AN IMPROVED DISPARITY MAP ESTIMATION BASED ON GRADIENT METHOD

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Abstract
Disparity map generation is used in many 3D applications. This paper focuses on improved stereo matching technique that improves the efficiency by using wiener filter for pre processing, gradient information is used for cost computation and guided filter is used for disparity refinement. The results show the improvement in disparity map produced by method used in this paper.
Keywords: Disparity; Gradient; Wiener

I. INTRODUCTION

Stereo matching plays an active role in the computer vision field [1]. Disparity map estimation is a very challenging task. Disparity map obtains the change in the projection of the pixels by correlating the left image and right image [2-5]. The various problems encountered in disparity map estimation are depth discontinuities and occlusion. Stereo matching algorithms are broadly divided as local stereo matching and global stereo matching. Global method uses energy function to find disparity map. Local method uses local features such as intensity, gradient. Global methods compute accurate result at the cost of time in execution where as local methods have fast execution time but do not provide accurate result. Thus, this paper mainly focuses on enhancing the accuracy of local method. The following steps are generally used in local method. They are computation of cost, aggregation of cost, computation of disparity and disparity refinement. Further pre processing step is used which is optional. The proposed method uses the above four steps along with pre processing step. Few existing pre processing approach are Bias–gain and histogram equalization. The method in [6] used the background subtraction to compensate radiometric differences. Cost computation is used to compute the cost of each pixel. Several cost measurement is used in the previous years. The commonly used cost measurements are squared differences, absolute difference of sum and normalized cross correlations. These methods are sensitive to noise. Median filter, Laplacian of Gaussian [7] are used to reduce this effect.

Nonparametric methods like rank and census transform, algorithms based on wavelet [8] were implemented because they performed better near the object boundaries. Methods proposed in [9, 10] used cost estimation that is robust to illumination difference. Cost aggregation can be window based [11-12], segment tree based [13]. Disparity refinement is performed to get better result. Several approaches like region voting, vertical voting is used for disparity refinement.

In this paper, the stereo pairs are preprocessed using Wiener filter. To obtain the disparity value the gradient information is used. This disparity map is post processed by means of a guided filter to get the final disparity map

II. PROPOSED ALGORITHM

The flow chart of the technique proposed in this paper is as follows

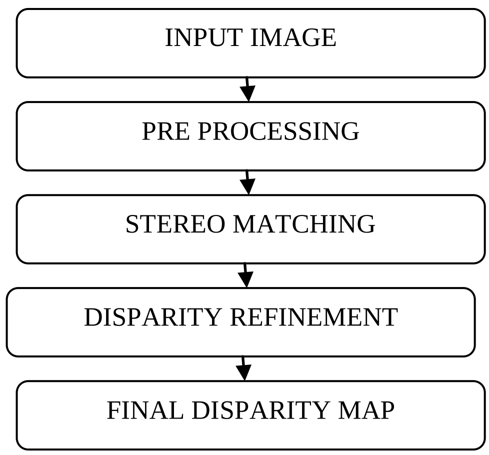


Fig. 1. Flowchart of technique proposed

A. *Pre processing*

The standard images from the Middlebury dataset are considered for implementation. The pre processing step is performed using wiener filter. This filter helps in deblurring of the images that are caused due to linear motion or error in optical focus. The Wiener filtering executes tradeoffs amongst inverse filtering and smoothing of noise. It reduces any added noise and the blurring is inverted at the same time. This filter gives optimal results based on mean square error. It tries to minimize the entire mean square error during the time of noise smoothing and inverse filtering.

B. *Stereo matching*

This step determines whether the corresponding pixels represent the same point in the image scene. This matching cost is calculated for all the pixels of the image under consideration. The proposed method uses block matching. For every pixel that is present in the left image we will consider a window centered at the pixel. This window is compared with the corresponding window in the right search image. The closest matching window of pixels in the right search image is found. Here gradient feature is considered. Gradient contains a lot of structural information, and it is also not sensitive to illumination. The cost computation based on the gradient value is as follows

$$SDG(x,y,d) = |Gl(x,y) - Gr(x-d,y)|^2 \quad (1)$$

Here Gl(x, y) and Gr (x-d, y) is the gradient value of the left image and right image respectively.

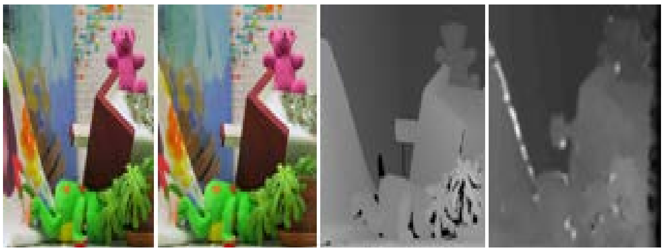
The computed cost is aggregated which is important for finding the performance of a disparity map. It is done to reduce any matching uncertainties. The details got for an individual pixel in matching cost computation is not enough for accurate matching. Here the matching cost is aggregated by summing them over a square window. Here we sum up squared differences of gradient value. To compute the initial map winner-takes all strategy [WTA] is used for disparity optimization. This method generates disparity at every pixel by selecting the lowest aggregated value disparity. Here the optimal disparity based on gradient value is chosen. This produces initial disparity map.

C. *Disparity refinement*

The disparity refinement stage is performed to decrease noise and hence enhance the quality of the disparity maps. The proposed method uses guided filtering for this purpose. It is a filter that preserves edge and it is not affected by the gradient reversal problem that is seen in bilateral filter. It performs well at the pixels close to the edges than the bilateral filter. By using the information in the guidance image, the output image preserves the edges. The output obtained is more structured than the input image. Here the left image is used as the guidance image. This fast and non approximation characteristics of linear time algorithm that is ideal for real time application.

III. EXPERIMENTAL RESULTS

The results are analyzed using the images taken from Middlebury dataset [14].Here the images such as Teddy and Baby are chosen. Results obtained are shown in Fig. 2.



(a) (b)

(c) (d)

Fig. 2 Results of images Teddy, Baby . (a) *Input left* image, (b) Input right image, (c) Ground truth image (d) Disparity Map

Percentage of bad matching pixel (PBMP) is used for the quantitative analysis of the result.

PBMP is a metric used to analyze the goodness of the disparity map. PBMP is obtained using the following formula

$$PBMP = \frac{\left[\sum_{x,y} dt(x,y) - dg(x,y) > \delta\right] * 100}{N} \quad (2)$$

Here N determines the total pixels. dt and dg represents the disparity map of the method proposed and ground truth image respectively. Here δ is the threshold error. Here threshold error is taken as1.

Lesser PBMP value, determines good quality disparity map.

PBMP values obtained by gradient method and proposed method are given in Table1. We find the PBMP in the proposed method is comparatively less than the gradient method

Table 1: PBMP

	Gradient based	Proposed Method
Teddy	1.4160	1.4099
Baby	0.1953	0.13580

IV. CONCLUSION

In the paper, an improved stereo matching method based gradient information. First the input image is pre processed using wiener filter, then disparity map is generated . The initial disparity map id refined using guided filter. The experimental results show that the method used in this paper generates disparity map of high quality.

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