Illumination-Guided Stereo Correspondence

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Abstract

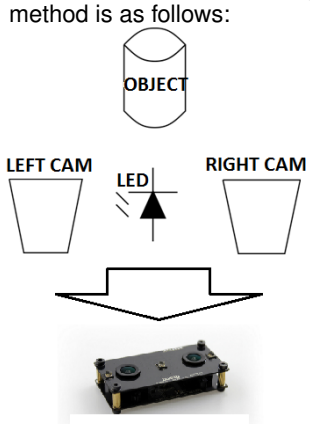
This work implements a method to improve correspondence matching in stereo vision by using varying illumination intensities from an external light source. By iteratively increasing the light intensity on the scene, different parts of the scene become saturated in the left and right images. These saturated areas are assumed to correspond to each other, greatly reducing the search space for stereo correspondence and increasing robustness to erroneous matches. The stereo camera and light source used in this work is the DUO3D camera by Code Laboratories. Visually, experimental results show the resultant point clouds from the proposed method is less noisy with fewer outliers compared to standard block matching method, but produces fewer matches.

1 Introduction

3D imaging technology have seen a dramatic increase in academic and commercial interest. 3D depth information of a scene can help solve computer vision tasks such as segmentation, tracking, navigation, recognition, etc [1]. Industrial applications include automobile design and verification, reverse engineering, and biometrics. Stereo vision is a popular depth sensing method due to its compactness, simplicity, and low cost. However, the acquired depth maps from conventional stereo cameras are generally low quality and low density. As well, robustness suffers from ambient lighting conditions and lack of features in the scene. Hence, this work aims to improve stereo correspondence matching from compact stereophotogrammetric devices by using varying illuminations of a scene. Using active illuminations on the scene, robustness and stereo matching accuracy are increased.

2 Methodology

The Duo3D stereo camera [2] is used and the overall setup and method is as follows:



1. Capture left and right image.
2. Create saturation masks
3. Compute stereo correspondence using saturation mask cues
4. Adjust LED power level
5. Repeat for all illumination levels

Solving the correspondence here is similar to methods using structured light, but instead of using encoded patterns the proposed method uses saturations of the scene. Saturated parts of the scene are presumed to correspond to each other in the left and right stereo images. Figure 1 shows some stereo left and right images with saturated areas.

Using these saturation masks helps reduce the search space for finding correspondences. The cost function is the sum of absolute difference (SAD) with cost aggregation as an averaging filter:

$$d(x,y) = \arg\min_i \frac{1}{N}\sum_k^N |I_L(x_k,y_k) - I_R(x_k+i,y_k)|,\ i \in de_i \pm w \quad (1)$$

where $d(x,y)$ is the disparity value, i is the disparity cost being calculated for starting from the initial disparity guess of the corresponding cluster de_i within a range defined by w, N defines the pixels within the cost aggregation window, I_L and I_R are the left and right stereo images.

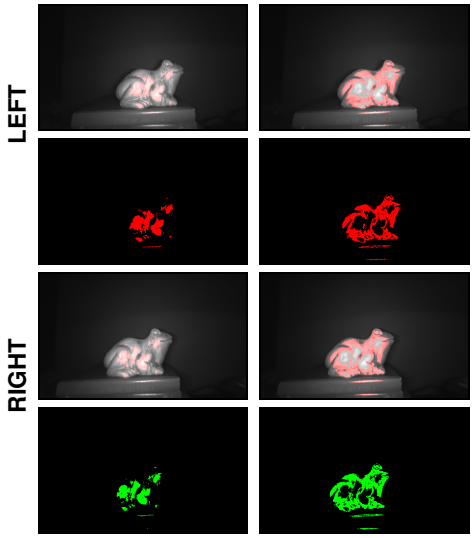


Fig. 1: Stereo images captured with illumination difference of 10% between frames. The saturation masks are overlayed on top of the IR images to show corresponding areas.

3 Results and Discussion

Shown in Figure 2 are preliminary results for the simple correspondence cost matching method. The method is compared against a standard block matching [3] and SAD method with standard images captured by the camera.

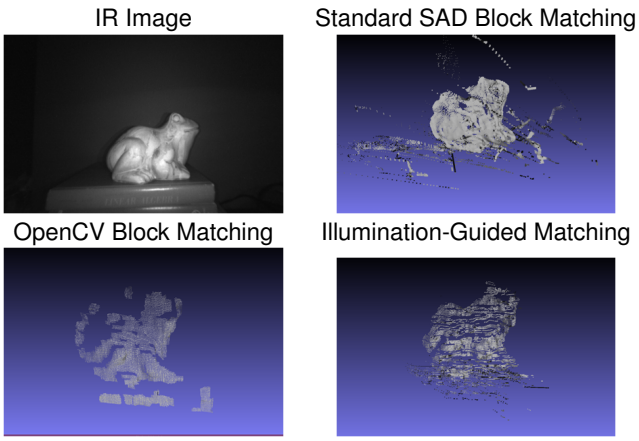


Fig. 2: Resultant point clouds on owl data. The proposed method is seen to be less noisy.

A simple and novel method is proposed to aid stereo correspondence using active illumination. Preliminary results show promise with increased robustness and accuracy. Future work include modelling and compensating the slight distortions between left and right saturation masks.

References

[1] Nalpantidis Lazaros, Georgios Christou Sirakoulis, and Antonios Gasteratos, "Review of stereo vision algorithms: from software to hardware," *International Journal of Optomechatronics*, vol. 2, no. 4, pp. 435–462, 2008.

[2] "Code laboratories inc.," https://duo3d.com/.

[3] "Opencv," http://opencv.org/.