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Extraction and Location of Monomer Coordinates of Amanita based on Fourier Transform

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Abstract: A discrete Fourier transformation-based algorithm to locate the monomer coordinates of Amanita was proposed in this paper according to the shape and size of the Amanita. Characteristics of image data of Amanita were used to determine borders and describe the image acquisition of Amanita. For the shape range of Amanita, coordinates of the mushroom center were calculated by the Fourier transform algorithm, which were processed by translation, rotation and zooming. Experimental results show that the proposed algorithm can extract accurate coordinates of Amanita effectively. The extraction accuracy reaches as high as 96.33%.

Keyword: Image Recognition, Orientation Processing, Shape Range Description

1. Introduction

Amanita Phalloides is also called as toxic umbrella, high-handled bacteria, garlic leaf bacteria, death cup and green hat bacteria. It is titled as the “death cap” in foreign countries for its cap characteristics. The sporocarp is generally moderate big. The cap has smooth touch. It is approximately oval and campaniform in early stage and skin appears brownish green, ash brown and dark green. The bacterial context is white. The lamella is white. The stipe is a long white cylinder and the base is expanded into a ball with soft or hollow internal structure. The volva is a big, thick white bud. The collarium is white and is above the stipe. It grows independently or in group in broad-leaved forest in summer and autumn. Main growth areas are in south China, including Jiangsu, Jiangxi, Hubei, Anhui, Fujian, Hunan, Guangdong, Guangxi, Sichuan, Guizhou, Yunnan, etc. Amanita is extremely toxic (it is recorded that young bacteria is more toxic than adult bacteria).

How to distinguish Amanita visually through images? Firstly, edible non-toxic mushrooms mainly grow on clean grasslands or pine trees and oak, while toxic mushrooms often grow on dark, wet and dirty areas. Secondly, toxic mushrooms have bright colors, including red, green, ink and cyanosis. Particularly, purple mushrooms are often highly toxic and are easy to change colors after being harvested. Thirdly, non-toxic mushrooms have flat cap and smooth umbrella cover, but no collarium and volva, but toxic mushrooms are convex at the cap center and have strange shapes, thick and hard surface, collarium on stipe as well as thin or thick long weak volva.[i]

With the continuous development of computer technology and image processing technology since 1990s, image recognition has become an important development direction. In this paper, a discrete Fourier transformation-based algorithm to locate the monomer coordinates of Amanita was proposed according to the shape and size of the Amanita. Characteristics of image data of Amanita were used to determine borders and describe the image acquisition of Amanita. For the shape range of Amanita, coordinates of the mushroom center were calculated by the Fourier transform algorithm, which were processed by translation, rotation and zooming.

2. Location points for searching growth scope of Amanita

2.1 Border description and shapes of Amanita

Amanita pictures were taken at field by using the Sony E6 (1230 mega-pixel) color single-lens reflex camera. The camera lens were kept with a certain angle to the cap to ensure adequate illumination (illumination scope will influence the grey level). Image size was 2682×1753 pixels and images were converted from JPG format into BMP format for the convenience of follow-up processing. They were stored in computer documents. All involved

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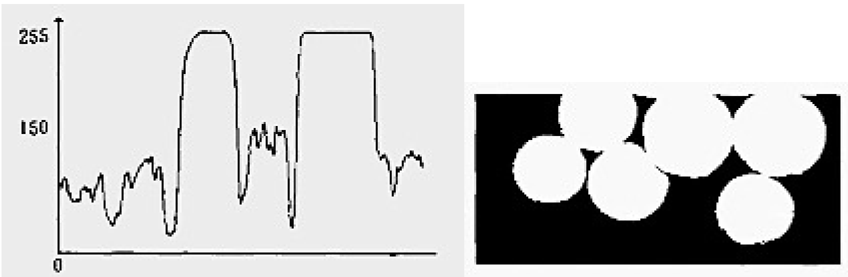
algorithms were realized in the Microsoft Visual C++ 6.0 environment and all software were operated in a computer.

The mushroom data were extracted from the big field background through low-threshold method (in the following text). With respect to pixel values of the same pixel point in the R-G-B three-dimensional space, since the pixel value of the G-dimensional space is often larger than those in the R-dimensional and B-dimensional spaces, borders of mushroom were extracted from the original images through the ultra-green features 2G-R-B. In other words, (x,y) was set the location coordinates of the pixel points, and R(x,y), G(x,y) and B(x,y) were grey values of the coordinate point in three-dimensional spaces (image brightness: 0 is black and 255 is white).

Image recognition of mushrooms is mainly to extract the central coordinates, area and perimeter of the mushroom. Neglecting monomer scope of Amanita, it may divide two or more overlapping mushrooms into one. Therefore, the central coordinates of the mushroom were searched according to the characteristic of non-overlapping center of mushrooms and then the cap region was identified by using different thresholds.

Secondly, shapes of mushroom could be identified according to different grey values. Fig.1 is one picture of grey value of mushrooms. It can be seen from Fig.1 that the grey value increases continuously from edges to the center point of mushrooms. The environmental grey value is about smaller than 140, the marginal grey value of the mushroom is about 140~210, and the grey value of central region is 210~255.



