FlyingSword: A Real-time Motion Video Registration,Stabilization,Mosaicing and Moving Object Tracking System

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1 Abstract

Developing a fully automatic, efficient and robust video content analysis system is a subject of great scientific and commercial interest. Intelligent video content analysis with a static camera has been well researched over the past decade, and many excellent algorithms and systems have been proposed in the literature. However, robust video content analysis for moving camera is still a challenge currently, and we saw this technology gap as an opportunity to develop our own advanced video processing algorithms and system,for important applications such as aerial video surveillance,wide-area monitoring, and moving camera based moving object tracking.

In this demo, we will present a novel motion video analysis system: FlyingSword. The FlyingSowrd was originally developed to perform video stabilization, but recent developments have added new algorithms and greatly improve its effective and efficiency. Currently, FlyingSword is a real-time system capable of performing registration, mosaicing, stabilization, moving object detection,tracking of videos taken from airborne and ground-based moving platforms(e.g. UAVs, aircraft, robot, intelligent vehicle,moving surveillance camera).

The FlyingSword System mainly contains two components:(1)Global motion compensation, and(2)moving object detection and tracking.

• Global motion compensation. Motion compensation is the premise and key technology of aerial video stabilization, panorama stitching and ground moving target detection and tracking. In FlyingSword System, we develop a novel scene complexity and invariant feature based aerial video registration algorithm. The main characteristics of the method include: (1) Based on analyzing the key difficulties and challenges of aerial video registration, several new methods are presented to realize fast and effective video registration under various real scenes, include integral image based fast image scale space generation, scene complexity based feature number controlling, and statistical error distribution of correspond features based cascade filtering. (2) Through combining the multi-scale Harris corner detection, SIFT (Scale Invariant Feature Transform) feature description,

and the RANSAC (Random Sample Consensus) based frame geometry transformation parameters estimation, our system achieves satisfied rotation, scaling, brightness invariance and accuracy of registration. We demonstrate the performance of the algorithm on ten groups of UAV (Unmanned Aerial Vehicle) aerial video sequences which contain a total of 7,255 frames, the results show that the proposed algorithm carries out real-time and precise image registration under complex conditions with change of scene, large image translation, scaling and arbitrary rotation, and the average processing speed for a resolution of 320x240 unmanned aerial video sequences achieves 20.7 fps.

• Moving object detection and tracking. Detecting moving objects automatically is a key component of an automatic visual surveillance and tracking system. In airborne video, the moving objects (car, people) may be small, sometimes even color information is not available (thermal video). To handle this problem, we develop a Motion Histogram Image(MHI) based foreground segmentation algorithm in FlyingSword. MHI combine object movement information over an image sub-sequence, usually it shows the cumulative object motion with a gradient trail. Tracking is the fundamental block for the high level content analysis and exploitation. Currently, blob tracking is implemented for its simplicity and efficiency, we implement Global Nearest Neighbor (GNN) for data association, and similarity scores between tracks and new measured blobs are estimated by computing their spatial distance. For occlusion handling, we maintain object moving direction, velocity as well as object appearance model. To deal with broken trajectories, a post-processing algorithm is under developed to create a global tracking trajectory.

The focus of this presentation will be on how to establish correspondence efficiently in complex motion video, register of long time video sequences and perform moving object segmentation and tracking with camera mounted on a moving platform. Besides that, some other interesting applications of our system include video stabilization to reduce heavy camera shake, automatic moving people detection and tracking with PTZ camera will be presented in this demo.

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