Optik 126 (2015) 3034–3038

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

An algorithm for fast extraction and identification of star target

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ARTICLE INFO

Article history:
Received 8 June 2014
Accepted 10 July 2015

Keywords:
Object extraction
Star image identification
Visual case searching
An improved triangle algorithm

ABSTRACT

How to extract the star targets from star image is a challenging problem, particularly when the background is intricate and star target is weak. In this paper, an algorithm based on visual case is proposed to achieve fast extraction of star target. It is necessary to get every pixel in the star area to calculate the central coordinate. The boundary searching method that can get the boundary pixels was developed to get every pixel in star area according to the max and min line number and column number. By establishing visual case, algorithm complexity can be reduced during searching boundary of star target. An improved triangle identification algorithm is proposed to identify star target by storing angular distance and marking the identifying state during searching angular distance library. Experimental results show that the consuming time of visual case method is reduced by 3/4 compared to the boundary searching method, and the identification rate and storage requirements are improved compared with conventional triangle algorithm.

1. Introduction

The trait of star image taken by astronomical telescope is that star targets are small and the contrast between target and background is low, together with noise, which led to the fact that the system may detect other small objects as star target in mistake. Researches on star target extraction and identification have received increasing interest in recent years. Some notable examples can be found in the literature. Ju Gwanghyeok presents a scanning method including five parts [1]: determining a threshold value, scanning threshold, clustering star pixels, separating binary star and computing centre coordinates. Scanning process to determine the star point pixel is very simple. The possible star pixels in star image can be simply determined by scanning a threshold point. However, the number of star targets determined by this simple scanning technique is sensitive to noise. With noise increasing, the number of possible star point may be dramatically augmenting, which result in that the process of determining navigational star becomes very time-consuming in step of clustering star targets. Junkins, Turner, Strikwerda put forward a new identification method which makes use of the characteristics of the triangle pattern [2]. In this method, the triangle constituted by three unidentified stars matches with the navigation triangle constituted by three stars in guide star catalogue, and when the match is found, the unidentified stars can be recognized (the navigation stars in guide star catalogue corresponding with unidentified stars can be found). This method is simple, direct, and timesaving if the guide star catalogue is small. But because of its low dimension and large redundancy match, it is weak at the aspect of noise immunity.

This paper presents a new star extraction and identification algorithm that is suitable for fast extraction and identification without decreasing the precision. A visual case is adopted to narrow the extraction range and reduce the calculation. An improved triangle algorithm is applied to lessen traversal steps and save identification time.

2. Extraction and identification system

The framework of star positioning system is shown in Fig. 1. It includes five parts: image preprocessing, star extraction, centroid coordinates calculation, triangle matching and star identification.

In star image, there are some noise points that their pixels and background contrast is similar to that of star targets, so that the computer may make mistakes to distinguish star targets from noise. To avoid this phenomenon, we have to preprocess star image with Filter Approaches [3]. Then, extracting every pixel in star area by using visual case to compute centroid coordinates of star target, which is the most important step of star extraction. When centre coordinates are calculated, star image can be recognized by using an improved triangle matching method whose main steps are library mapping of angular distant and state marking.

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http://dx.doi.org/10.1016/j.ijleo.2015.07.067
0030-4026/

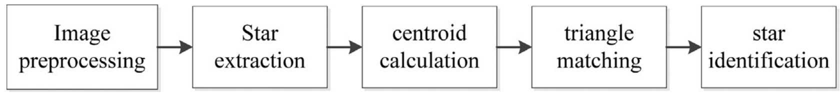

Fig. 1. Architecture of proposed extraction and identification system.

3. Star extraction based on visual case

As shown in Fig. 2, the features of star image taken by telescope are that stars are brighter than background and the distant between stars are greatly longer than radius of star pixels [4]. By establishing visual case, all calculations of star extraction can be done depending on the case.

The requirements for establishing visual case are that the visual case only contains a star target and the entire star target needs to be included in the case, so that extraction processes will not be affected by other star targets, because if the case contains more than one star pixels, the star target cannot be extracted accurately, which will damage centroid accuracy, produces large errors for following star database matching, and have effect on the positioning accuracy of star target.

