세그멘트 평면 추정을 이용한 깊이 지도 개선

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Depth Map Refinement using Segment Plane Estimation

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요 약

Depth map is the most common way of expressing 3D space in immersive media. In this paper, we propose a post-processing method to improve the quality of depth map. In proposed method, a depth map is divided into segments, and the plane of each segment estimated using RANSAC. In order to increase the accuracy of the RANSAC process, we apply matching reliability of each pixel in depth map as a weighting factor.

1. Introduction[1]

As VR technology advances, interest in immersive media is increasing. To produce immersive media, a way of expressing 3D space is needed. Depth map is the most common way of expressing 3D space in immersive media. Thus, it is important to acquire a high-quality depth map to improve the quality of immersive media.

In this paper, we propose a post-processing method to improve the quality of depth map. This proposed algorithm divides image into segments and estimates each segment's plane. Following to estimated segments' plane, we adjust each pixel's depth value.

This paper consists of five section. In section 2, we introduce about depth map and super-pixel segmentation. In section3, we introduce about our proposed method. In section 4, we show our algorithm's experimental results.

2. Related Works

A. Depth map

Depth map is an image that express distance between camera and the scene captured at camera viewpoint. In general, depth map is calculated from disparity calculated by stereo matching. This process can be divided into 4 detail processes, each (a) matching cost computation, (b) matching cost aggregation, (c) disparity optimization, (d) post-processing.

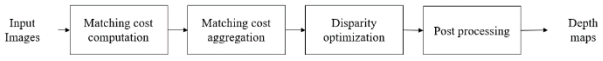

Figure 1. Block diagram of depth map estimation

B. Super-pixel segmentation

Super-pixel segmentation is a technique in which grouping similar pixels together. This technique was first proposed by Xiaofeng Ren and Jitendra Malik[1] in 2003.

So far, several super-pixel segmentation methods have been proposed, which can be categorized into graph-based and clustering-based. Typically, Mean Shift, SLIC(Simple Linear Iterative Clustering) methods are used for super-pixel segmentation. Murong Wang et al[3] evaluated 15 super-pixel segmentation algorithms in their paper.

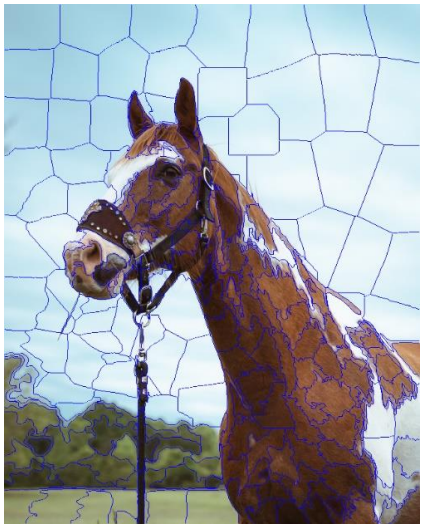

Figure 2. Example of super-pixel segmentation using SLIC method.

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3. Proposed method

The proposed algorithm is as follows: (a) Depth map segmentation, (b) plane estimation using RANSAC, (c) apply plane formula to segment. General block diagram of proposed method is shown on Fig. 1.

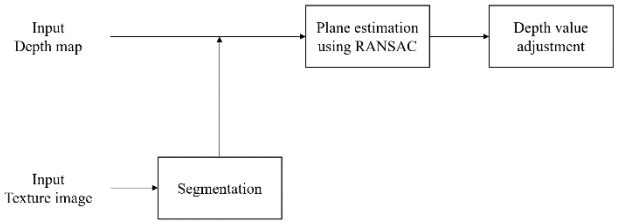

Figure 3. Block diagram of proposed method.

We assume that each pixel's stereo matching cost has been calculated in depth estimation process and normalized.

First, we calculate super-pixel segmentation label with texture image of depth map. Then we calculate plane of each segment using RANSAC. When calculating distance between estimated plane model and each pixel, we multiplied weight factor w calculated from pixel's matching cost. w is calculated as follows.

$$If(1=<c)\ w=1 \tag{1}$$

$$If(c_{min}<c=<1)\ w=\left(\frac{1-w_{min}}{1-c_{min}}\right)*c+\left(1-\frac{c_{min}}{w_{min}}\right) \tag{2}$$

$$If(c=<c_{min})\ w=w_{min} \tag{3}$$

And then we adjust all pixels in segment following to estimated plane formula.

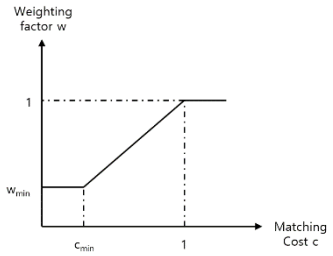

Figure 4. Graph of Matching cost c and weighting factor c

4. Experimental Results

We used middlebury 2003 dataset [4] for experiment. Proposed algorithm was implemented into C/C++ platform. We used MSLIC method for super-pixel segmentation which is implemented in OpenCV version 3.4.7. We set w_{min} = 0.7 and C_{min} = 0.7 to calculate weighting factor. Result is shown on Fig. 5.

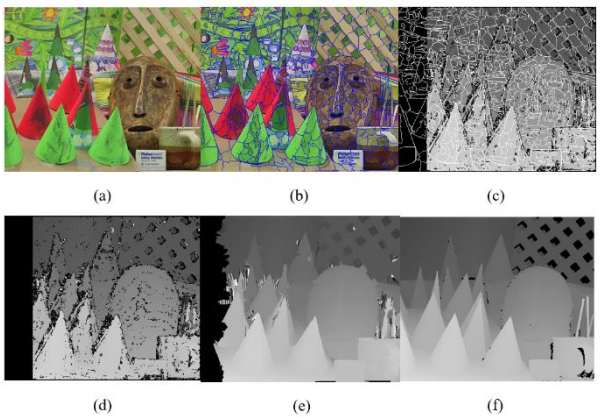

Figure 5. (a) texture image(left) , (b) divided texture image, (c) divided depth map, (d) result depth map using conventional method, (e) result depth map using proposed method, (f) ground truth.

5. Conclusions

In this paper, we proposed new method for depth map quality improvement. This proposed algorithm was processed in segments using super-pixel segmentation and calculated the segment's plane by RANSAC under the assumption that each segment can be represented as a plane. To enhance RANSAC's accuracy, we applied pixel's matching reliability as a weighting factor

We presented the result using proposed method and compared it with conventional method. The result showed that proposed method filled the hole occurred in conventional method.

ACKNOWLEDGMENT

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