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A Framework for Aerial Video Stabilization

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Abstract: Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. Aerial surveillance is now a day's very popular for broadcasting, news, shooting or gathering data from air and providing large quantity of video data for many purposes, including search and rescue, military operations, commercial applications, counter terrorism, and border patrol. In video surveillance the major task is to trace the moving object as it is in small screen. So for this it is required to track the moving object until the object is visible. But the main challenge is to trace the moving object in mobile platform including moving camera. Therefore video stabilization is necessary for mobile video surveillance. Present paper gives the review of aerial video stabilization.

Keywords - Aerial Surveillance, Video Stabilization, and Moving Object Detection

I. INTRODUCTION TO AERIAL VIDEO SURVEILLANCE

Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. Aerial surveillance is now days very popular for broadcasting, news, shooting or gathering data from air and providing large quantity of video data for many purposes, including search and rescue, military operations, commercial applications, counter terrorism, and border patrol.

Digital imaging technology, miniaturized computers, and numerous other technological advances over the past decade have contributed to rapid advances in aerial surveillance hardware such as micro-aerial vehicles, forward- looking infrared, and high-resolution imagery capable of identifying objects at extremely long distances. For instance,

the MQ-9 Reaper, a U.S. drone plane used for domestic operations by the Department of Homeland Security, carries cameras that are capable of identifying an object the size of a milk carton from altitudes of 60,000 feet, and has forward-looking infrared devices that can detect the heat from a human body at distances of up to 60 kilometers. In an earlier instance of commercial aerial surveillance, the Killington Mountain ski resort hired 'eye in the sky' aerial photography of its competitors' parking lots to judge the success of its marketing initiatives as it developed starting in the 1950s.

The United States Department of Homeland Security is in the process of testing UAVs to patrol the skies over the United States for the purposes of critical infrastructure protection, border patrol, "transit monitoring", and general surveillance of the U.S. population. Miami-Dade police department ran tests with a vertical take-off and landing UAV from Honeywell, which is planned to be used in SWAT operations. Houston's police department has been testing fixed-wing UAVs for use in "traffic control".

A. Applications of aerial video surveillance Aerial surveillance is now a day's very popular for

1. Broadcasting news
2. Shooting or gathering data from air and
3. Providing large quantity of video data for many purposes, including
    a. Search and rescue
    b. Military operations
    c. Commercial applications
    d. Counter terrorism, and
    e. Border patrol

B. Challenges in aerial video surveillance

Some of the challenges in aerial video surveillance are mentioned below:
1. Video cameras have lower resolution than framing cameras
2. Objects of interest move in and out of the field of view. [2]
3. Challenge in manually tracking an object due to camera's small field of view. [2]
4. Video contains much more data than film frames; Storage is expensive. [2]
5. Aerial surveillance usually suffers from undesired motion of cameras, which presents new challenges. [1]
6. The main challenge is to trace the moving object in mobile platform including moving camera.
    a. Video uses telephoto lens to get high resolution to identify objects
    b. Telephoto lens - Narrow field of view [2]

Therefore some stabilization techniques are required for mobile video surveillance.

II. LITERATURE SURVEY

In [1] the author presented a novel video stabilization and moving object detection system based on camera motion estimation. Local feature extraction and matching is used to estimate global motion and demonstrate that SIFT keypoints are suitable for the stabilization task. Future work is to increase the accuracy of matching point, color information can be involved for a robust point matching strategy helping the affine transform estimation and also more local and global features, such as object contour and geometrical relationship, can be applied to trade of noise and significant image distortion. A different descriptor for feature point has to be constructed for this purpose.

In [3] this paper presents a video stabilization algorithm based on the extraction and tracking of SIFT features through video frames. Implementation of SIFT operator is analyzed and adapted to be used in a feature-based motion estimation algorithm. SIFT features are extracted from video frames and then their trajectory is evaluated to estimate interframe motion. A modified version of iterative least squares method is adopted to avoid estimation errors and features are tracked as they appear in nearby frames to improve video stability and intentional camera motion is filtered with Adaptive Motion Vector Integration. Experiments have confirmed the effectiveness of the method. Further works include improvements in the SIFT extraction and in the motion filtering stage to handle different resolution videos.

In [4] the goal of video stabilization mainly is to solve the blurred video caused by the unwanted camera movements.

This paper proposes an algorithm, which can treat the different video objects respectively based on their value of information and reduce the time wasted on the background region effectively. Compared with existing algorithms, the performance of the algorithm proposed by the paper has been greatly enhanced and improved in some areas.

