A three-dimensional topographic survey based on two-dimensional image information

一种基于二维图像信息的三维地形测量

Cite this as: Xiao-long Song, Yu-chuan Bai, Chao Ying, 2014. A three-dimensional topographic survey based on two-dimensional image information. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 15(1):68-82. [doi:10.1631/jzus.A1300317]

- The riverbed topographic survey is one of the most complex tasks in river model experiments. To improve measurement efficiency and solve the riverbed interference problem in traditional methods, this study discussed two measurement methods that use digital image-processing technology to obtain topographic information

- A new and improved approach for calibrating camera radial distortion was firstly proposed to enhance the accuracy of image measurement

- One measurement method is based on perspective projection transformation among multiple images.

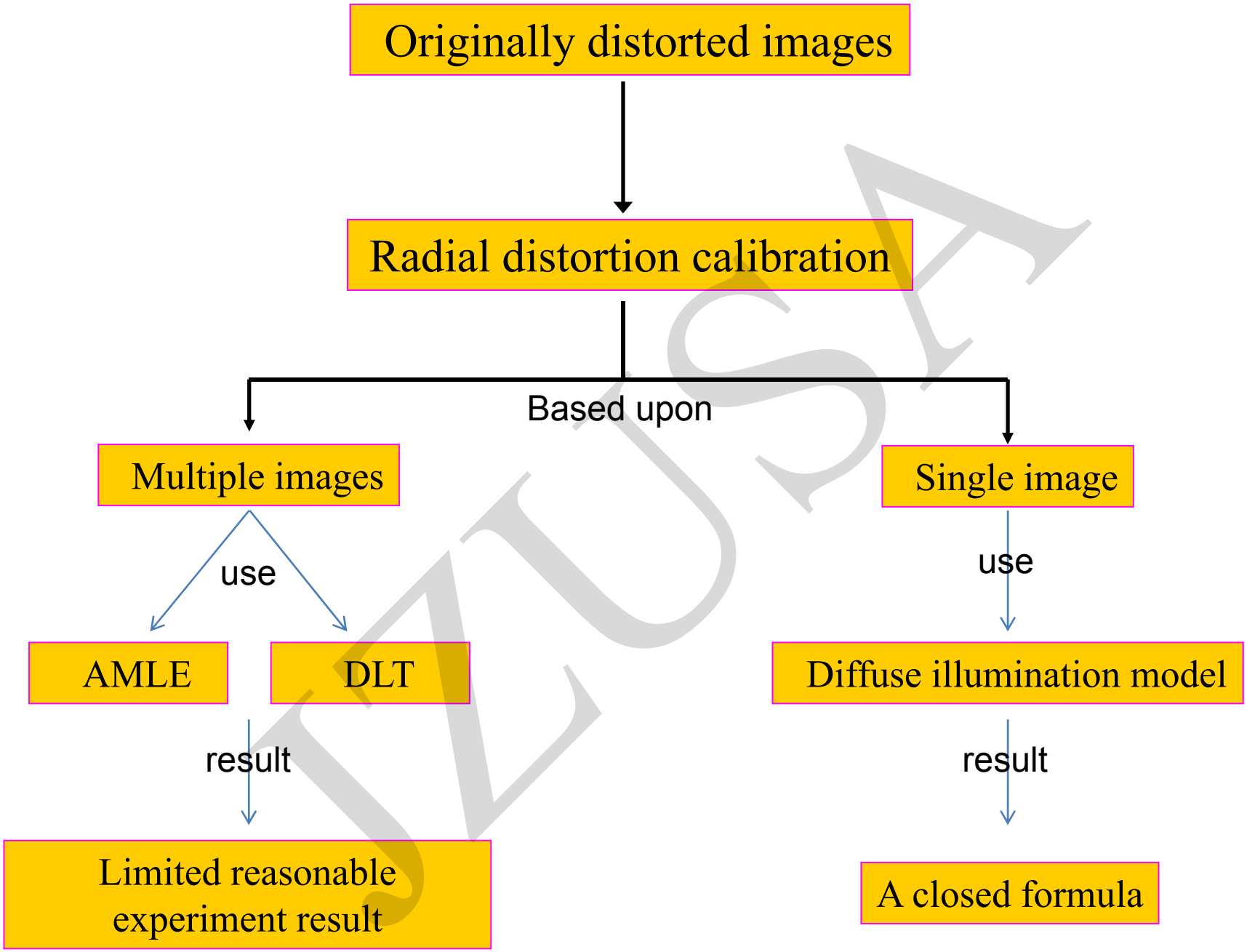
- The other one is theoretical derivation of 3D topography according to grey information from a single image.

Methods and Results

(1) Our image distortion method use a Canny edge detector with new arithmetic to obtain edge magnitude and orientation, with a combined golden section search method and quadratic interpolation method to calculate the optimal distortion parameter. The precision and computational efficiency of distortion parameters are improved.

(2) We viewed the calibrated images as a ground central projection, and used direct linear transformation to calculate the transformation parameters. we used the AMLE considering the first-order error propagation of the residual error, to compute transformation parameters, and used an iterative weighted total least square method to do an iterative computation. Control points in the control region should be distributed as uniformly as possible; and the more control points, the better.

(3) With the diffuse illumination model, assuming that the ideal grey value and topographic elevation value are positively correlated, we derived a novel closed formula to explain the relationship of 3D topographic elevation, grey value, grey gradient, and the solar direction vector. They have some positive advantages even if they are not perfect.


Originally distorted images
Radial distortion calibration
Based upon
Multiple images
Single image
use
use
AMLE
DLT
Diffuse illumination model
result
result
Limited reasonable experiment result
A closed formula