Search and tracking method of cloud fields on image

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ABSTRACT

In work the method and algorithm of data use for passive sounding of the earth (satellite remote sensing) are offered for estimation of speed and direction of wind. Presented the method of object search and tracking of the cloud fields in images

Keywords: search method, tracking method, ASIFT, Mean Shift.

1. INTRODUCTION

Today, a powerful information source about different parameters of the atmosphere and land surface (including about cloud formations) are the data of satellite passive sensing. One of open sources is the API Google tool kit of cards. Satellite data over a section with the given coordinates are provided with an interval of 1 hour. In this case, according to the movement of the cloud formations can be estimated important meteorological parameters: wind speed and direction. This information is necessary for meteorological forecasts.

2. SEARCH AND TRACKING METHOD

The proposed estimation method of these parameters can be represented by the following sequence:

1. Selection of candidate areas on the image.

2. Search and localization of the object among the candidate areas.

3. Evaluation of wind speed and direction by relocation of controlled (candidates) areas on images.

The task of the first stage is selection of subareas from all area of the image on which search of object will be carried out. The method based on local properties of the image is offered to use for selection of candidate areas. The object image areas, which differ for some visual characteristics from other areas of the object image in a certain neighborhood, belong to local properties (features) of image. One of the common approaches based on the use of local properties are the methods based on feature points [1]. For example, Harris-Laplace [2], ASIFT [3] methods. They find some feature points on image, which are unique and contrasting. The first stage can be divided into the following steps:

- search of feature points;
- specification of feature points through descriptors;
- comparison of descriptors;
- determination of candidate areas.

In work the execution of search feature points and the specification of feature points through descriptors is offered to perform by ASIFT method. Method ASIFT is fully affine invariant method. This method searches for an object which rotated by 180 °, the zoomed up to 10 times and ASIFT is robust to a change of total brightness of the image.

For comparison of descriptors it is offered to use Bhattacharyya Coefficient [4] based on calculation a cosine of the angle between vectors:

$$p = \cos(\alpha) = \sum_{i=0}^{n-1} \sqrt{a_i \cdot b_i} \ ,$$

21st International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics,
edited by G. G. Matvienko, O. A. Romanovskii, Proc. of SPIE Vol. 9680, 96805V
 · doi: 10.1117/12.2205433

where a, b – vectors of dimension n, p – similarity criterion and $p \in [0,1]$. Bhattacharyya Coefficient is only used for normalized vectors, which have the same length.

Let's call a rectangle area, on which there are key (feature) points of the object image, by candidate area. For definition of candidate areas it is offered to divide the image into rectangular parts of the size w_{win} x h_{win} with 0.5 overlapping of width and height, and to calculate the sum of similarity criteria in each rectangular area for feature points, where w_{win} and h_{win} - width and height of window respectively.

The task of the second stage is search of the object area among all selected candidate areas, which has the maximum of some criterion of similarity. The method based on global properties of the image is offered to use for localization of object. Color and light properties, general geometrical form of object can be referred to global properties of image [1]. One of the most common global characteristics is a color histogram. The color histogram is calculated quickly, however the spatial arrangement of pixels isn't considered in calculation. It is offered to take color values of points with a certain weight: the closer to the center point of the window, the greater its weight. Also, the small offsets of window should lead to small changes in the error mapping, and error mapping should be smooth. Epanechnikov kernel corresponds to this condition [5]:

$$K(x) = \begin{cases} 1 - x^2, & |x| \le 1 \\ 0, & |x| > 1 \end{cases}.$$

So, the color of the x pixel will be included in the color histogram with a certain weight $K(x)$.

It is offered to use technique Mean Shift [6] in a basis of object localization. Mean Shift is based on search of a maximum of probability density of some function, which describes discrete data. As the similarity criterion for localization of object it is proposed to use also Bhattacharyya coefficient:

$$p_i = \sum_{col} \sqrt{h_{ref}(col) h_i(col)},$$

where p_i - the similarity criterion (measure), h_{ref}, h_i – the normalized relative histograms of reference object and of area with i index corresponding, col – color value of histogram.

The estimation of wind speed and direction is done after determining the location of the object in the image. Shift of observed object in pixels is determined based on the calculated current and previous steps of the object positions. Information about the images scale, the period of the frame appearance is known, and knowing the shift of the object, wind speed and direction can be calculated.

