Digital Image Stabilization Technique for Fixed Camera on Small Size Drone

Ekkaphon Mingkhwan
Control and Communication Division
Defence Technology Institute
Pakkret, Nonthaburi, Thailand
ekkaphon.m@dti.or.th

Weerawat Khawsuk
Control and Communication Division
Defence Technology Institute
Pakkret, Nonthaburi, Thailand
weerawat.k@dti.or.th

***Abstract*—This paper explores a digital image algorithm to stabilize videos recorded from a fixed camera (without stabilized machanical tools) on a small size drone. In particular, this paper focuses on implementation of the Speed-Up Robust Feature (SURF) method. The fundamental concept is to match 2 pictures, one obtained from the current image frame and another from the previous (or reference) frame. The matching process is achieved by locating common keypoints between the current and reference frames and associating them together. Then transformation is then implemented to translate and rotate the current image frame so that keypoints remain in the same position or as close as possible to those of the reference frame. Various video samples are used to validate the SURF method's efficiency. The scenarios include recorded videos under a normal light condition and having partial shadows on the image. The movement due to drone's engine and environmental winds are also under this study. The results indicate that the SURF method can be used to stabilize image frame so that the processed video becomes smoother and more suitable for viewing.**

***Keywords*—SURF, Video Stabilize, Matching Estimation, Warping**

I. Introduction

Nowadays, there have been widespread uses of unmanned aerial vehicles (UAVs) or drones for landscape survey and aerial images. These UAVs come with various sizes depending on applications. A larger sized UAV can carry more payloads such as high quality cameras and stabilized devices (or gimbals). This gimbal has capability to compensate the UAV's attitude into an opposite direction such that the view of camera remains unchanged (with respect to the Earth's axis). Thus, the resulting video images appear smoother for viewing. For a smaller sized UAV, on the other hand, there is not enough available space to install both a video camera and a gimbal. Typically, the camera is fixed to the UAV's body. When the UAV is in operation, its engine causes vibration and shaky maneuver due to environment's uncontrolled disturbances. These movement directly contribute to unstable video images.

It is obvious that video images from a fixed camera on a small UAV are not smooth enough for human eyes. To record small objects, their images and movement can be difficult to notice to some extends. Moreover as continually monitoring these unstable video images, a viewer can develop the uneasy states such as motion sickness or nausea feeling. These symptoms are caused by lacks of coordination between viewing position and body balance. Hence if problems due to unstable motion images from a fixed camera can be solved or reduced without adding extra payloads, the video quality from a small UAV for landscape survey application will efficiently be improved.

The image stabilization can be achieved via mechanical devices, optical sensors, or digital methods. For a digital stabilization, there are various well-developed algorithms such as Scale-Invariant Feature Transform (SIFT) method and Speed-Up Robust Feature (SURF) method. In particular, this work focuses on implementation of the SURF method.

The organization of this paper is as follows. The literature review in Section II provides summarized topics on motion in mobile videos, motion model, image stabilization techniques, feature detection method, SURF algorithm, and related researches. Section III describes implementation consisting of experimental setups, stabilization process, and performance measures. Results and discussion are presented in Section IV. Finally, the conclusion remarks are given in Section V.

II. Literature Review

A. Motion in Mobile Videos

When an untrained person records videos, various types of motions are acted on a hand held camera. In general, the object motion or the camera movement causes video images to shake or move. There are 7 typical motions in video images, which can be described as follows [1, 2].

- *Track* is a left or right translation in a horizontal or X-direction.
- *Boom* is an up or down translation in a vertical or Y-direction.
- *Dolly* is a forward or backward translation in the camera axis direction.
- *Pan* is a left or right turn around the vertical axis.
- *Tilt* is an up or down turn around the horizontal axis.
- *Roll* is a rotation around the camera axis direction.
- *Zoom* is not a camera position movement, but a change of camera focal length causing changes of image size.

Various camera movement in each axis cause motions in recording videos. Therefore to generate stabilized video images, we should estimate these camera movement and then compensate them in an opposite direction.