공간 다중레벨 Optical Flow 구조를 사용한 이동 카메라에 인식된 고정물체의 움직임 추정

Spatial Multilevel Optical Flow Architecture for Motion Estimation of Stationary Objects with Moving Camera

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ABSTRACT

This paper introduces an approach to detect motion areas of stationary objects when the camera slightly moves in the scene by computing optical flow. The flow field is computed by two pyramidal architectures of 5 levels which are built by down-sampling the size of the images by half at each level. Two pyramids of images are built and then optical flow is computed at each level. A warping process combines the information and generates a final flow field after applying edge smoothness and outliers reduction steps. Moreover, we convert the flow vectors in order of magnitude and angle to a color map using a pseudo-color palette. Experimental results in the Middlebury optical flow dataset demonstrate the effectiveness of our method compared to other approaches.

I. Introduction

Vision-based motion detection is a challenging area of computer vision. It has a wide range of applications especially in the areas where moving objects are involved, such as video surveillance, pedestrian and vehicular tracking, object detection, etc. Some particular applications might include indoor and outdoor scenarios. However, the high variation in the conditions of real applications makes the motion estimation a difficult task.

Optical flow is the pattern that represents motion caused by objects in a visual scene. Although the results of the recent optical flow algorithms are promising, however, there are still some limitations to deal with: 1) Traditional algorithms can only detect small pixel displacements and are not able to distinguish motion when an object is static while the camera slightly moves in the scene; 2) Discontinuities in the final flow field do not allow to clearly distinguish the edges of the object; 3) Noise severely affects the flow vectors.

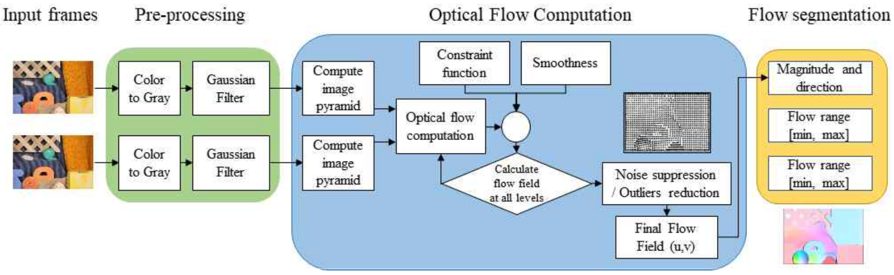
This paper defines a method for optical flow estimation with a especial focus on stationary objects. Therefore, the main contributions of this paper are as follows: 1) We introduce a method for detecting motion of stationary objects in image sequences based on the principle of optical flow; 2) A multi-level architecture that is able to detect different displacements of pixels; 3) We evaluate the performance of our method in the Middlebury Optical Flow dataset and compare our results with other optical flow methods.

II. Related Works

The field of optical flow has been a largely studied topic in Computer Vision during the last years. Most of the current methods to compute optical flow are based on the original formulation of Horn and Schunck algorithm (HS) [1]. However, this formulation suffers from the problem that is sensitive to outliers. To deal with that problem, Sanchez et al. [2] propose a method that uses a minimization and regularization functions to make the optical flow more robust to noise. Meinhardt-Llopis et al. [3] describe an implementation of the HS algorithm, and also introduce a multi-scale strategy in order to deal with large displacements.

III. Spatial Multilevel Optical Flow Method

By estimating the optical flow from an image sequence, it is possible to estimate motion in the scene. An overview of our proposed framework is shown in Figure 1. The system is divided into three



▶▶ Fig.1. System Overview of the proposed approach.

main parts: 1) Preprocessing; 2) Optical Flow Computation; 3) Flow segmentation. We first consider two consecutive frames as input. A Gaussian filter is then applied to get a uniform color distribution. Optical flow links the target and current frames by computing the corresponding pixels between them. The optical flow uses a pyramidal architecture of 5 levels which are built by down-sampling the size of the images by half at each level. Two pyramids of images are built and then optical flow is computed at each level. A warping process combines the information and generates a final flow field after a noise filtering step and outliers reduction. Flow vectors are finally converted to a color map using a pseudo-color palette.

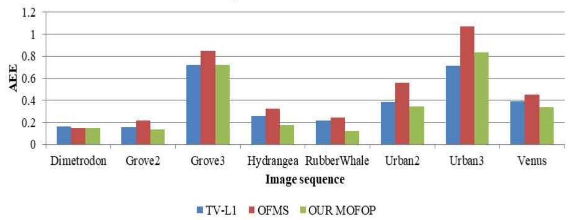
Ⅳ. Experimental Results

We conducted experiments of our approach using the Middlebury optical flow dataset, which consists of 8 image sequences with its respective groundtruth. The performance has been measured in terms of the Average End-point Error (AEE) and Average Angular Error (AAE). Figure 2 presents the results of our approach. It shows the values of AEE, AAE and Max flow vector for the image sequences of the dataset.

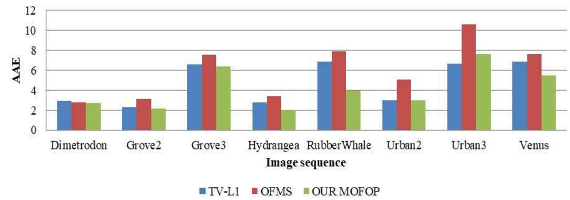
Img. / Param.	Dimetrodon	Grove2	Grove3	Hydrangea	Rubber Whale	Urban2	Urban3	Venus
Result								
AAE	2.903	2.662	6.993	2.033	3.963	3.557	7.621	5.509
AEE	0.150	0.186	0.729	0.179	0.122	0.447	0.835	0.340
Max Flow	4.37	5.14	12.83	10.54	4.29	24.62	17.40	8.66

▶▶ Fig.2. Evaluation results of our optical flow method in the Middlebury Optical Flow dataset.

Additionally, we compare the quantitative results of our approach with other optical flow methods TV-L1 [2] and OFMS [3]. As shown in Figure 3, our spatial multilevel method achieves a substantially better AEE and AAE in 7 of the 8 the image sequences of the dataset. Thus, we demonstrate the effectiveness of our method to estimate motion in images containing stationary objects.



(a)



(b)

▶▶ Fig.3. Comparison of our method with the TV-L1 [2], OFMS [3] approaches in the Middlebury dataset. (a) AEE; (b) AAE.

Ⅴ. Conclusion

In this paper we have proposed a spacial multilevel architecture for motion estimation of stationary objects. The system is able to deal with both large and small displacements while providing an outstanding performance in the Middlebury optical flow dataset.

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