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摘要: 建立了基于光学自准直法的测量系统,利用该系统提取转台的十字丝坐标,完成了对三维物体的挠曲角测量。首先,采用Sobel提取算子对CCD拍摄到的十字丝图像进行边缘检测。然后,采用了自适应的阈值分割进行直线提取;由于转台上有其它划痕存在,采用局部最小二乘进行十字丝的提取。最后,采用加权整体最小二乘法进行十字丝两条线的直线拟合,联立两方程,得出交点坐标值。结果表明,此方法获取的两直线斜率之积的精度在±1%以内,非常接近十字丝斜率之积的真值(理论真值为-1)。使用徕卡经纬仪(精度为0.5")的角度值作为真值进行精度标定,测得 α 的精度为3.59", β 的为3.76",完全满足系统挠曲角测量的精度要求。

关键词: 挠曲角测量 自准直法 Sobel算子 直线拟合 局部最小二乘法 加权整体最小二乘法

Application of weighted total least squares in measurement of deflection angle with optical self-collimation method

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Abstract: A self-collimating optical measurement system was set up to measure the deflection angles of three-dimensional objects, in which the values of the deflection angles were obtained by extracting the coordinate of a turntable cross wire. First, Sobel operator was used to detect the image edge of the cross wire taken by a CCD camera, then lines of the cross wire were extracted through self-adaptive threshold division. Because of other turntable scratches, the partial least square method was used to extract the cross wire, and the weighted total least squares was adapted to fit the cross-wire lines. Thus two equations were set up, and the intersection coordinate was obtained through solving the two equations. Experimental results show that the precision of the two line-slope product is within ±1%, very close to the true value (theoretical true value is -1). By taking the angle from Leica the odolite (the accuracy is 0.5") as the true value to calibrate the precision, the measured precision angles for α and β are 3.59" and 3.76", respectively, which satisfies the requirements of deflection angle measurement.

Keywords: deflection angle measurement self-collimation method Sobel operator line fitting partial least squares weighted total least squares

收稿日期 2012-03-15 修回日期 2012-05-10 网络版发布日期

基金项目:

国家863高技术研究发展资助项目

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