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A Four-Step Ortho-Rectification Procedure for Geo-Referencing Video Streams from a Low-Cost UAV

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Abstract : Ortho-rectification is the process of geometrically correcting an aerial image such that the scale is uniform. The ortho-image formed from the process is corrected for lens distortion, topographic relief, and camera tilt. This can be used to measure true distances, because it is an accurate representation of the Earth's surface. Ortho-rectification and geo-referencing are essential to pin point the exact location of targets in video imagery acquired at the UAV platform. This can only be achieved by comparing such video imagery with an existing digital map. However, it is only when the image is ortho-rectified with the same co-ordinate system as an existing map that such a comparison is possible. The video image sequences from the UAV platform must be geo-registered, that is, each video frame must carry the necessary camera information before performing the ortho-rectification process. Each rectified image frame can then be mosaicked together to form a seamless image map covering the selected area. This can then be used for comparison with an existing map for geo-referencing. In this paper, we present a four-step ortho-rectification procedure for real-time geo-referencing of video data from a low-cost UAV equipped with multi-sensor system. The basic procedures for the real-time ortho-rectification are: (1) Decompilation of video stream into individual frames; (2) Finding of interior camera orientation parameters; (3) Finding the relative exterior orientation parameters for each video frames with respect to each other; (4) Finding the absolute exterior orientation parameters, using self-calibration adjustment with the aid of a mathematical model. Each ortho-rectified video frame is then mosaicked together to produce a 2-D planimetric mapping, which can be compared with a well referenced existing digital map for the purpose of georeferencing and aerial surveillance. A test field located in Abuja, Nigeria was used for testing our method. Fifteen minutes video and telemetry data were collected using the UAV and the data collected were processed using the four-step ortho-rectification procedure. The results demonstrated that the geometric measurement of the control field from ortho-images are more reliable than those from original perspective photographs when used to pin point the exact location of targets on the video imagery acquired by the UAV. The 2-D planimetric accuracy when compared with the 6 control points measured by a GPS receiver is between 3 to 5 meters.

Keywords : geo-referencing, ortho-rectification, video frame, self-calibration
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