Presented in Figure 1 an overall block diagram of the algorithm, based on the feature points positions, where I – the image on which search of object will be carried out, I_{ref} – the image of object for search, T, T_{ref} –feature vectors of I and I_{ref} images respectively, V – subareas vector of I image.

3. EXPERIMENTS

Input parameters of the implemented method are two images: an image of object for search and an image, on which the search will be performed. Developed and implemented method of search and tracking object on a video stream [7]. This program was used for the experiment.

Some parts from cloud fields were selected and used as reference image for search (example is shown on Figure 2). The images received from the satellite with an interval at one hour (Δt = 1) were images for tracking process. The total of images was 20. The Figure 2 shows the image of a cloud field for search. The results of the experiment are shown in Figure 3.

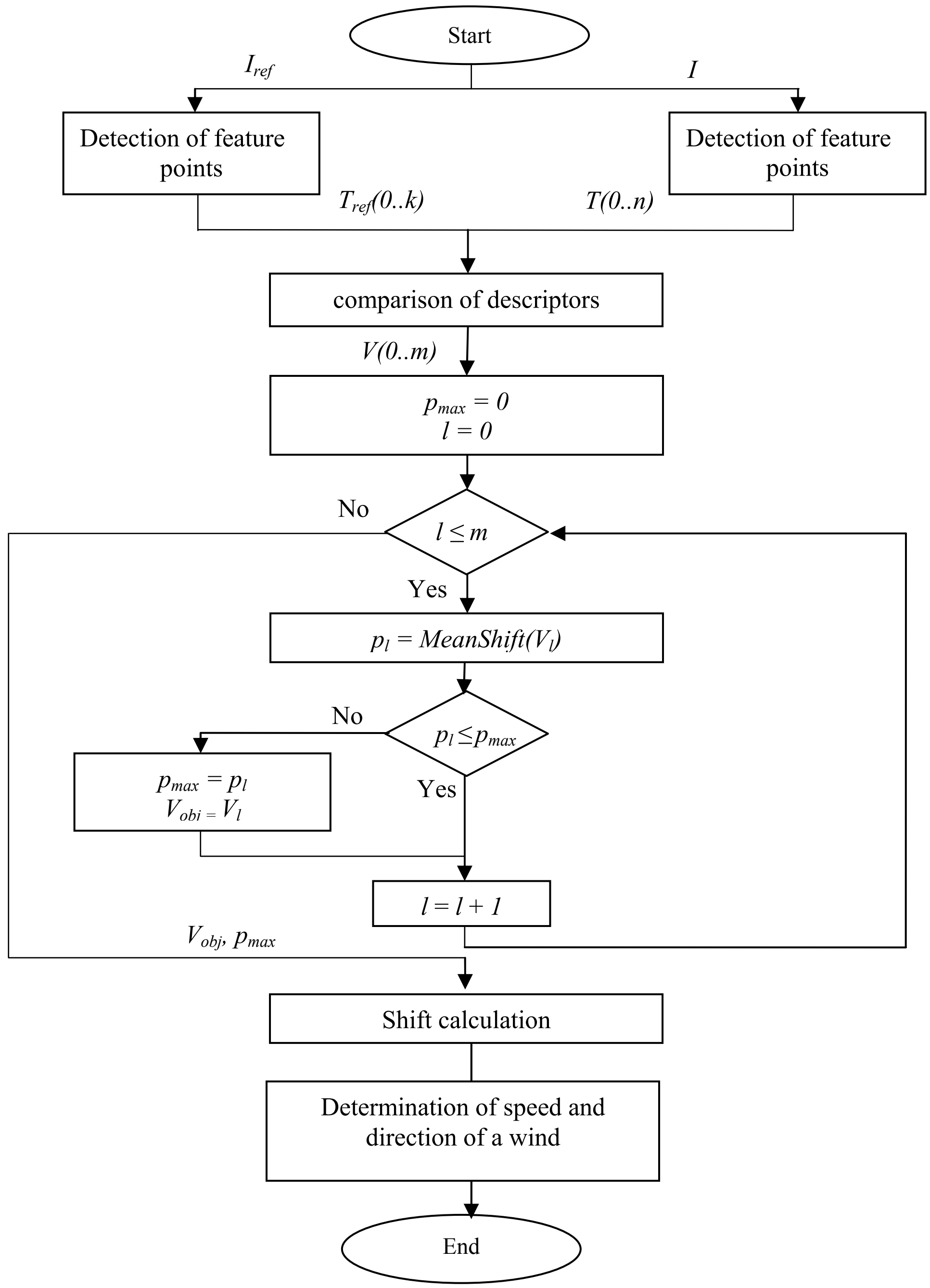

Figure 1. The block diagram of method for search object on a video stream.

