論文の内容の要旨

Enhancing Video Quality and Recovering 3D Information from Motion Estimation

(動き推定と三次元復元に基づいたカメラ映像の安定化とフレーム補間)

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Studying relation between consecutive frames of a video and between frames of a video and corresponding frames of a desired output video is one of the fundamental problems in computer vision. The relation between consecutive frames of a video can be in the form of 3D camera motion or 2D pixel motion between them. Camera motion is useful for recovering 3D information and pixel motion is useful for enhancing quality as well as recovering 3D information. The relation between consecutive frames of a video also guides us to synthesize new videos that are more desirable. This requires studying relation between frames of the original video and corresponding output desired video, too.

Majority of methods in computer vision are developed for conventional images. Omnidirectional images, however, are becoming more popular recently. Our main aim in this thesis is developing new methods for omnidirectional videos, especially those captured by cameras mounted on top of a moving vehicle. Most methods developed for conventional images cannot be applied on omnidirectional images directly. We show

how we extend conventional methods to work on omnidirectional images, if possible, and how we develop new methods when it is not possible to use conventional methods.

Since recovering the relation between frames of a video is a very difficult problem to solve for a general case, different methods are developed for specific applications. In this thesis, we propose a robust an efficient method to recover camera motion in a video to estimate road width for facilitating localization in urban areas. We also extend current state-of-the-art methods for video stabilization to stabilizing omnidirectional videos. A quantitative measurement is introduced to measure smoothness or equivalently shakiness of videos by analyzing pixel motions in consecutive frames. We also utilize the motion estimation between consecutive frames to develop a method for increasing frame rate of omnidirectional videos.

To obtain road width, we estimate camera rotation and translation and use the equation of a homography induced by a plane. There are many methods to estimate camera motion between two frames. The method proposed in this thesis has the advantage of being robust and efficient. This is achieved by decoupling rotation and translation and compensating first for rotation and then for translation.

We extend current state-of-the-art methods for conventional video stabilization to omnidirectional videos. We also show that by decoupling rotation and translation, our method performs better than the state-of-the-art methods. One of the main reasons for having shakes in videos is unwanted changes in camera orientation. We show that the results are improved by first compensating for rotation and then for translation.

Current video stabilization methods compare smoothness or equivalently shakiness of videos visually. We, for the first time, introduce a method to estimate smoothness quantitatively. This is obtained by analyzing interest point trajectories in consecutive frames of videos.

We also address the problem of increasing frame rate of videos. Our main contribution is handling occlusion problem. In the presence of moving objects near camera, the occluded regions become very big and inpainting methods fail to recover them, especially when the occluded regions contain content visible in one frame but invisible in the other one. Our method is based on analyzing motion between consecutive frames and recovering the motion for occluded regions from surrounding regions.