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斜轴式天文望远镜机架的驱动控制

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Driving control for mounting rack of slant axis astronomical telescopes

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摘要 针对斜轴式天文望远镜传统机架中的非垂直轴系结构会导致像场旋转,从而影响天文望远镜指向和跟踪控制的问题,研发了新的45°斜轴式天文望远镜机架.设计时,选取太阳为跟踪目标来搭建硬件机架驱动控制系统;利用图像传感器实时捕获目标,经数字信号处理(DSP)芯片精确解析目标质心,通过图像消旋解耦出方位与斜轴两方向的偏差.然后,结合模糊控制与神经网络的各自特点,设计了单神经元模糊自适应PID控制算法实施偏差调节,以实现对目标的定位与跟踪.实验结果显示,该驱动控制系统的水平与斜轴方位的跟踪偏移误差均在±2 pixel以内,水平指向偏移误差均值为0.123 2°,俯仰指向偏移误差均值为0.155 3°.得到的结果表明该驱动系统鲁棒性强,能够克服斜轴机架像场旋转导致的控制问题且满足精度要求.

关键词 : 天文望远镜, 机架, 斜轴, 数字信号处理器, 单神经元模糊自适应PID

Abstract : The non-vertical structure in traditional mounting rack of a slant axis astronomical telescope may cause an image field rotation, which will effect the pointing and tracking of the telescope. There fore, a mounting rack with a slant axis of 45° is developed. By selecting the sun as the tracking target, a hardware driving control system for the mounting rack is designed. Capturing the target by a camera in real time, the system uses Digital Signal Processors(DSPs) here for analyzing exactly the centroid position of target image and decouples the deviation between the two directions by image despun scheme. Combined the fuzzy control and neural network, a self-adaptive fuzzy PID approach with a single neuron is proposed for regulating the position errors of the slant and azimuth respectively to achieve tracking and positioning. The experimental results show that the horizontal and slant axis azimuth tracking bias errors are within 2 pixels, and the average tracking error is 0.123 2° for the horizontal orientation and 0.155 3° for the vertical direction respectively. Experimental results indicate that the driving system is very robust. It solves the control problem caused by image rotations and can meet the precision requirement.

Key words : astronomical telescope mount slant axis Digital Signal Processor(DSP) single neuron adaptive fuzzy PID

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