Parity Check of Human Anatomy Multimedia System Based on Irregular Closed Curve Test Algorithm

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Abstract. In image processing, especially medical image processing, an accurate determination of the position and shape of tissues and organs is the basis for medical diagnosis, which requires that massive medical staff and medical school students can master the knowledge of human anatomy very well. In this paper, a test algorithm in the irregular closed curve was proposed and applied to the parity check in the multimedia system of medical anatomy images. The experimental results show that the proposed algorithm has an accurate judgment, high execution efficiency, and fast speed.

Keywords: Irregular, Image Processing, Closed Curve, Point of Tangency

1. Introduction

In image processing, especially medical image processing, accurate determination of the position and shape of tissues and organs is the basis for medical diagnosis, which requires medical staff and students of medical schools to master the knowledge of human anatomy [1-2]. Given the actual needs of medical students and medical staff in learning anatomy and clinical diagnosis, a “computer multimedia system for human anatomy” was developed. The system requires a point to be selected on a specific tissue and organ, and the outline and name of the tissue where it is located are determined and displayed according to the point [3-4]. Users can use tools such as the mouse or menu to understand the external contour features of the tissue easily for clinical diagnosis. How to determine which organization the point belongs to, and how to find its contour line [5-6], according to the characteristics of the system, a parity check method of points in a closed area is used. This paper presents a test algorithm within an irregular closed curve and applies it to a parity check in a multimedia system for medical human anatomy images.
2. Implementation of the irregular closed curve test algorithm

2.1 The basic idea of the algorithm
In this human anatomy image, the contours of any tissue and organ are closed curves, and their shapes are irregular, making it difficult to determine points and present contours. The parity check algorithm can better solve this problem. The algorithm is practical and effective for the system in the application. The basic idea is that if a point is determined to be inside a certain tissue area, a straight line can be drawn through the point, then the line intersects this closed area, and then the calculation is made separately. The number of intersections of the line on both sides of the specified point. If the number of intersections on both sides is odd, this point is inside the area; otherwise, it is outside the area. The parity check algorithm comes from the following proposition. Straight lines and closed graphics phase change, the intersection points generally appear in pairs. A line passes through a point intersects with a closed polygon (this point is not on the polygon), then the number of intersections is an even number (when the line is tangent to some contour points of the polygon, the point of tangency is calculated as two intersection points; When some line segments of the polygon coincide, check whether this point is a point of tangency. If so, count as two intersection points; otherwise, count only at the starting point of the coincident line segment.) If the number of intersection points on both sides of the point is odd, then the point is inside the polygon; otherwise, the point is outside the polygon.

2.2. Algorithm verification description
According to the characteristics of human anatomy images in the system, the algorithm is described and verified from two aspects as follows:

1) Convex polygon
A straight line intersects a convex polygon with at most two points of intersection. If the number of intersections on the left side of point A and A is 0, then the number of intersections on the right side is 2, indicating that the part of the line segment does not intersect the polygon. Point A is not inside the polygon. Similarly, when the number of intersections on the right is 0, point A is not in the polygon. Therefore, only when the number of intersections on both sides is 1 (as shown in Figure 1), point A is in the area, i.e., when the number of intersections on both sides is odd, point A is in the convex polygon area; otherwise it is outside the area, hence the proposition conclusion is established.

![Figure 1. Example 1](image)

2) Concave polygon
It is only necessary to prove that the line passing through point A intersects the polygon, and when
the number of intersections on both sides is odd, point A is in the inner domain of the polygon. Prove using mathematical induction. When a straight line passing through point A intersects a polygon and the number of intersections on one side is odd, the number of intersections on the other side is also odd, so the left side of point A is taken as an example for discussion. Suppose that a straight line passing through point A intersects a polygon, and the number of intersection points on the left side is 2k-1 (k ∈ N), where N represents a set of positive integers.

a) When k = 1, the number of intersections is 1, the conclusion is true i

b) Suppose that when k = m (m ∈ N), the conclusion holds, i.e., when the number of left intersections of point A is (2m-1), point A is inside the polygon area i

c) When k = m + 1, it is only necessary to prove that the conclusion also holds when the number of left intersections of the point is 2 (m + 1) -1.

\[ 2(m+1)-1=(2m-1)+2 \]  \hspace{1cm} (1)

From b), it can be seen that when the number of intersections is 2m-1, point A is in the polygon area, as shown in Figure 2, A ' and A are on the same straight line, and the line segment AA' and the polygon have an intersection point, and A 'is at Outside the polygon, the number of left intersections at point A' is the number of left intersections at point A + 1, i.e., (2m-1) +1. Similarly, for A ′′, the number of intersections of A 'is +1, i.e.,

\[ (2m-1)+1+1=(2m-1)+2 \]  \hspace{1cm} (2)

At this point A'' is inside the polygonal area.
Hence, when k = m + 1, the point is within the polygon, and the conclusion holds.
In summary, the conclusion is correct.

![Figure 2. Example 2](image)

The algorithm is simple and easy to understand. It can find all the area points in the closed curve, but what is needed is to find the contour of the area corresponding to it in the corresponding set according to a certain point, whether the known point is in the current area is determined. If not, the search continues until it is identified.

According to the coordinates of a point, whether it belongs to an irregular closed area is determined. The above parity check algorithm idea is used, and the specific implementation method is as follows:

① Calculate the screen absolute coordinates x₀, y₀ of a known point, and open its index file at the same time.
② Identify the area to which point $x_0, y_0$ belongs from the current position of the index file, and read out the starting position posi of the edge coordinate of the area in the data file of the edge coordinate point.

③ Open the data file of the edge coordinate points and skip to posi.

④ Read the coordinate values x and y of the contour points from the file.

⑤ Set the flags leftsum = 0 and rightsum = 0.

⑥ while (the outline is not over).

⑦ leftsum = leftsum% 2

rightsum = rightsum% 2

⑧ if (leftsum = 1 and rightsum = 1) then

The point is within the area, and this contour line is what is required.

else

Proceed to step ② and continue execution.

In this algorithm, a particular case is taken into consideration, i.e. a processing method when a part of the contour line is a straight line. In this case, it is detected whether the linear contraction is a point of tangency. If it is, the calculated value of the intersection of the part is increased by 2; otherwise it is increased by 1.

3. Experiment and analysis

3.1. General situation

Figure 3 shows that point A is inside the closed curve, and the number of intersection points on the left and right of A are odd numbers, which are consistent with the conclusion of the proposition.

![Figure 3. Example 3](image)

3.2. Special circumstances

When the line passing through point A is tangent to some contour points of the polygon, the point of tangency is calculated as two intersection points. At this point, the judgment of whether the point is in the area is still accurate. Figure 4 shows that the line passing through point A intersects the polygon. The number of intersections on the left is 1 (odd) and the number of intersections on the right is 4 (even). According to the judgment of normal conditions, point A is not in the area and contradicts the facts. According to this algorithm, point B in the right intersection is a point of tangency, and it is calculated as 2. At this point, the total number of intersections on the right is 5 (odd number), then point A is in the area and is consistent with the facts.
4. Conclusions
According to the characteristics and functional requirements of medical anatomical images, the parity check method for the points in the closed curve is adopted in this paper. The algorithm is clear, simple, and fast. In particular, for massive complex irregular tissue and organ curves in the systematic medical images, this algorithm has good judgment capacity and reliability. The algorithm is practical and efficient in the processing of medical anatomy images, which has proven to be effective and accurate in practice.

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