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微纳技术与精密机械

基于虚拟立体视觉的气液两相流三维测量系统的标定

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摘要： 研究了基于虚拟立体视觉的气液两相流三维测量系统的标定技术。首先,基于单台高速摄像机和两组反射镜组构建虚拟立体视觉测量系统,建立高速摄像机透视投影变换模型以及虚拟立体视觉三维测量模型,对虚拟立体视觉系统中摄像机及虚拟立体视觉传感器进行标定。用靶标基准球模拟气泡在水中的分布,以其空间距离作为测量评价指标,比较了不同标定方法对三维重建精度的影响。实验结果表明,将标定参照物置于水箱内,并且分别对左、右虚拟摄像机及传感器进行标定,三维重建精度最高,测量空间距离绝对误差优于0.13 mm,相对误差优于0.49%。实验认为,对基于虚拟立体视觉的气液两相流三维测量系统进行标定时,必须充分考虑折光分光光路以及管壁折射对三维重建所带来的影响。

关键词： 气液两相流 三维测量系统 虚拟立体视觉 标定 误差分析

Calibration of three-dimensional measurement system for gas-liquid two phase flow based on virtual stereo vision

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Abstract: A calibration technique for the three-dimensional measurement system of gas-liquid two phase flow based on a virtual stereo vision was researched. Firstly, a single high-speed camera and two groups of mirrors were used to construct the virtual stereo vision system and to establish a perspective transformation model for the high-speed camera and a virtual stereo vision three-dimensional measurement model. Then, the camera and the virtual stereo vision sensor in the virtual stereo vision system were calibrated. Finally, the distribution of the bubble in the water was simulated by a target standard ball and its space distance was regard as the measurement standards. Furthermore, the impacts of different calibration methods on the accuracy of three-dimensional reconstruction were compared. Experimental results indicate that the accuracy of the three-dimensional reconstruction is the best when the calibration reference is placed in a water tank and the left and right virtual cameras and sensors are calibrated, respectively. The absolute error and the relative error of the measurement distance are better than 0.13 mm and 0.49%, respectively. It suggests that the impact of the light splitting path and tube wall refraction on the calibration accuracy should be taken full account of in the calibration of the gas-liquid two-phase flow three-dimensional measurement system based on the virtual stereo vision system.

Keywords: gas-liquid two phase flow three-dimensional measurement system virtual stereo vision calibration error analysis

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