A Study on Camera Calibration of Smartphones or Tablet PCs

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ABSTRACT: For close-range photogrammetry applications, interior orientation (I.O.), including focal length, principal point displacement, and lens distortion etc., is essential to the further measurements on the photograph. Conventionally only metric cameras are capable of the required stability among taking photographs. Benefit from the giant leap in the development of the micro elelectro mechanical system (MEMS), modern smartphones or tablet PCs are often built up with several sensors, such as a camera, a GPS receiver, and a gyroscope. These integrated MEMS provide position and orientation information while taking photographs, and thus, can be taken as minimalized direct geo-referencing equipment. However, it is necessary to determine the interior orientation of the camera before making any measurement on the picture. This process is called camera calibration, can be done at the lab, in the field, or on the fly. Since the manufactory would not reveal any information about their camera module, this study applies the Australian software - iWitness - to calibrate the cameras. Three smartphones (hTC Desire, EVO 3D and NOKIA Lumia 920) and one tablet PC (ASUS TF300T) are selected as the experimental group, and one DSLR (SONY Alpha 65 with 18-55mm kit lens) is used for control. Several experiments are designed to clarify following issues, (1) the stability of the I.O., (2) the real focal length, (3) the real pixel size, (4) the effects of JPEG compression level, (5) the effects of image format (16:9 v.s. 4:3), (6) the effect of illumination (indoor v.s. outdoor), and (7) the lens distortion pattern. A test field consists of 12 composite targets is set up as the software suggested. Twelve photographs from six position are taken by each camera in each experiment. The measurements of the target are automatically done by the iWitness software to avoid manual errors. The results shows that, even the settings are the same and the field remains unchanged, the I.O. parameters are changed from time to time. In other words, the camera is not as stable as we expected. But the good news is that, from the distortion pattern graph, the central part of the image remains the same distortion. Therefore, it is possible to correct the central part of the photograph with a set of pre-calibrated I.O. parameters. Clipping the central part of the photograph and it can be used as the texture image for façade mapping. In this way, smartphones or tablet PCs would be the most convenient photogrammetric equipment.

KEY WORDS: Camera Calibration, Smartphones, Tablet PCs, Interior Orientation, Focal Length, Lens Distortion