지능로봇트제어를 위한 영상정보의 실시간 3차원 위치측정

오 원 근 °이 한 식
충 북 대 학 교

Intelligence Robot control for real-time Measurement of three-dimension object using information

Weon Geun OH, Han Sik Lee
Chunbuk National University

Abstract

In this paper , we describe the principle, the procedure and calculation of the measurement. Finaly the experimental results are shown and discussions are given.

Interpreting of a skewed symmetry in the image as a real symmetry in the 3-D space provides strong constraints on 3-D shap analysis. In order to apply the idea to the real scene, a method is presented which can find the skewed symmetry in the image of the skewed symmetrical object, even if it is occluded partly.

there parameters of the skewed symmetry are estimated by examining peaks in two 2-D hough spaces, onto which the parameters of all candidates of boundary line segments for skewed symmetries are voted. The method is characterized with a small amount of computation, finding of multiple symmetry axes and inference of the occluded parts of the symmetrical object.

1, Introduction

we had reporded a method which uses shadow information with one point light source, to measure the three dimension position of linear edges.[1] the recover of the three-dimensional shape of an object from its signal view is an imporant task in the computational vision. Most investigations on this problem deal with mapping image properties, such as source illumination and reflectance properties or the texture gradient of the surface, into shape constraints. One interesting idea in the above research for recovering the 3-D surface orientation is the heuristic for interpreting a skewed symmetry in the image as a real symmtry in the 3-D space.[2]

Analysis of symmetry in 2-D images has been already studied. For example, Davis presented a hierarchical method of clustering the local properties of symmetry [3], and Dutta et al. used curvatures at vertices of polygons [4,5]. But these methods fail in finding the symmetry viewed from an oblique direction, because skewed symmetry appears, instead of symmetry, in the image.Freedberg presented a method for finding the skewed-symmetry axes by using the relations of the moments between 2-dimensional and 3-dimensional symmetrical p-

atterns and comparing the areas of reciprocal [6]. This method is simple in its algorithm, but it takes much time to compare the reciprocal areas for every possible symmetrycal axis and, moreover, it cannot find the skewed symmetry in the image of symmetrical object occluded partially.

This paper describes a new method for finding the skewed symmetry in the image by a Hough method, characterized with robustness to the partial occlusion, which is an essential need for the scene analysis. Approximating the object boundary with line segments, we calculate calculate the parameters of skewed skewed symmetry between all possible pairs of line segments, and vote them onto Hough spaces. The skewed-symmetry axes are determined by finding the most frequently voted parameters. This method is characterized by one a small amount of computation, two findig of multiple symmetry axes and three inference of occluded parts of the symmetrical object.

2, Skewed Symmetry and Hough space

A real symmetry in a 2-D picture viewed from an oblique direction appears as a skewed symmetry in the image if the projection of a scene to a imge is orthographic. The skewed symmetry is defined as being symmetry along transverse lines not necessarily perpendicular to an axis, the skewed- symmetry axis, but at a fixed angle to it [2]. A skewed symmetry is, therefore, represented by three parameters; the direction of transverse lines and the distance from the origin and the direction ofthe skewed symmetry axis (see fig.1).

Two line segments AB and CD are skewed-symmetrical if AD and BC are parallel, and the symmetry axis passes through the intersection of two line segments and both centers of AD and BC. Approximating the boundary of a skewed-symmetrical region with line segments, we compute the parameters for all combinations of the line segments and vote them onto a Hough space, in which the highest peak determines the skewed symmetry. Sine such a voting method extracts the global properties of a picture, the method is robust to the partial occlusion of the symmetrical object in the scene, in other words, we can extract the skewed symmetry in some parts of input images.

It is wellknown that the computing time and memory space needed for a Hough transformation increase rapidly with the dimension of its parameter space. Rather than to vote the three parameters directly onto a 3-D Hough space, we use two different 2-D commutators sequentially.

It must be note that although a 2-D Hough space of and seems to determine the skewed-symmetry axis, the experimental results indicate that false peaks appearing in the space prevent us from finding the true peak. We,therefore, use the - space for filtering at the first stage and, then, use another 2-D parameter (- _ space for selecting the true peak, specifying the skewed symmetry.

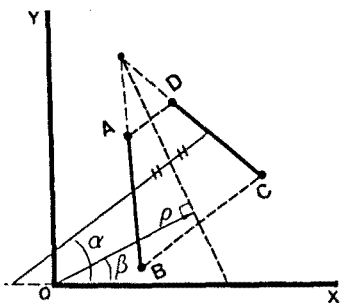


Fig.1. 3 Parameters of skewed symmetry

3, Method

In this section, we describe the detailed method for finding the skewed sy-

mmetry in the image under the assumption that any part of the symmetrical object in space is not occluded.

The method consists of three steps; One fitting line segments to the boundary, Two selction of the candidate pairs for skewed symmetry and computation of their parameters, and three the sequential voting of the parameters onto two 2-D Hough spaces and determining of skewed-symmetry axes by finding the most frequently voted parameters.

Fitting line segments to boundary

Following the boundary of the region detected by binarizing the image intensity, we calculate the curvature at each point along the boundary. We detect the points where the curvatures change abruptly as vertices of the region, and approximate the boundary with directed lines connecting these vertices. Fig.2 shows the results of binarization, the curvature graph, and the vertices detected by the split method 8).

