Survey on Stereovision Based Disparity Map Using Sum of Absolute Difference

Parvathy B H
M.Tech Scholar
Department of Electronics and Communication
LBSITW, Poojapura, Trivandrum

Deepambika V A
Assistant Professor
Department of Electronics and Communication
LBSITW, Poojapura, Trivandrum

Abstract—The present paper provides the recent trends in stereovision based disparity map algorithm using sum of absolute difference. There are so many modifications in the original SAD algorithm for performance improvement. Some of them obtain the disparity map with higher accuracy and less computational complexity. From the SAD algorithm matching cost is computed, by aggregating the sum of absolute differences. Here algorithms based on disparity map using SAD are reviewed.

Keywords—Stereomatching, Disparitymap, FPGA, Stereovision.

I. INTRODUCTION

Stereovision means imitating binocular vision. Stereovision provides 2D to 3D reconstruction of an image. Stereo matching is a sub problem of stereo reconstruction. The various challenges in stereo matching occurs at depth discontinuities, low textured regions and occlusions. Stereo matching using SAD is still a challenging task in practical applications. The applications include motion estimation, object tracking, medical applications, and video conferencing [3].

II. SUM OF ABSOLUTE DIFFERENCE

SAD takes every pixel in a block. It takes the sum of absolute difference intensity value of the left image and its candidate disparity.

$$SAD(x, y, d) = \sum |I(x, y) - I(x-d, y)|$$

$I(x, y)$ -intensity value of left image
$I(x-d, y)$ -intensity value of right image
d -Disparity

Disparity means the horizontal displacement between the left image and right image. Depth map is also called disparity map.

$$Z = f\,b/d$$

z- Depth
f- Focal length of the camera
b- Distance between the camera centers

The depth is directly proportional to the focal length of the camera and the horizontal diaplacement. Different types of camera are used for image capturing, like stereo camera, dynamic vision sensor etc... After finding the depth map reconstruction of the 3D information involves several post processing steps like disparity refinement, rectification etc. Application specific architectures based on SAD along with other methods improve the accuracy in depth map. Mostly used methods make use of SAD, with some modifications, which also improve the performance.

III. REVIEW

In 2013, D.V Manjunantha et.al used SAD to detect motion in the video subsystem. Power efficient 4x4 and 8x8 SAD architectures are used. This is implemented using FPGA platform. 4x4 SAD proves 29%, 63.23% and 61.31% improvement in leakage power, dynamic power and total power respectively as compared with that of 8x8 SAD is 57%,46.16 and 46.78%.[1]

3D video application is becoming popular in our daily life because of its use in home entertainment. It is necessary to convert 2D video to 3D video because of its various applications in image analysis. The conversion algorithm makes use of depth cues to generate depth map. These types of algorithms can be classified into two groups, supervised algorithms and unsupervised algorithms. Supervised algorithms make use of a human operator whereas unsupervised algorithms are purely automatic. In the former output is dependent on the input. In the latter case output is independent of the input. Here, reconstruction of depth map is performed based on hybrid segmentation algorithm. It uses SSD and SAD to find depth map. SAD was used in this work since SSD requires double time. Along with Mean Shift algorithm and Belief propagation provide accurate segmentation.[2]

Sum of Absolute difference calculation is one of the most difficult and time consuming operation. SAD can be used to simplify such complicated problems .In 2017 Bianca Silveria, Guilherme Paim, Brunno Abreu developed a SAD hardware architecture for HD videos (1920x1080). This architecture reduces power dissipation by 25.5%. The encoding capability in real time for HD (1920x1080) videos is at 30 frames/sec. [3]

During 2013, Suyog Patil et.al implemented the cost aggregation method using SAD, SSD, ZNCC using MATLAB, and SAD is the ideal choice for implementation using FPGA. The window size used for SAD was 3, 11, 25; SAD perform well with larger window size.[4]

In 2014, Chirag S.Panchal et.al, used SAD for disparity map calculation. They evaluated the system with mean square error (MSE) and peak signal to noise ratio. The disparity map obtained from Teddy and Book dataset have MSE 76, 91 respectievely, PSNR value 29.32 and 28.54 respectievely. The time taken to obtain the disparity map using BOOK dataset was 5.8839s.[5]

In 2013 Xiang Zhang and Zhang wei Chen et.al SAD-based stereovision machine on a system-on programmable-Chip architecture implemented in a FPGA chip. It consists of 32-bit Nios ii microprocessor, having a soft IP for managing the image buffer and user's data. The dense disparity map using SAD was built in MATLAB-based DSP builder. This machine system focuses on real time stereo vision applications. FPGA hardware, uses 90MHZ clock, 23 frames of 640x480 disparity maps produced in one second having 5x5 matching window and maximum 64 disparity maps.[6]

In 2017, FPGA based video applications using SAD was developed by DV Madjunatha et.al. The template image and search image of 4x4 was given to the SAD processor the similarity of SAD was obtained from a comparator. The main problem in real time coding applications is higher computational complexity. To overcome this heavy computational complexity low power implementation of 4x4 SAD in FP GA and ASIC was designed. In FPGA design reduction in power, area and speed was achieved by 4x4 SAD.[7]

IV. CONCLUSION

Most of the hardware implementation used SAD for obtaining dense disparity maps. Compared to other methods SAD is the simplest one for the use in real time applications. All the other methods like Mutual information and Census transform are work under various radiometric and illumination conditions. The major drawback of other methods is very bad occluded areas in dense disparity map. This is usually found during hardware implementation. There is always a tradeoff between time and speed in most of the algorithms. SAD is the one which is most appropriate one used in many of the real time situations.

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