计算机集成制造系统
Computer Integrated Manufacturing Systems

计算机集成制造系统 » 2015, **Vol. 21** » Issue (第1期): 123-134 DOI: 10.13196/j.cims.2015.01.014

基于形状特征的管路接头测量和三维重建方法

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Measurement and 3D reconstruction method for pipeline's joints based on shape feature

全文: HTML (1 KB)
输出: BibTeX | EndNote (RIS)

摘要 针对复杂管路系统中的接头同步测量和三维重建的难题,提出一种基于形状特征的管路接头测量和三维重建方法。该方法通过接头CAD模型边缘轮廓和实物图像边缘轮廓进行形状特征匹配来实现接头空间位姿的测量。首先通过建立虚拟相机“视点球”获取接头CAD模型边缘轮廓的投影图像,经过金字塔分层组成接头的形状特征图库|然后与获取的接头实物图像边缘轮廓进行对比匹配|最后利用最小二乘法迭代求解接头的空间位姿,并重建接头的三维模型。开发了管路多目视觉测量系统并进行了接头位姿测量和管路三维重建实验,实验表明该方法的接头测量和三维重建时间可控制在1 min内,位置误差为0.654 mm,姿态误差为0.73°,测量和重建的效率与精度满足工程要求。

关键词 : 管路接头, 位姿测量, 三维重建, 形状特征, CAD模型

Abstract : To resolve the problem of joint's synchronous measurement and reconstruction in complex pipeline system,a measurement and 3D reconstruction method for pipeline's joints based on shape feature was proposed.A shape feature matching between contours of joint's CAD model and those of joint's material object was adopted to realize the measurement of joint's spatial pose.Projected images of joint's CAD model were acquired through setting up “sphere of viewpoints” of virtual cameras.These projected images were layered in the pyramidal structure to compose a gallery of matching images,and the joint's edges images acquired from material object were matched with its matching images.The joint's spatial pose was calculated iteratively by the least square method,and the joint's 3D model in the pipeline system was reconstructed.A pipeline multi-camera measurement system was proposed,and the experiments on a pipeline's joint pose measurement and 3D reconstruction were carried out.The result showed that the measurement and reconstruction time could be controlled within 1 minute,the position and rotation error were respectively 0.654 mm and 0.73°.The efficiency and accuracy of the proposed measurement and reconstruction method could meet the engineering requirements.

Key words : pipeline joint pose measurement 3D reconstruction shape feature computer aided design model

ZTFLH: TP391.4

基金资助:国家自然科学基金资助项目(51305031)。

引用本文:

张天,刘少丽+,唐承统,刘检华. 基于形状特征的管路接头测量和三维重建方法[J]. 计算机集成制造系统, 2015, 21(第1期): 123-134.

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