Before extraction, binaryzation processing by using threshold segmentation should be employed to improve contrast between target pixels and background pixels so that star extraction can be easier [4]. The formula of threshold segmentation is

$$G(i,j) = \begin{cases} G(i,j) - \delta & G(i,j) > \delta \\ 0 & G(i,j) \le \delta \end{cases} \quad (1)$$

where $G(i, j)$ is the gray value at the point (i, j), δ is threshold value. Fig. 3 shows the enlarged binarized FIG of a star target.

After binaryzation, every star target can be extracted by using the algorithm of visual case. Edge pixels of the binary star target can be easily determined based on threshold value. When the first edge pixel of the star target is determined (to label this edge pixel with 1), a visual case can be established by centering this edge pixel, as shown in Fig. 4, then the boundary searching algorithm is adopted to extract star target by searching all edge pixels and computing grey values of all the pixels in star area.

Before edge extraction, neighboring pixels of edge pixels need to be numbered, as shown in Fig. 5. The steps of boundary searching are described as follows:

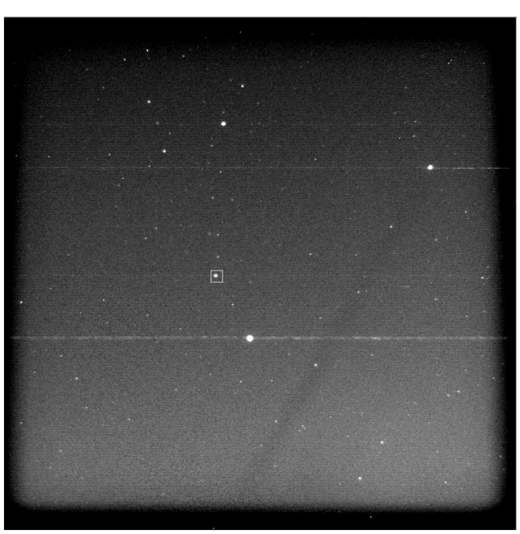

Fig. 2. Star image.

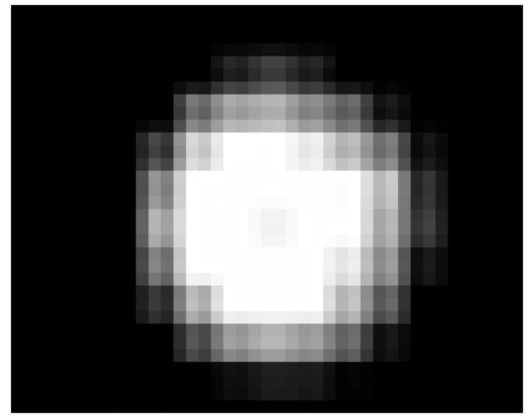

Fig. 3. An enlarged binarized FIG of a star target.

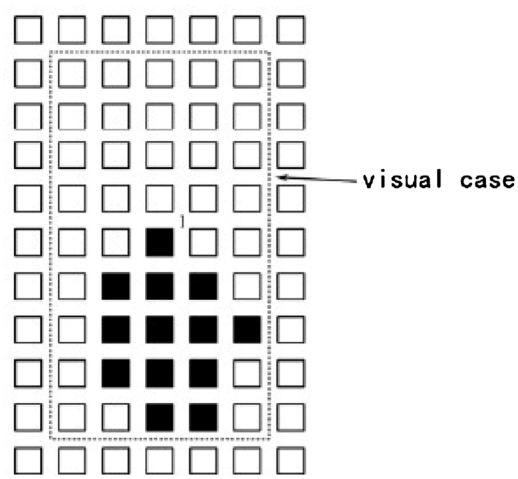

Fig. 4. The construction of visual case.

(a) Projecting star image from left to right, top to bottom; setting star area as S; searching the first edge pixels belonging to S, $S(k) = (x(k), y(k))$, $k = 0$.
(b) Checking the neighboring pixels of the first edge pixel in sequence until the second edge pixel is found, as shown in Fig. 5.
(c) Repeating step (b) until all the edge pixels of S are found.

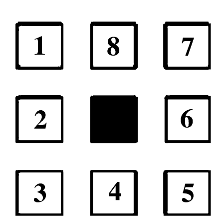

Fig. 5. Numbering neighboring pixels of edge pixels.