2D to 3D Image Conversion Using Segmentation Approach

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Abstract: Our lives continue converging with an advancing innovation, which keeps progressing and changing our society. The recent development of 3d innovation brings about highly realistic and immersive resolution visuals as the resultant stereoscopic image provides a perception of the depth. The primary motivation behind the 2D-to-3D image transformation is to create the second view picture of an input 2D image that feels intentional. Conversion includes two procedures to be specific namely, the depth estimation of the given input image and the depth image-based rendering. The depth estimation from an image is a very computationally intensive process and a more challenging procedure. Depth estimation methods are been formulated into conventional and semi-automatic approaches. Conventional methods, where no human intervention is needed and an automatic computer algorithm estimates the depth for a single image, however, has not accomplished the level of quality. Therefore to accomplish a superior quality stereoscopic image, a hard segmentation algorithm is been proposed for calculating a better depth map that is fast and strong in preserving the edges. Furthermore, Image noise removal is done by using median filtering technique and the cross-bilateral filtering is used which smoothens away the local variations without affecting the strong edges which are especially reasonable for the applications with a 3d stereoscopic display.
Index Terms–3D Image, depth estimation, depth fusion, depth smoothening, image rendering.

I. INTRODUCTION

Over the years, the popularity of the 3D framework is fulfilling the development of high-quality stereoscopic images as the interest for 3D viewing is expanding rapidly. Stereoscopy builds up an illusion of three-dimensional depths from given two-dimensional images. Stereoscopic 3D has been consolidated into several industrial areas and has been made extremely prominent in medical field. Stereo can be displayed in any format including anaglyph for preview purpose. There exist some methods for making anaglyphs using only one image by changing into a 3D picture, called stereo conversion. Anaglyph 3D is the name using filters of different colors, commonly red and cyan. When viewed through the anaglyph glasses, each of the two images reaches the eye revealing a stereoscopic image. 3D glasses are recommended to see the generated anaglyph image. Anaglyph images create a picture with a low cost yet the Color information appears disruptive when used for bright colors. Only few color anaglyph process can reconstruct a full-color 3D images. So, then an auto-stereoscopy is been proposed for enhancing the quality of an image.

An important step in any 3D system is the 3D content generation. The most typical task in conversion is depth estimation from the given input image. Most 3D systems will cut down the brightness of the picture considerably. 2D-to-3D conversion adds the binocular disparity depth to the digital images, thus, if done properly, it enormously enhances the immersive effect. However, in order to be successful, the conversion should be done with adequate accuracy and correctness.

Two methodologies for the stereo conversion are been characterized into conventional and semi-automatic methods [1], [2] for estimating the depth of a given input image. Conventional depth estimation methods, that does not need human help has not created a good quality image in image conversion. So, to accomplish the high-quality depth map as the user alone will provide the input, the proposed methodology uses a hard watershed segmentation estimating the depth map of an image [3], [7].

Depth estimation is the main task of image conversion to produce the second view image based on the structure of the input 2D image. The depth map is a separate grayscale image having the same dimensions as the original 2D image, with various shades of gray. Depth map is a monochromatic image which stores the depth information as 8-bit grey values where a low intensity indicates a far distance and a high intensity indicates a closer distance from the viewer. This depth map is given to the depth image-based rendering for generating a stereoscopic 3d image.

The paper is organized as follows; Section 2 depicts the generation of depth map by means of a semi-automatic 2D-to-3D conversion system with the help of hard watershed segmentation and the Image noise removal is done by using median filtering

and finally smoothening by the cross bilateral filtering technique. Section 3 gives an analysis of the experimental results acquired from the depth map, depth fusion, depth smoothening and the final stereo images.

II. PROPOSED METHOD

This work describes a different approach for 2D-to-3D image conversion.
Figure1illustrates a block diagram of proposed method.

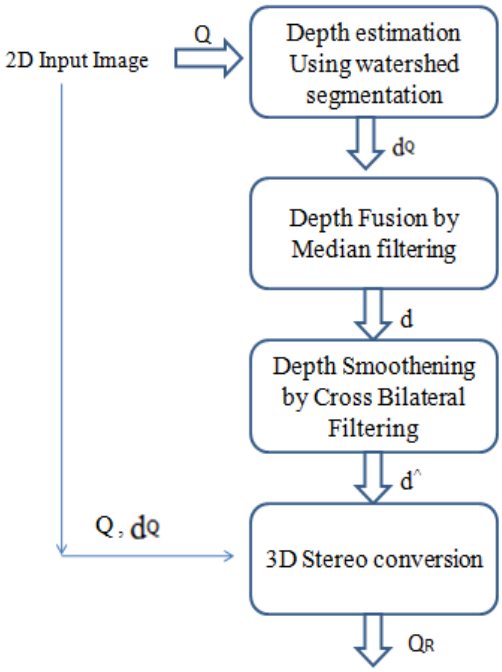

Figure 1 : Block Diagram

Recently, many researchers have been proposed different automatic algorithms for estimating the depth map of a given input query image and for conversion but these methods still have not able to produce a good quality image due to the poor quality of depth image for image conversion. According to[2], 2D image has been directly estimated from the database with the help of KNN search using Make3D and NYU KINECT dataset with poor quality image so to improve the performance,
The proposed method uses a different approach for finding depth map of a query image using watershed segmentation and further new procedure for 3d conversion.
The detailed explanation of the proposed method will be discussed in below sections.