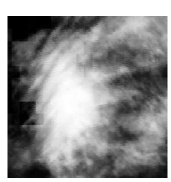

Figure 2. Object for search.

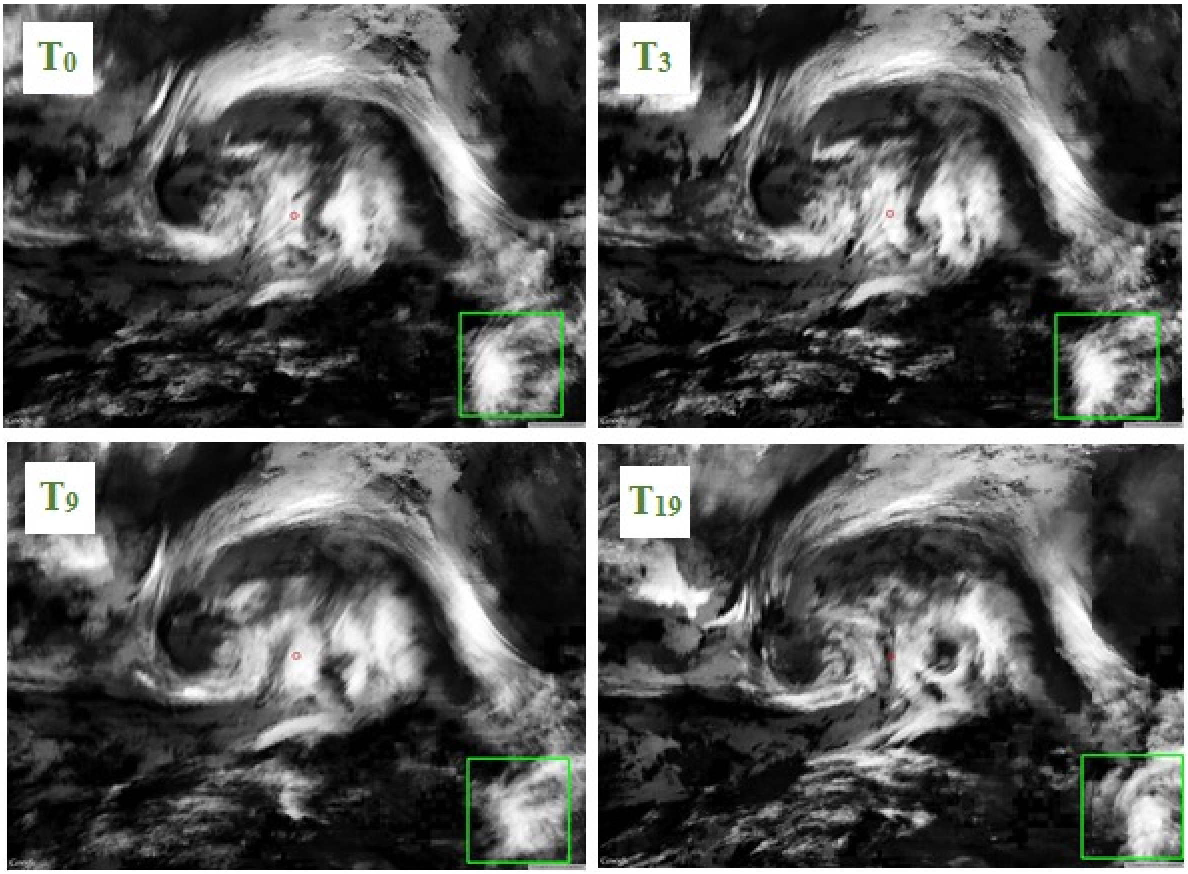

Figure 3. Object search results on a set of images (T_0 – picture of t_0 timepoint, T_3 – picture of $t_0+3\Delta t$ timepoint, T_9 – picture of $t_0+9\Delta t$ timepoint, T_{19} – picture of $t_0+19\Delta t$ timepoint).

As a result of experiments, the location coordinates of the cloud region were obtained at each picture. The vector of shifts was calculated based on the calculated coordinates. This information allows to define the speed and the direction of a wind, which help to do meteorological forecasts accurate.

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