Automatically Generating 3-D Image Imagined from Drawing Lines

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Abstract

In the paper, we automatically create a three-dimensional image using the occluding contours that exist in a viewed image. We propose a new method to generate the surface based on the rules needed to reconstruct the stable surface known in the psychology field from the occluding contours. The method is useful because it can be used as a modeler in computer graphics.

1 Introduction

Human can imagine three-dimensional images based on drawing lines. This paper describes a method to make a three-dimensional image from drawing lines. The important rules are discussed to imagine three-dimensional image from the contour in the psychological field[1][2]. A method which qualitatively estimates three-dimensional objects from a silhouette contour[3] is also discussed. Recently, drawing lines are automatically detected from the picture[4]. Three-dimensional objects are detected from drawing lines[5][6]. The interface used to easily make three-dimensional object from drawing lines is the main purpose. The purpose of this study is to make a three-dimensional object from drawing lines. Such a goal cannot be achieved without the use of a model.

On the other hand, the method to reconstruct three-dimensional object from a contour using the general cylindrical model and superquadrics is discussed in the field of computer vision[7][8]. The shape strongly depends on the function and model.

As well, the detection of an object motion in order to make three-dimensional animation based on a cartoon has been attempted[9]. The deformation of three-dimensional surface is estimated in the case that the basic three-dimensional model exists. In this paper, we reconstruct a shape using the rules that the contour normal vector is perpendicular to the viewing direction on points on the contour and the surface is smooth on the point in which a contour does not exist.

2 Rules to reconstruct the stable surface from the occluding contour

The following important rules are necessary to make a three-dimensional image based on occluding contours[1][2]. In general, a contour exists on the gray boundary in the viewing image. The gray boundary exists on the color boundary between neighboring pixels in the viewing image. So the contour exists on the color boundary between neighboring pixels in the viewing image. Though the color boundary does not exist on the object surface, the contour is sometimes caused by occluding the surface in the viewing image. We call this the occluding contour. We make a three-dimensional image based on the occluding contours.

The stable surface necessary to cause the occluding contours satisfies the following rules.

- The normal direction of the tangential line on a point existing on an occluding contour is perpendicular to the viewing direction.
- If an occluding contour does not exist in this position, the surface is smooth.

We generate the curved surface which satisfies the stable surface rules to generate a three-dimensional smooth surface.

3 Reconstructing a three-dimensional image based on an occluding contour

A surface is made from a circle contour using the knowledge that the contour shape is a circle. If the shape satisfies the stable surface rules, it is a sphere whose radius is the same as that of the circle. At first, all points existing on a circle are connected to the circle's center. Next, we define the depth which is the radius of the circle. Thus, the sphere surface is reconstructed from the circle contour. There are a point that have the constant distance from all points existing on a circle. The point is the circle center. The estimated sphere radius is the same as the circle radius in the case that the contour is the circle.

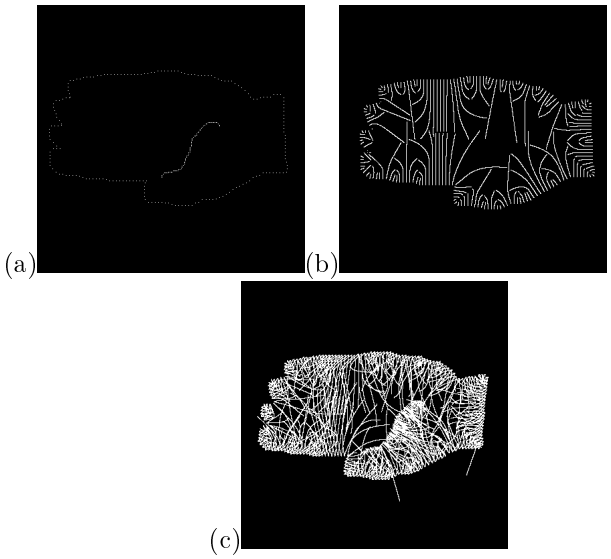

Figure 1: Three-dimensional image made from the occluding contours of a hand.(a) A hand contour. (b) The process by which points existing on the silhouette contour move. (c) All generated surfaces.

Moreover, the points move to the perpendicular direction for the tangential line on contour with the velocity based on the curvature. If the curvature is big, the velocity is fast. If the curvature is small, the velocity is slow. $\vec{x}(s,t)$ shows the position on the contour, with the contour represented using parameter $0 < s < S$. The points existing on the contour move according to the time t. $\vec{n}(s,t)$ shows the normal direction of the contour position, and κ shows the curvature of the position on the contour. The points on the contour move with the velocity based on curvature. The diffusion velocity F of the equation is based on the curvature, and the direction of movement on the position $(x_t(s,t), y_t(s,t))$ is perpendicular to the tangential line in the points existing on the contour.

$$(x_t(s,t), y_t(s,t)) = F(\kappa) \cdot \vec{n}(s,t) \tag{1}$$

Where,

$$F(\kappa) = 1 - 0.25\kappa \tag{2}$$

$$n(\vec{s},t) = \frac{(y_s(s,t), -x_s(s,t)))}{(x_s(s,t)^2 + y_s(s,t)^2)^{\frac{1}{2}}} \tag{3}$$

$$\kappa = \frac{y_{ss}(s,t)x_s(s,t) - x_{ss}(s,t)y_s(s,t)}{(x_s(s,t)^2 + y_s(s,t)^2)^{\frac{3}{2}}} \tag{4}$$

The points on the contour move to the position where they contact to the other point. The moving distance is measured. The depth in the contour is defined as the moving distance. The point on the contour moves Δxy and the depth changes Δz. The moving line is divided into max lines. We calculated the jth points in max number. The max lines are defined by the depth $\theta_b = \frac{\pi}{2}\frac{j+1}{max}$ $\theta_a = \frac{\pi}{2}\frac{j}{max}$.

$$\Delta xy(j) = rcos(\theta_b) - rcos(\theta_a) \tag{5}$$

$$\Delta z(j) = rsin(\theta_b) - rsin(\theta_a) \tag{6}$$

$(j = 0 \cdots max - 1)$ Thus, the contour depth is defined.

4 Making a three-dimensional image based on occluding contours

We show the algorithm used to generate the three-dimensional image.

- The occluding contours are detected from a viewing image.
- A direction for an occluding contour is assigned.
- All points existing on the occluding contours move in a direction perpendicular to the tangential line in the points existing on the occluding contour, and the points stop when it contacts other point.
- The distance in which all points existing on the occluding contour move is calculated.
- Depth is calculated using the distance moved and we define the depth such that the shape is a sphere.

Figure 1(a) is a hand contour, and Figure 1(b) shows the process by which points existing on the silhouette contour move. Figure 1(c) shows an estimation of all surfaces of the hand. All surfaces of the hand surfaces are generated. We confirmed that we can generate three-dimensional image using the occluding contour from this result.

References

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