In [5] a novel method is proposed which synthesize shaking videos from stable frames. The shaking video synthesis method can not only give a benchmark for full-reference video stabilization performance assessment, but also provide a basis for exploring the theoretical bound of video stabilization which may help to improve existing stabilization algorithms. With the existence of ground-truth videos and its shaking ones, it is possible to make more robust assessment on video stabilization algorithms, especially for those with close performance judged by human eyes. Moreover, we could try to analyze the theoretical bound of video stabilization for improvement on existing algorithms.In [6] removal of visually unpleasant motion from videos is an important video enhancement technology. Feature-based approach is presented for video stabilization that produces stabilized videos, while preserving the original resolution. Future work is to conduct more in-depth experiments including: the comparison of the state-of-the art video stabilization methods and the investigation/comparison of the more sophisticated feature extraction methods so as to evaluate the proposed method quantitatively and qualitatively.

In [7] an adaptive parameterization technique is proposed to define the characteristics of the filter used to eliminate high frequency components in the motion path. Motion of the camera is estimated using SIFT feature tracking. To improve the algorithm so that the feature tracking procedure is not affected by lack of insufficient lighting. Future work in this area also includes improvement of the algorithm to achieve real-time performance.

III. AERIAL VIDEO STABILIZATION

Video stabilization is a technique used to improve the video quality by removing unwanted camera shakes due to hand jiggling and unintentional camera panning. The goal of video stabilization mainly is to solve the blurred video caused by the unwanted camera movements.

A. Types of video stabilization

Video stabilization falls into two types:

1. Hardware-based stabilization
2. Software-based stabilization

1. Hardware-based stabilizers consist of complex and expensive sensors and lens systems to reduce the movement of cameras. Cheaper cameras also adopt sensors and firmware to offset camera motions. However, these hardware-based systems fail to provide sufficient stabilization function to compensate for complex camera motions and severe jerking. Therefore, to obtain stable videos, post- processing video stabilization is still required. The Post-processing digital video stabilization is defined as “the process of removing the unwanted motion from input video sequence by appropriately warping the images”. It is not a real-time solution but can be applied to the aerial videos [8].

2. Software-based video stabilization can be divided into two types
   a. 2D video stabilization
   b. 3D video stabilization

A general 2D video stabilization method is composed of the three steps as shown in Fig. 1.

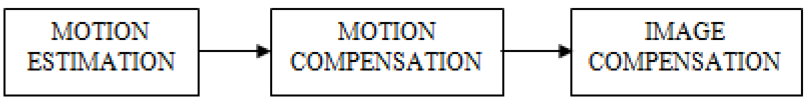

Fig. 1 General Video Stabilization Method [8]

a. Motion estimation means the estimation of motion between two sequential frames (i.e., motion between the previous and current frames) [8].

b. Motion compensation provides the computation of global transformation to stabilize the frame content [8]. Motion compensation steps are as follows:

i. Video image will be split into static parts and moving parts.

ii. Obtain the previous frame image data according to motion vectors.

iii. Through the use of prediction filter, obtains the forecast difference block of the previous frame image.

iv. Combine static parts and the forecast difference block to regenerate a new image. [4]

c. Based on the transformation, image composition warps the current image. [8]

Table 1: Comparison of some video stabilization techniques

S. No	Paper name	Motion estimation	Motion compensation	Benefits	Future scope
1	Video stabilization with moving object detecting and tracking for aerial video surveillance (Walha A. et. al.) 2014 [1]	SIFT	Kalman filters with RANSAC	SIFT: locate regions of the image where a residual motion occurs Kalman filters: applied on the moving region and not on the whole image in order to estimate the motion of the region.	To increase the accuracy of matching point. More local and global features can be applied to trade of noise and significant image distortion.
2	Video Stabilization Algorithm Based on Video Object Segmentati on (Zhang G. et. al.) 2010 [4]	Line-Square Search (LSS)	Prediction Filters	Treat the different video objects respectively based on their value of information and reduce the time wasted on the background region effectively.	To solve the problems about video object extraction and the image distortion in in some complex environments, because of scene light, shadow and other factors.
3	SIFT Features Tracking for Video Stabilization (Battiato S. et. al.) 2007 [3]	SIFT	-	A modified version of Iterative Least Squares method is adopted to avoid estimation errors	Improvements in the SIFT extraction and in the motion filtering stage to handle different resolution videos.
4	Full-frame Video Stabilization via SIFT Feature Matching (Chen Y.H. et. al.) 2014 [6]	SIFT	Time domain filter	Time domain filter is applied to generate the motion compensated version of transformation associated with each frame.	To evaluate the proposed method quantitatively and qualitatively by comparison of the state-of-the art video stabilization methods and the comparison of the more sophisticated feature extraction methods.

IV. CONCLUSION

This paper gives introduction to aerial video surveillance along with its challenges and applications. This paper also gives the detailed view of video stabilization and also explains the general video stabilization method. Also comparison of some techniques used for video stabilization is shown. Further a framework will be proposed for aerial video stabilization using speeded up robust features by estimating the global motion using SURF algorithm and detect the moving object using extended kalman filters accompanied with RANSAC technique.

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