Stereoscopic Vision for A Rotating Spherical Object Covered with A Smoothly Varying Surface

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One of the first method that occurs to one who wants to get three-dimensional information of object(depth) is we use the difference between the images in our left and right eyes to judge depth. Two cameras, or one camera from two positions are pararel and separated by a distance(baseline) used to obtain a image pair with difference viewpoint. We can obtain information three-dimensional depth of image by calculate disparity between the two images. But one of the most difficult problems in stereo vision is identifying corresponding points in two images. As Okutomi[1], the distance between a pair of cameras(baseline), greatly affects the accuracy and error rate of the correspondence process. Fujii[8], describe matching using Dynamic Programming. Grotch and Roese describe stereoscopic images based on rotations[7]. So far the researchs were concerned with stereo vision mostly stereo matching for calculating disparity between the two images and estimating motion of camera and structure from correspondences of points between two perspective images. But the methods are stereoscopic vision using plural camera and when difficult to establish view angle of plural camera like observation satellite, we can not use the methods. There are two way to produce stereoscopic images, the first way uses plural fixed camera with difference visual angle, the second way moves single camera or fixed single camera by rotate an object. In the case of binocular stereo, when difficult to establish view angle of plural camera like observation satellite, we use single camera by move it in an orbit or fixed single camera by rotate it an object. In such a case, for the rigid object, because as long as the camera was moving or the object was rotating, the shape of object doesn't change and we can display accurate stereoscopic images. But for the case of spatiotemporal-varying objects, the errors which are occured between the image pairs cause lose the stereoscopic effect in the image.

In this paper we present a method to correct errors between the image pairs which are caused by spatiotemporal-varying surface of object. Using the corrected image pairs we calculate three-dimensional depth image. In this method first we make a model of rotating spherical object covered with smoothly varying surface by Computer Graphics(CG), and build image pairs which are taken at difference time and difference rotation angle. Here we assume rotating spherical object as observation object and use single fixed camera to get stereo image pairs. Finally we treat X ray solar images which are taken from observation satellite "Yohkoh" as real images.

This paper is organized in the following way :

- Modeling of rotating spherical object and deformation its surface.
  We know that there are rigid object and non rigid object in the real world. In the case of rotating non rigid spherical object, because image pairs was taked using single fixed camera, we can not display stereoscopic in the varying part of spherical object. For this reason, in this research we form the background of X-ray solar image is obtained from X-ray observation satellite "Yohkoh" to modeling of spatiotemporal smoothly varying spherical object. We modeled motion of sphere's surface as magnification-reduction and translation which form background of motion of solar's corona. We also suppose motion of object's surface is spatiotemporal smoothly and not include the discontiuous motion. The deformation like extinction, immediately occur, complicated change and illumination's effect do not exist. The details are given in section 2.

- Using Morphological processing to correct stereoscopic errors in the image pairs.
  As the above-mentioned, in the case of non rigid rotating spherical object occurs miss matching in the varying part of sphere's surface. When we display stereoscopic image, it's also can not look solid in the part of varying sphere's surface. For this problem, we use morphological processing(erosion, dilation) to correct errors in the image pairs. We do correcting by select suitable structuring element(mask) depend on shape of the surface. We decide the number(times) of dilation, erosion processing and type of structuring elements by SSDA(Sequential Similarty Detection Algorithm) pattern matching. Concerning the masks of erosion and dilation are detailed in section 4.

- Pattern matching for deciding correspondence between the image pairs.
  To correct the image pairs, do several times of dilation, erosion processing using combination variety of structuring elements. We decide the number(times) of dilation, erosion processing and combination of type of structuring elements by SSDA pattern matching. We do correspondence between the image pairs which are taken difference time by select an ordinary the most suitable size of template. In this research, 3×1 pixels size of template was used. The details are given in section 5.

- Apply this method for real image(X ray solar images were taken from observation satellite "Yohkoh").

In the last, we apply the metod to display stereoscopic real image((X ray solar images were taken from observation satellite “Yohkoh”) in computer’s display and observe it using Liquid Crystal Shutter Systems. Then evaluate availability this method.

The next question is : can we improve the precision of image pair for build the accurate stereoscopic image ?

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