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论文

低速风洞绳牵引并联支撑系统的机构与模型姿态控制方案设计

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Design Methodology of Wire-Driven Parallel Support Systems in the Low Speed Wind Tunnels and Attitude Control Scheme of the Scale Model

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摘要 首先介绍作为风洞试验中新型"软式"支撑系统的绳牵引并联支撑系统;其次,在给定的设计要求下,依据缩比模型所需运动,探讨绳牵引并联支撑系统的设计原理,并提出详细的设计步骤,得到了一个8根绳牵引的RRPM:WDPSS-8,使缩比为1∶40的F-15E模型可实现的俯仰角达-79°~71°、滚转角达-90°~90°、偏航角达-38°~39°;最后,在建立系统的动力学模型的基础上,采用基于绳长关节空间的驱动力矩控制器的位置控制方案来进行缩比模型的姿态控制,并用Lyapunov函数证明缩比模型在该控制规则下的运动稳定性。

关键词: 机械原理与机构学 绳牵引并联支撑系统 几何法 风洞 姿态控制

Abstract: Firstly, the wire-driven parallel support system is presented. Secondly, the designing principle of the support systems in a low speed wind tunnel is investigated according to the experimental requirement of a vehicle model. Under the principle, the detail of the design about a new kind of redundantly restrained positioning mechanisms with 8 wires, WDPSS-8, is presented to suspend the 1∶40 scale model of F-15E. By this design, the ranges of pitch , roll and yaw angles of the model at the home pose respectively are -79°~71°, -90°~90°, -38°~39°. Finally, based on the systematic dynamics model, a position control scheme in wire length coordinates applying an actuator torque controller is proposed to implement the attitude control of the model. Moreover, the motion stability is proven by a Lyapunov function.

Keywords: theory of machines and mechanisms wire-driven parallel support system geometrical method wind tunnel attitude control

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