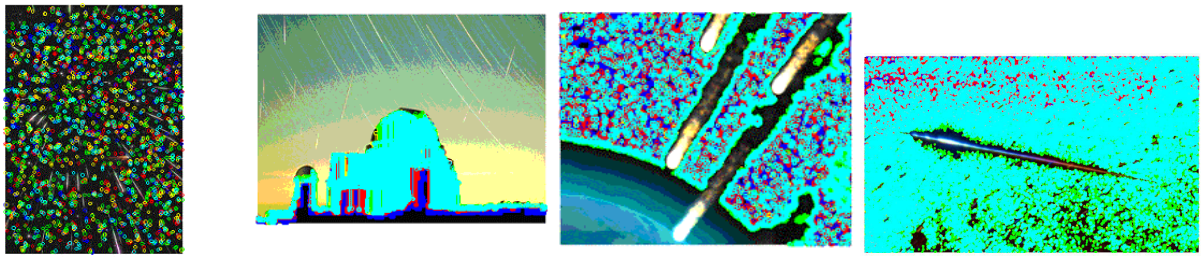

Figure 2: Detection of meteors using single linkage clustering method

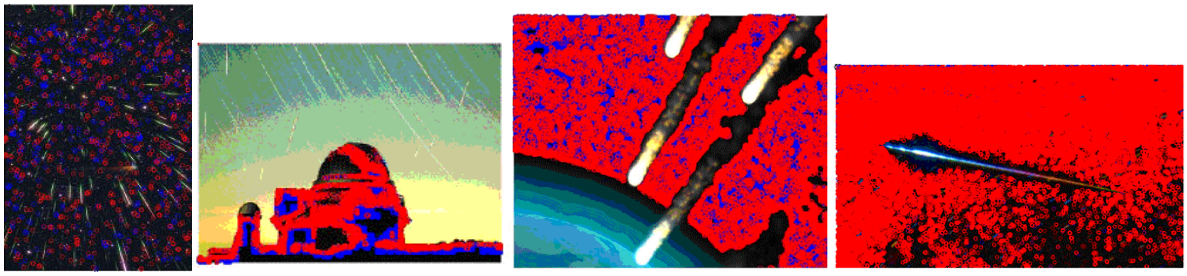

Figure 3: Detection of meteors using k-means clustering method

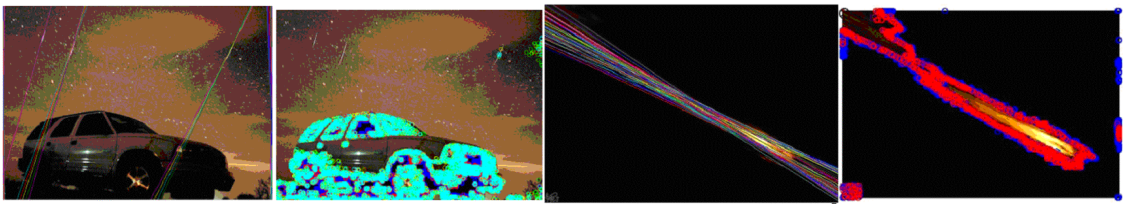

Figure 4: Detection of meteors by Hough transformation (left) and clustering (right)

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References

Jain,, A. K., Murty, M.N., Flynn, P.J., 1999. Data Clustering: A Review. *ACM Computing Surveys,* Vol. 31, September 1999.

Kubičková, E.A., 2011. *Cluster Analysis in Meteor Detection.* Semestrální project, ZČU FAV, Plzeň.

Lukasová, A., Šarmanová, J., 1985. *Metody shlukové analýzy.* SNTL, Praha.

Martinez, W.L., Martinez, A.R., 2005. *Exploratory Data Analysis with MATLAB*. Chapman & Hall/CRC Pres UK, London.