ROBUST GLOBAL MOTION COMPENSATION AND ITS APPLICATIONS

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ABSTRACT

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This thesis presents algorithms for robust global motion compensation (GMC). GMC algorithms are used to remove camera motion and transform the video such that in the resultant video, the background appears static and the only motion rises from foreground objects. Many computer vision algorithms are tailored for static camera, and using GMC, it is possible to apply these algorithms on videos from moving cameras. For instance, motion-based video analysis is strongly affected by camera motion. If camera motion is not compensated, it interferes with the motion of interest, such as motion of human, and renders the analysis problem to be more challenging.

Generally, in sequential schemes, GMC estimates the homography transformation between two consecutive frames by matching keypoints on the frames, and maps the second frame to a global coordinate. Then, by accumulating these transformations, a composite transformation is calculated which maps each frame to the global coordinate. However, existing GMC algorithms are sensitive to existence of foreground motion and fail easily in the case of considerable foreground motion or ambiguous and low texture background.

To address the challenges in GMC, first, we propose a Robust Global Motion Compensation (RGMC) algorithm which explicitly suppresses the foreground effect and utilizes a comprehensive probabilistic verification model to find the best mappings between consecutive frames. Despite the robustness offered by RGMC, we further identified the problem of temporal drift of the estimation, due to accumulation of errors in estimation of mappings between consecutive coordinates.
Furthermore, to address the issues of sequential GMC, we propose a Temporally Robust Global Motion Compensation (TRGMC) algorithm which by joint alignment of input frames, estimates accurate and temporally consistent transformations to the global coordinates. Joint alignment not only leads to the temporal consistency of GMC, but also improves GMC stability by using redundancy of the information.

Many applications can benefit from a reliable and accurate GMC algorithm. We first briefly look into these applications. Then, among the many applications, we further investigate the problem of sequence alignment, and propose an alignment algorithm for non-overlapping sequences, enabled by performance of TRGMC. Given the transformation to a global coordinate, offered by TRGMC, and capability of background reconstruction using TRGMC result, we are able to align sequences even if the spatial overlap between the sequences is minimal or nonexistent. To this end, we first spatially align the sequences such that extrapolated backgrounds are aligned well and trajectory of moving objects are spatially smooth in the global coordinate. Next, we temporally align the sequences based on the smoothness of spatio-temporal trajectory of moving objects across field of view of different cameras.

PUBLICATIONS

- S. Safdarnejad, Y. Atoum, and X. Liu, “Temporally Robust Global Motion Compensation by Keypoint-based Congealing”, in Proc. of European Conf. on Computer Vision (ECCV) 2016.


