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Comparative Study between Rectangular Windows and Circular Windows Based Disparity-Map by Stereo Matching

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Abstract— *Stereo matching is the basic problem to achieve human like vision capability to machines and robots. Stereo vision researches produced many local and global algorithms for stereo correspondence matching. There are two popular methods one is rectangular window-based cost aggregation another is circular window-based cost aggregation used for solving correspondence problem have attracted researches as it can be implemented in real time using parallel processors. In this paper we have done comparative study between rectangular windows and circular windows based disparity map by stereo matching. Motivated by human stereo vision, the technique uses to enhance the strategy of finding the best match to compute dense disparity map. Performance of the both method is efficient.*

Keywords— Disparity map, Stereo correspondence, Stereo Vision.

I. INTRODUCTION

It has been established that the depth can be recovered from stereo pair images of the scene taken from slightly different known viewpoints using principle of triangulation. The fundamental basis for stereo vision is the fact that a single visible three dimensional physical location of a scene is projected to a unique pair of image locations in two observing cameras. As a result, given a stereo pair images, if it is possible to locate the image points that correspond to the same physical point in the scene, then it is possible to determine its three dimensional location[1]. The recovery of image points depth permit the recreation of a three dimensional model of the scene from 2-D images.

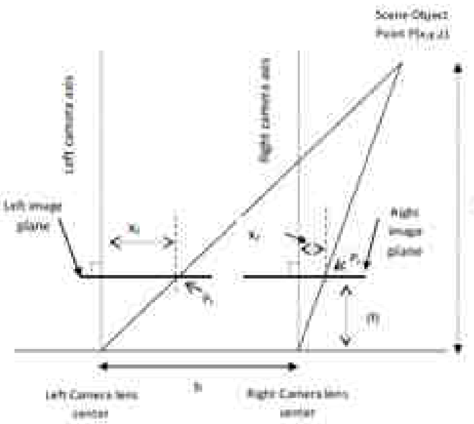


Fig.1: Depth estimation from a stereo system

Where,
b = the baseline distance (distance between the axis of two cameras),
f = focal length of the cameras,
z = depth to be computed and
d = xl - x_r r is the calculated disparity
x_l = Location of point projection in left image from left camera axis
x_r= Location of point projection in right Image from right camera axis

Stereo correspondence algorithms are classified as local, global methods and hybrid methods. In local methods pixels in a small Circular window surrounding pixel of interest are used whereas global methods use complete scan lines or the entire image. In case of hybrid methods local or global method is used at various stages. Global methods offer excellent performances but are computationally expensive and do not meet real time requirements and cannot be implemented on parallel computers. On the other hand, the local methods are simple and fast but do not produce good results.

Local stereo matching typically operates on a rectangular Circular window that is shifted on the corresponding scanline in the right image to find the point of maximum correspondence. The choice of an appropriate Circular window size and correlation functions are important for accurate disparity determination. Small Circular window do not capture enough intensity variation to give correct result in less-textured regions. On the other hand, large Circular window tend to blur the depth boundaries and do not capture well small details and thin objects.

Motivation of the present paper is the process of image formation in actual pinhole camera. The aperture size of an actual camera is of some finite circular window size contrary to the ideal pin-hole camera. Due to this noise and error are projected as a circular window spot instead of a rectangular region on image plane. Since effect of aperture is circular window it is proposed to use circular window Circular window in place of rectangular Circular windows as used by the previous researchers. Further, biological model of stereo vision seems to be better approximated by using circular window shaped Circular window.

In this paper a local method that uses a circular window and rectangular window surrounding the pixel of interest is proposed. This method significantly improves the computation time and results compared to the rectangular Circular window based algorithms.

Disparity Computation

The left image is taken as a reference image and circular is shifted over the disparity range in the right image. The aim is to find out the best match for the left image coordinate *(x,y)* in the right image over the disparity range.

The computation of the disparity using circular uses intensity values of the images within a finite Circular. For the matching procedure, various block

$$c(x, y, d) = \sum^{n/2} \sum^{n/2} (I_l(x+i, y+j) - I_r(x+i-d, y+j))^2$$

Where I_l and I_r are the left and right image intensities respectively, d is the disparity, it ranges from d_{min} to d_{max} in the right image. The computed disparity D at *(x,y)* is given by equation (3) .

$$D(x, y) = \min_{d=d\,\min\,.d\,\max} (c(x, y, d)) \quad (3)$$

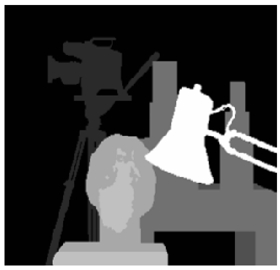
II. METHOD OVERVIEW

In local method the search for pixel correspondence between the two images of a stereo pair is normally done by comparing the surrounding regions of the examined pixel in place of pixel alone. Normally a window of fixed size (also called support window) and a similarity criterion, a measure of the correlation between windows in the two images, are used and the corresponding element is given by the window that maximizes the similarity criterion within a search region. The correspondence problem may be solved by selecting a support window that vary in shape, size and could be either fixed or adaptive.

The rectangular window is most commonly selected support window by researchers because of its easy implementation. In the proposed method the correspondence problem is solved by considering a circular window for cost aggregation in two rectified image pair. An inscribed circular window with diameter n is made out of *n* x *n* square window as shown in figure (2). The centre of the circle is the pixel of interest and only pixels inside the circle are used for the cost aggregation. Disparity refinement- A median filter with a 5x5 rectangular Circular is used to smoothen out the disparity map.

(a) Left image

(b) Right image



(c) Ground Truth Image

(d) Estimated Disparity Image

(e) Estimated Disparity Image

Fig. 2: (a) Tsukuba left image (b) Tsukuba right image (c) Ground Truth Image (d) disparity map using Rectangular window (e) disparity map using circular windows

Table.1: Computational time with Rectangular window based and circular windows based method.

Disparity Estimation Method	Window size	Computation time (second)	Disparity (%)
Rectangular Window Based	5x5	43.531	21.13
Circular Windows Based	5x5	33.342	17.21

III. DISPARITY COMPUTATION ALGORITHM

The input to the algorithm is a rectified stereo images I_l and I_r , circular Circular size and disparity range *d*. The algorithm performs the following four steps.

a. Matching cost computation-The matching cost is the squared difference of intensity values at a given disparity
b. Cost aggregation- aggregation is done by summing matching cost of all the pixels within circular .
c. Disparity computation- disparity is computed by selecting the minimum aggregated value at each pixel in the disparity range.

IV. CONCLUSION

In this paper a both approach has been presented that uses to compute dense disparity map. The algorithm has been tested on benchmark stereo images show that the circular windows disparity computation methods perform better than rectangular window based disparity computation.

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