A MOBILE PLATFORM WITH A CATADIOPTRIC SENSOR

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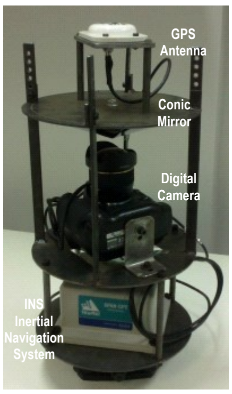
ABSTRACT:

Panoramic cameras have gained attention in Photogrammetry due to their extended field of view, which makes feasible the recording of larger area extents, when compared to conventional perspective cameras. Several systems have been developed, with multiple cameras, rotating heads, fish-eye lenses and catadioptric optics. The aim of this paper is to present a mobile catadioptric omnidirectional vision system composed of a camera and a conic mirror with direct georeferencing system (double frequency GNSS receiver and IMU), the photogrammetric modelling alternatives and some results with real simulated and real data. The catadioptric unit and the system mounted over a vehicle are shown in Fig. 1.a and 1.b. The acquired images have a distorted geometry (see Figure 1.c) and special mathematical models are required for calibration, orientation and rectification. The acquired images can be used in several applications, such as generation of control scenes, generation of panoramas, road sign identification and location and many others. Two approaches have been developed within the research group: empirical-generalized and rigorous-physical modelling. The first group of techniques requires a very dense network of control points to estimate parameters of polynomial-like models. Some models which were implemented and tested are RPC and theta-radius polynomials. The second group of approaches relies on rigorous modelling of all the physical components of the system. In this case, an existing mathematical model was adapted and improved, taking into account the non-alignment between the camera optical axis and the conic mirror, which produces systematic errors. In this system a camera with fish-eye lenses looks upward to a conic mirror. The rigorous modelling requires several intermediate steps: (1) camera modelling, which was done using existing equidistant fish-eye camera model with Conrady-Brown distortion coefficients; (2) Cone modelling, which was carried out by photogrammetric reconstruction and model fitting; (3) cone to camera boresight estimation, which required some reference points in the cone base; (4) projection of the image coordinates to the conic mirror surface, which was done by inverse collinearity equations; (5) Cone to object space projection. The system was mounted over a vehicle, as shown in Fig. 1.b and some images over open areas in roads and streets were acquired and some of them were selected. Control points were generated by bundle adjustment using high resolution aerial images; with these coordinates and corresponding image coordinates in the panoramic image the parameters for both group of models were estimated. Then, rectified images were generated and compared to aerial images. With dense control points network the empirical models provided good results, although some imperfections could be identified due to the irregularities in mirror manufacturing and other non-modelled effects. Rigorous modelling achieved also good results with discrepancies around 5 cm in the object space for points close to the system. This paper will present some details of the system along with details in the achieved results with both models.



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