A. DEPTH ESTIMATION

The reason behind 3D image conversion is that it offers a more realistic sense of view to the viewer. The key concept in 2D to3D conversion is depth estimation of a given query image. There are various conventional and semi-automatic depth estimation approaches. Quality of the depth map from automatic methods is low .So, to improve the quality of the depth map; semi-automatic conversion process was proposed to tackle the drawbacks of the automatic approach. Three color segmentation based algorithms namely Random Walks, Graph cuts and Watershed segmentation can be used for depth estimation. Besides random walks and graph cuts, depth map from watershed has the characteristic of sharp object boundary with strong edge preserving technique.

- Steps involved in finding depth map of a query image::

The Watershed algorithm considers 2D grayscale image as a topographical map with mountains of high pixel values and valleys of low pixel values.

1> Before segmentation, the raw image needs to be filtered. First, if the raw image is an RGB image, it should be converted to grayscale intensity image. All subsequent segmentation operations are performed on the gray image.
2> Use a Morphological top-hat operator which is a background subs tractor that is used to smooth out the uneven illuminations .Then the filtered image needs to be threshold saying the pixels in the darkest group belong to the watershed background.

3> Compute the distance transform of the complemented filtered image so that objects are dark on a light background. All the background pixels are then set to the same low elevation, so they will collect into one catchment basin that is later discarded.

4> Finally, compute the watershed transform on the filtered image and fill the segmented regions using the morphological operators.

The resultant depth map can be shown in the below results section.

B. DEPTH FUSION

- ✓ Once the depth map has been estimated the filtered image may be noisy. Hence, Low pass filtering is employed to remove the high spatial frequency noise from a digital image.
- ✓ A Median filter is more effective than convolution to remove the impulse noise and it is also widely claimed to be an 'edge-preserving' since it theoretically preserves the edges without blurring.
- ✓ However, in the presence of noise it does blur edges in images slightly.
- ✓ The basic premise behind the median filtering is that it is a sliding window spatial filter which replaces the center value in the window with the median of all the pixel values in the window as the result keeping edges well maintained.

The resultant fused depth map can be shown in the below results section.

C. DEPTH SMOOTHENING

- ✓ Since the resultant fused image is not smoothed and which is incoherent to the query image, [8] Cross bilateral filter is been applied.
- ✓ The Cross Bilateral filter is a non-linear filter which is a well known edge preserving image that smoothes the images and the level of that smoothness is applied to a pixel constrained by a photometric weight.
- ✓ It is an edge preserving smoothed output results the image in red.
- ✓ Cross bilateral filter is applied on the fused image to achieve the two main goals :

-To remove the misalignment of the edges and to suppress the noise.

The resultant smoothed depth map can be shown in the below results section.

D. 3D STEREO CONVERSION

- Steps that are involved in finding the stereo image are as follows ::

1. Convert rgb2gray images and compute the averaging between the input, fused image and the smoothed image since the averaging is replacing each pixel value in an image with the average value of its neighbors as this is used as a convolution filter for smoothening.
2. For better visualization, gray images are been enhanced using image adjust, histogram equalization and the adapt histogram equalization.
    - In image adjust; the image intensities are basically stretched to fill the entire range. Visually, we observe the dark pixels turn to black and white in brightest pixels.
    - In histogram equalization; it modifies the histogram to keep it uniform. The contrast is being improved and generally used for foreground detection.
    - Adapt histogram equalization operates on small local regions of the image. Contrast enhancement is limited in order to reduce the noise. So, adapt histogram equalization is been considered as it operates even on the local regions.
3. Finally, compute the Stereo disparity and create a composite image out of the two images left image as a red image and the right image as a cyan image on top of one another.
   Therefore, in the disparity map, the brighter shades represent more shifts and are at a lesser distance from the point of view .The darker shades represent lesser shift and therefore greater distance from the point of view.

III. EXPERIMENTAL RESULTS AND DISCUSSION

At first, the most challenging step that needs to be considered before stereo conversion is to estimate the depth map. Many researchers have used various methodologies in finding depth. Depth map has been estimated directly from the database with the help of KNN search results a poor quality depth map [2].