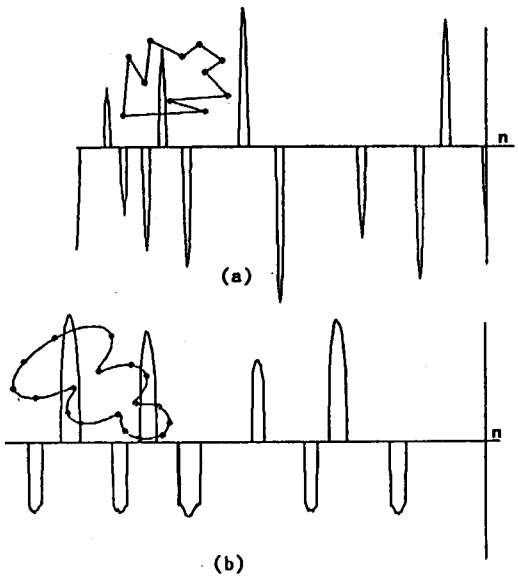


Fig.2. Change of curvature along the boundary and extracted vertices. (a) Polygonal image. (b) Curved image

Selecting candidate pairs for skewed symmetry

If the skewed-symmetry parameters are computed for all the pairs of line segments,then the image of n-vertices can have nC2 possible axes. we can save the computing time if the pairs of the line segments of definitely non-skewed -symmetry are discarded before voting. Let AB and CD be two line segments of which directions are determined by following the boundary counter clockwise. These segments are skewed-symmetrical if AD and BC are parallel (see Fig.1) This condition is discard pairs unqualified for the skewed symmetry if the boundary is a polygon . For the curved boundaries, the results are sometimes unsatisfactory, because of the instability in fitting the line segments to them. We, therefore, use a less severe condition that the pair is unqualified if the intersection of AD and BC exists in□ ABCD as shown in Fig.3.

For the qualifid pairs, we determine the skewed-symmetry axis as passing through the intersection O of AB and CD as shown in Fig.4.αs and βs determined from both AD and BC are voted to Hough spaces.

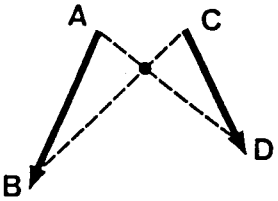


Fig.3. The line segment pair of definitely non-skewed-symmetry.

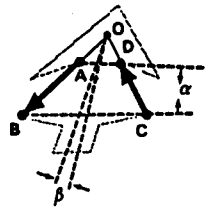


Fig.4. Allowable range of parameters.

4. Experimental Results

The performance of the above-mentioned method are investigated using real images.

Polygonal image

Fig.5 shows the histogram of a voting for example a polygonal image of taken by a TV camera. The hishest peak has very high frequency and is easily detected. Extracted axes are shows.

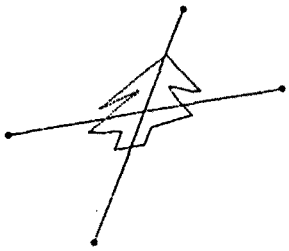


Fig.5 Extracted axes of histogram of polygonal image.

In the case of the image which has plural axes like a quadrangle, even though the frequencies of parameter pairs were not the same for all axes because of smoothing, we could detect all of them by variable thresholding (Fig.6)

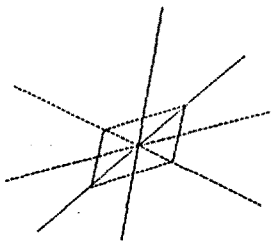
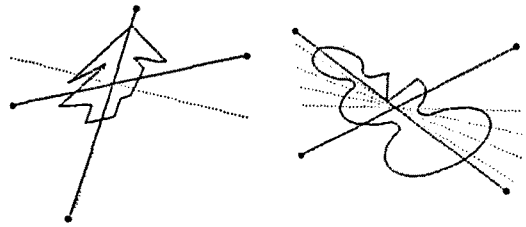


Fig.6 Extracted axes of Quadrangle

Occluded image

we test the robustness of the method using images occluded partly. For the polygonal image (Fig.7-a), the peak value is smaller, but the axes are extracted if no more than a quarter of the vertices is occluded. For the curved image(Fig.7-b), peak value also is smaller as in the case of the occluded polygon, and more false axes appear in ρ-β space than the image without occlusion.



(a) (b)

Fig. 7 Experimental results of the occluded images. (a) Polygonal and (b) Curved images

5. Conclusion

In this paper, we have presented a new method for finding the skewed symmetry in the image. To find the skewed-symmetry axes, we use two 2-D Hough spaces sequentially instead of a 3-D hough space, and consequently, we can save computing time and memory space. At first, we approximate the image's boundary with line segments. The parameters of skewed symmetry between all the pairs of line segments are then computed. Finally, computed parameters are voted onto two 2-D Hough spaces sequentially; ρ-β space for filtering and α-β space for extracting the true axes of skewed symmetry. This method can be used to find multiple axes, and is robust to the partial occlusion of the pattern.

References

1) Han Sik,L &Oh, "The measurement of vision system for many linelike object" The summer con of KIEE, pp.469-472, 86.7.10

2) Takeo Kanade:"Recovry of the three-dimensional shape of an object from a single view", Artificial Intelligence 17,pp.409-460 (81)