A Universal Kinematic Assist Platform Based on Active Floating-Drive Mechanism: Achieving Load-Adaptive Traction and Passive Freewheeling

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Traditional figure skating jump-assist devices often require manual coach operation and lack adaptability to varying athlete heights and weights. This project developed a universal kinematic assist platform built upon a self-researched Active Floating-Drive Mechanism. It autonomously tracks skaters while providing aerial retention extension and safe landing protection for independent practice. The core research is a three-gear meshing floating-drive system. Utilizing gear assembly internal resistance during motor initiation, the mechanism facilitates a state transition: the floating beam tilts to engage drive wheels for Active Traction, and reverts to Passive Freewheeling for low-resistance gliding when stationary. The platform integrates an XY angle sensor and kinematics matrix to achieve precise autonomous following. For safety, a Centrifugal Ratchet Tensioner locks the support strap instantly upon detecting rapid movement, paired with an elastic buffering system to protect joints during descent. Experimental analysis confirmed that the platform achieves stable propulsion through the floating balance bar mechanism. Test data indicates that as long as the support wheels maintain effective contact with the surface—ensuring that the frictional force exceeds the driving force—the motors can continuously output propulsion to move the entire system forward. Evolving through three prototype generations, this study demonstrates that this mechanical system can be expanded to serve as a platform for gymnastics, martial arts, and rehabilitation, offering a versatile solution for safe, independent athletic skill development.

Awards Won:

Second Award of $2,400