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Motion Based Animal Detection in Aerial Videos

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Abstract

Computer vision techniques are applied to perform automatic wildlife surveying and animal monitoring. Animal detection in aerial videos is challenging because of the complexity of wild environments. In this paper, a method for moving animal detection is proposed by taking advantage of global patterns of pixel motion. In the video dataset, where animals make obvious movement against the background, motion vectors of each pixel are estimated by applying optical flow methods. A coarse segmentation then removes most parts of the background by applying a pixel velocity threshold. Based on the segmented regions, another threshold was employed to filter out negative candidates that could belong to the background. The pros and cons of this method are discussed.

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Keywords: optical flow; image segmentation; computer vision; object detection; animal tracking; dynamic background; moving camera; UAV; drone; wildlife survey;

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1. Introduction

In nature conservation management, wildlife surveys are important either to provide animal population and abundance information or to monitor threats to animals. Such surveys are usually conducted on the ground by conservation workers. It is labour intensive with a high financial cost. Aerial videos of wildlife collected by UAVs (unmanned aerial vehicles) provide a great substitution if combined with proper automatic detection techniques.

Object detection and tracking has been developed for decades within the field of computer vision. However, all algorithms proposed have restrictions based on the specific circumstances. Moving object detection in stationary cameras with a constant background can be easily handled today. A great amount of trackers have been formed utilizing different methods, such as background modelling methods [1] and State Estimation methods [2]. Addressed the problem of moving object detection from moving cameras, a typical method is the extension of background subtraction [3] [4]. In [5], a panorama of the video sequences was generated by applying a geographic information system (GIS), and the background was modelled by registration methods.

However, animal detection from aerial videos is beyond the reach of such algorithms. The context we are set to is totally different from the conventional applications such as aerial traffic management [6] [7], civil surveillance [8] [9], and military operations [10]. Observed above, animals don't have a stable contour, and consistent movement orientation and speed, which are usually assumed in vehicle detection. Besides, the dynamic background and natural camouflage of the animals will bring more challenges.

In this paper, an animal detection method is proposed by highlighting the different motion patterns between the background and the animals. The advantage of motion feature is that it takes little account on the texture, colour, and influence of illumination which form the major difficulties in our context. Experiments are done on aerial videos captured from a real world wild scene, and the results are discussed in detail.

2. Method design

2.1. Optical flow theory

Optical flow illustrates the pattern of apparent motion between the observer and objects in visual scene. The Horn-Schunck algorithm [11] assumes smoothness in the flow over the whole image, which is denoted as,

$$I(x, y, t) - I(x + dx, y + dy, t + dt) = 0 \quad (1)$$

The flow is formulated as a global energy functional. Solving the associated multi-dimensional Euler-Lagrange equations, the energy functional can be minimized to obtain the optical flow of each pixel.

2.2. Animal detection

Fig. 1 illustrates the flowchart of the algorithm. Fig.2 (a) shows the original frame of a video sequence captured from a UAV. Several zebras in the scene move in different directions while the UAV tries to follow the herd. From the optical flow vectors shown in Fig.2 (b), it is possible to recognize the moving zebras based on the relative motion difference between the foreground and background. Because the background motion is caused by the undertaking of the observer, optical flow vectors of the background pixels exhibit little deviation in exterior orientation and motion magnitude.

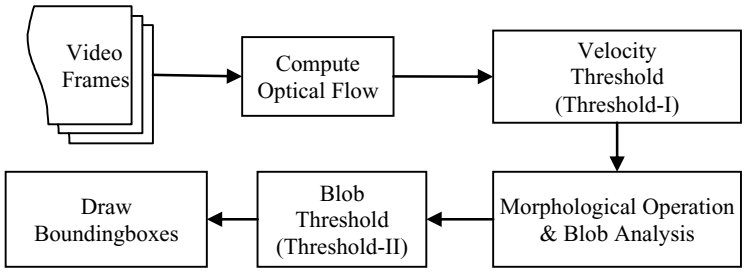

Fig. 1. Flowchart of the algorithm