

Intelligent Motion Detection/Segmentation

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Potential Research Topics

The topics of this proposal include but are not limited to:

- Background Subtraction in Complex Environment under Stationary Camera.
- Background Subtraction under Freely Moving camera.
- Motion Segmentation in Complexly Natural Scenes.
- Camera Motion Estimation in Complex Scenes.

Topic Introduction:

Motion is a powerful cue for image and scene segmentation in human visual system [7]. It has wide range of applications such as video monitoring, optical motion capturing and multimedia applications. The human ability to detect, segment, analyze and understand motion is nearly instantaneous, and work well in diversely complex scenes, such as the presence of multiple objects, complex background geometry, observer motion and even camouflage. While there has been much recent progress related to motion, it still appears we are far from human capabilities. This study focus on intelligently detecting, segmenting moving objects in the complexly natural scenes without the artificial interference. The final target of this study is trying to achieve the level of human capabilities for detecting, segmenting or even understanding the motion.

Project Significance and Background

Motion detection/segmentation is a fundamental problem of computer vision, which is usually the step of understanding the content of videos [3]. Although plenty of work have been proposed for this problem [5] over decades, there is still lack a general solution for segmenting moving objects accurately in the exist and the potential natural scenes, due to the complexity and the diversity of natural scenes. Traditionally, motion detection/segmentation algorithms assume several requirement, such as the stationary camera, enough learning frames, invariant illumination condition, scenes with low complexity or even human interference and so on [6]. Currently, previous work already achieve well performances in the scenes with ow complexity [6]. However, With the continuous growth of videos obtained from diversely scenes through different types of camera in recent years, all these assumption contribute the limitation of motion detection/segmentation algorithms, and more and more applications require the motion related algorithms are effect in diversely complex scenes, especially, the videos obtained by the freely moving camera [2]. The problem becomes quite challenging once without the assumption of stationary camera, For example, as shown in the Fig. 1. The environments around the horse in different images are completely different due to the camera motion, and it is very challenging to segment the moving horse accurately. The image sequences shown in Fig. 1 are captured from the FBMS dataset [9], which is the largest dataset to the best of our knowledge. Until today, no approach which achieves over 80% accuracy in the FBMS dataset. Therefore, there is still lack of general solution for the motion detection/segmentation in highly complex scenes, and the intelligent motion detection/segmentation research are trying to handle this problem.



Figure 1: Segmenting moving objects in freely moving camera.

The Expected Outcome in the Future 3~4 Years

The intelligent motion detection/segmentation is a research contain several sub-research problems, which can be divided into three comparatively independent parts:

- Moving objects segmentation in the stationary camera.
- Accurate camera motion estimation in the freely moving camera.
- Moving objects Segmentation in the freely moving camera.

The last problem listed is the final target of intelligent motion detection/segmentation, which focus on detecting and segmenting moving objects in all exist and potential scenes.

These three problems should be solve on time sequence. In the first year, we may focus on how to detect moving objects in the stationary camera, which is a traditional problem of computer vision. Even with 20 decades development, it remains a challenging problem in the complex natural scenes, and the publications will mainly related to the background subtraction in complexly natural scenes. In the next years, the estimation of camera motion should be handled for the further research. Since the camera motion is the main challenge to segmenting objects in freely camera, it is important to handle the motion of camera. Although, several exist work are proposed to estimate the camera motion, the accuracy is not enough to produce accurate segmentation results. In the step, the research may related to multi-view geometry, spatio-temporal features or motion segmentation. Finally, in the rest of time, we will focus on how to eliminate the boundary between the motion detection/segmentation in the stationary camera and the freely moving camera intelligently. The research in this step will be integrating the researches in the first two step, and the publications may focus on the detection/segmentation of moving objects in diversely natural scenes obtained by the stationary or the freely moving camera.

How the Project Aligned with the Projects in Computer Vision in ANU

There are two main challenges in the intelligent motion detection/segmentation for complexly natural scenes obtained through the stationary or the freely moving camera. The first challenge comes from complexity and the diversity of natural scenes, which already attracts attentions of researcher [1]. The second challenge is the camera motion, which is closely related to the projects of computer vision group in ANU. In order to handle the camera motion, the estimation of camera motion is a direct solution, and it is closely related to Shaodi et al's work [16] and Hongdong et al's work [11, 14]. In particular, the descriptor based estimation is related to Barnes et al's work [17], and the geometry related algorithm belong to Hongdong et al's work [15]. Beside the estimation of camera motion, the spatio-temporal features is another possible solution, and optical flow shows advantages in motion segmentation, which is exactly hongdong et al's work [12, 13]. In addition, there is maybe a refine procedure to improve the accuracy of results, and the image segmentation is usually be used in this part, which is related to hongdong et al's work [19]. In a word, this project is closely related to the projects of computer vision in ANU, and some sub-research problem is exactly the same such as hongdong et al's work [11].

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