2.2 Estimation of the central region
It can be seen from Fig.1 that the maximum grey value at center point of the mushroom is higher than 210. In this paper, the central region (m, n) of mushrooms was estimated through image gridding based on thr=210. The grey value of corresponding pixels is F(m, n).

F(m, n) >= thr m = 1, 2, ... , rowm; n >= thr n = 1, 2, ... , coln(1)

rowm and coln are number of rows and number of columns in one image. The coordinate point that satisfies the Equation (1) is at the central region of the mushroom. The coordinates of the mushroom are estimated by the Equation (1).

That is, $\mathbf{x=1/A \iint xdxdy}$

$\mathbf{y=1/A \iint ydxdy}$

where A is the area of central region of the mushroom.

2.3 Mushroom bordering algorithm

Start searching from the central coordinates and choose one start border point along the positive direction of x-axis. Next, a chain table was defined to store dynamic bordering points of mushroom range.

```
typedefstruct
 {
  intPixel_x;
  intPixel_y;
  POINTER *next;
}POINTER;
```

The environmental background of the mushroom image was filtered by thr=170. Since the mushroom cap can be viewed approximately as a circle, the border following algorithm based on discrete Fourier transformation is introduced by the round first quartile.

(1) In the first quartile, one of the following three pixels is chosen as the next bordering point when the connecting lines between points on cap edges and the central point range between 0° and 45°. If the coordinates of the current pixel point are (m, n), coordinates of another three points in Fig.2 are (-1, +1), (m, n+ 1) and (+ 1, + 1), respectively. Since grey values of these three points are larger than the threshold and these three points are far away from the central point, they are used as the next bordering points which are searched by the current bordering point.

(2) One of the following three pixels is chosen as the next bordering point when the connecting lines between points on cap edges and the central point range between 45° and 90°. If the coordinates of the current pixel point are (m, n), coordinates of another three points in Fig.2 are (-1, -1), (-1, n) and (-1, + 1), respectively. Since grey values of these three points are larger than the threshold and these three points are far away from the central point, they are used as the next bordering points which are searched by the current bordering point.

According to description of pixel points under above conditions, the searched next pixel point will be used as a new starting pixel point of the current algorithm for the next searching. This repeats until all pixel boundary points are found. Similarly, bordering points in the second, third and fourth quadrants could be calculated by the same border following algorithm based on discrete Fourier transformation.

Since this border following algorithm couldn't make the system stop searching border points of surrounding mushrooms again after returning to the start point of autostop. Hence, it is necessary to introduce an angle to prevent repetition of the algorithm. This reflects that the border following algorithm stops when the angle between the current bordering point and the connected central point is 360°.

3. Discrete Fourier algorithm and its performance range

The description of the discrete Fourier algorithm provides a method to express the two-dimensional borders. According to description on computer vision and monomer detection, the bordering points are set (u0, v0), (u1, v1), (u2, v2) ... (u N-1, v N-1) (where u k=u(k) and v k = v(k)) according to the above border positioning algorithm.

A function about s (k)=(u(k), v(k)) was set, which could be expressed as:

$$S(k)=u(k)+j\,v(k),\ k=(1,2,3\ldots.N-1)$$

The Fourier formula is expressed as:

$$F(u)= \quad =U(x)+jV(x) \quad x=(0,1,2,3\ldots.N-1)\ (2)$$

F(u) is the well-known border shape that is described by the Fourier. Based on the discrete Fourier inversion of F(u), the border shape could be rebuilt as:

$$S\ (k)= \quad k=(0,1,2,3\ldots.N-1)\ (3)$$

The coordinates of several important pixel points based on Fourier description are:

(1) Barycentric coordinates

F(0)=u(0)+jv(0) expresses the central point of the mushroom. This is the barycentric coordinates of the mushroom images, which are used to locate the monomer Amanita.

(2) Rotation region

F (x)=F(x)e ^jθ. Next, surrounding point could rotate for θ° around the starting point by border reconstruction based on discrete Fourier transformation.

(3) Translation region

F (0)= F(0)+Δm+Δ n. The central point F(0) of the initial pixel point F translates along the x-axis and the y-axis for Δ m and Δ n. Subsequently, translation of graphs among different coordinates could be realized by the border reconstruction based on discrete Fourier transformation.

(4) Zooming region

F (x)=γF(x). Next, the image region could be zoomed according to the proportional coefficient (γ) through border reconstruction based on discrete Fourier transformation

4. Conclusions

(1) The proposed algorithms takes mushroom cap as the research object and has important reference values to recognition and border description of other similar objects (e.g. pumpkin). Meanwhile, it is characteristic of simple algorithm and time-saving. It is not only particularly applicable to shape measurement of complicated objects, but also applicable to interferometry field and optical elastic mechanics analysis.

(2) According to the first threshold of the direct searching central region, grey distribution and mushroom in the central region and marginal image shall be searched. Next, search the tangential direction along bordering points. These are to identify overlapped mushrooms accurately and recognize borders of monomer mushroom.

(3) The border following algorithm based on Fourier transformation can select, zoom and translate regions of pixel coordinates effectively. Moreover, it can get the barycentric coordinates of Amanita cap effectively and is an excellent algorithm to describe borders.

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