Figure 2: Input 2D image

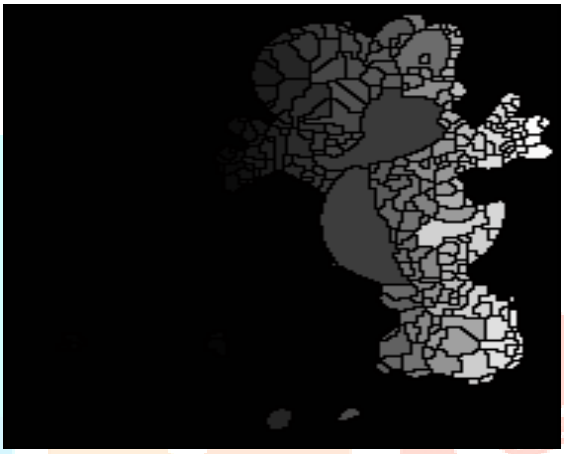

Figure 3: Depth estimation using watershed segmentation

The main problem with this method is that the images are often noisy and leads to an over-segmentation because of the local minima so then it can be minimized using the height threshold value for suppressing the shallow minima and morphological operators are been applied to fill the regions. As observed, none of the depth pairs match the query image accurately and hence the median based fusion is used to make the depth map more consistent.

The fused depth map in turn, often results in lack of edges and smoothness where sharp boundaries should occur and hence Cross bilateral filtering, an edge preserving image smoothing method is applied. The level of the smoothness applied to an image is by a photometric weight, which can be obtained from the same image to be filtered. The photometric weight incorporates the information from an image to be filtered which makes the proposed filter an efficient and effective tool for image smoothing. Fig 4.shows the smooth aligned generated final depth map.

Figure 2 : Final Smoothed depth-map

In order to generate the final stereo image, at first the generated depth map, smoothed image and the input images are been averaged replacing each pixel value in an image with the average value of its neighbors resulting an average image. Secondly, to enhance the gray scale images perform the adaptive histogram equalization to avoid the noise that might be present in the image to limit the contrast. Finally generate a stereo image by taking two images left and right as the input query image and the image from adaptive histogram equalization. Figure 5 shows the proposed stereo image for the given input.

Figure 3 : Stereo image

To better understand the proposed methodology, an heritage site is also been synthesized justifying the generated stereo image from the query input image and the results are shown below.

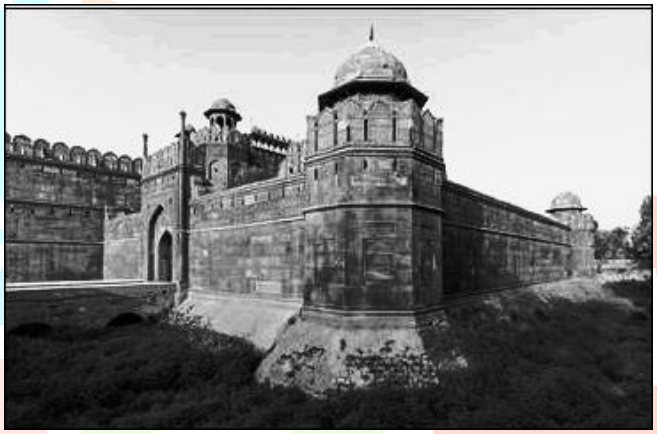

Figure 4 : Input image

Figure 5 : Depth-map from Watershed segmentation

Figure 6 : Final Smoothed depth-map

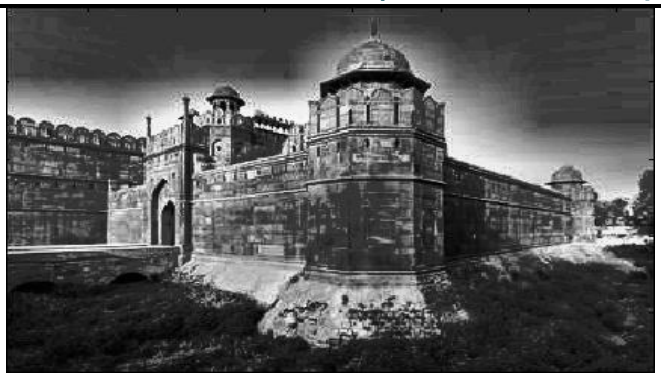

Figure 7 : Stereo image

IV. SUMMARY

Many algorithms have been developed in the last few years for conversion which are less complex. Depth estimation is the key step for image conversion. For high quality and accurate 3D output the depth map should be reliable so in this paper, a simple segmentation algorithm has been proposed for depth map estimation. The depth map is a very significant cue and hence it is necessary to extract it for conversion. Finally, the stereo pair generation is done to get a 3D output and it is observed that the accuracy of the result has been improved.

V. REFERENCES

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