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Trajectory tracking control of lower limb exoskeleton rehabilitation robot based on extended state observer

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I. INTRODUCTION

This paper presents a linear active disturbance rejection control (LADRC) method for lower limb exoskeleton rehabilitation robot. Because the lower limb exoskeleton control system has variability, nonlinearity and model parameter uncertainty, it is difficult to achieve accurate control of gait trajectory tracking. In this paper, a linear extended state observer (LESO) is designed to estimate the total disturbance inside and outside the system, and linear active disturbance rejection control is used to suppress the total disturbance, in order to transform a nonlinear, time-varying and uncertain system into a linear, time invariant and known system.

II. EXOSKELETON ROBOT

We use PC as the upper computer, which maintains certain gait data and communicates via serial connection with the joint drivers. In this process, we use CANopen protocol. After the gait data is sent to the driver, the driver converts the control command into PWM signal to control the movement of the motor. The angle encoder at the four joints transmits the angle signal through ZigBee protocol.

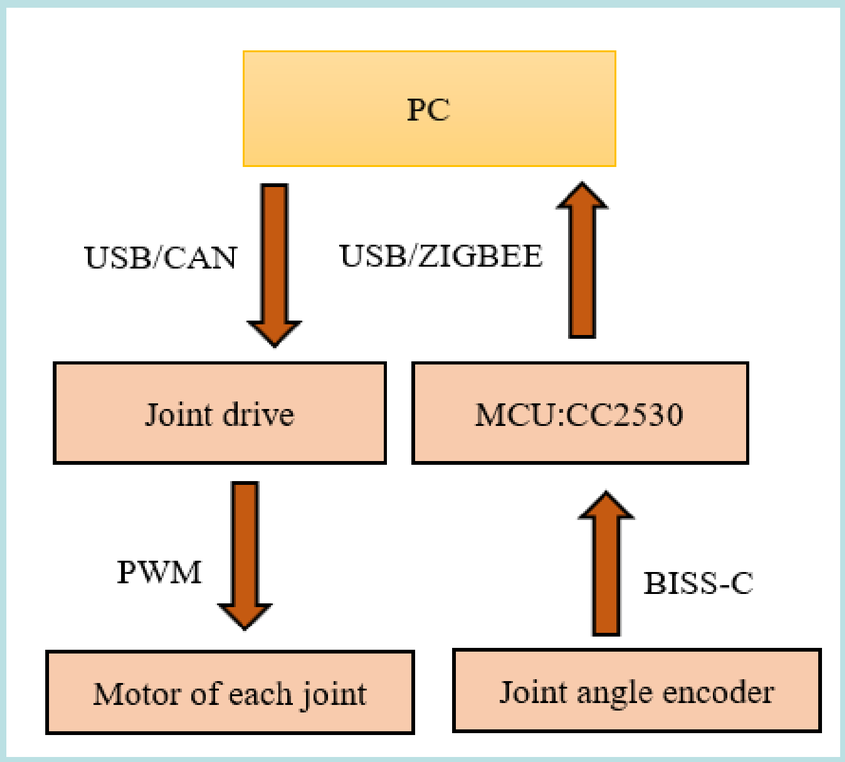


Fig. 1. Exoskeleton communication

III. ACTIVE DISTURBANCE REJECTION CONTROLLER

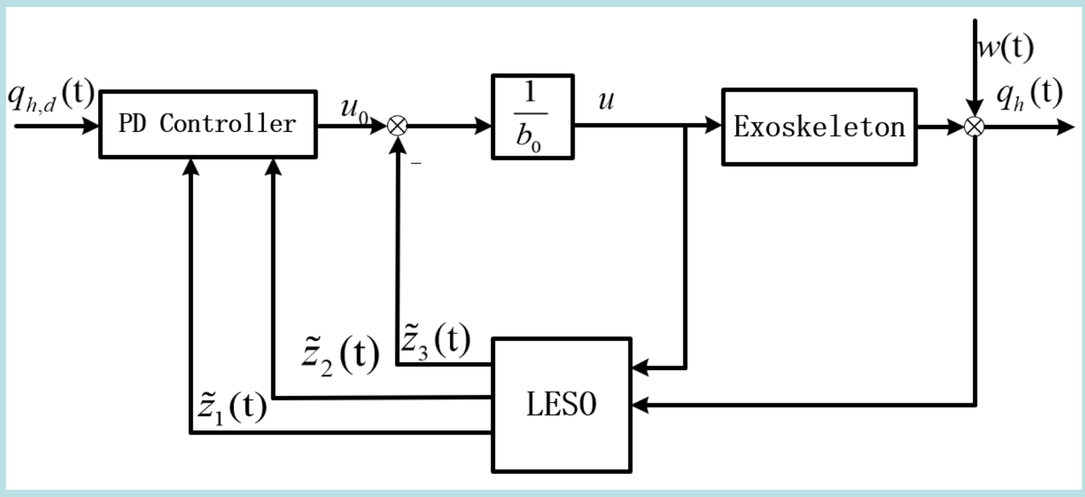
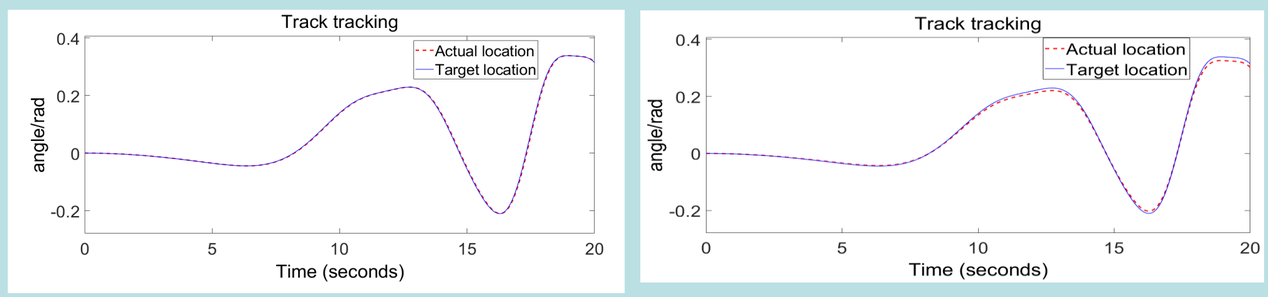


Fig. 2. LADRC diagram



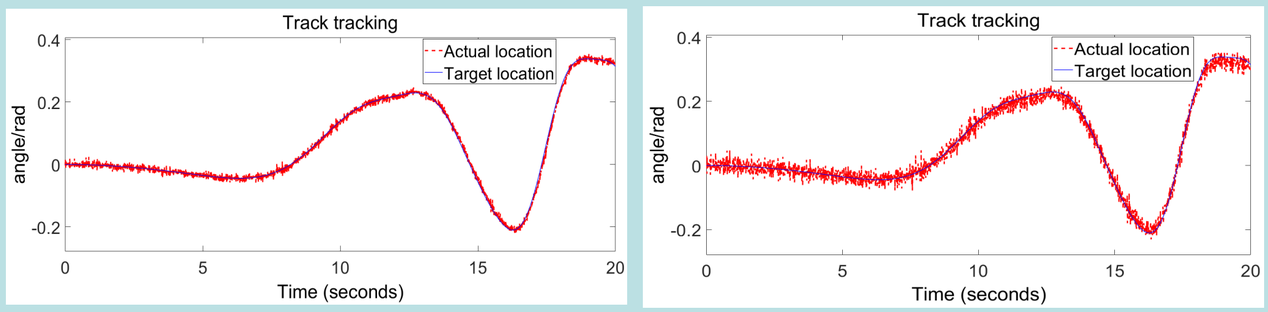


Fig. 3.Trajectory tracking of hip joint.

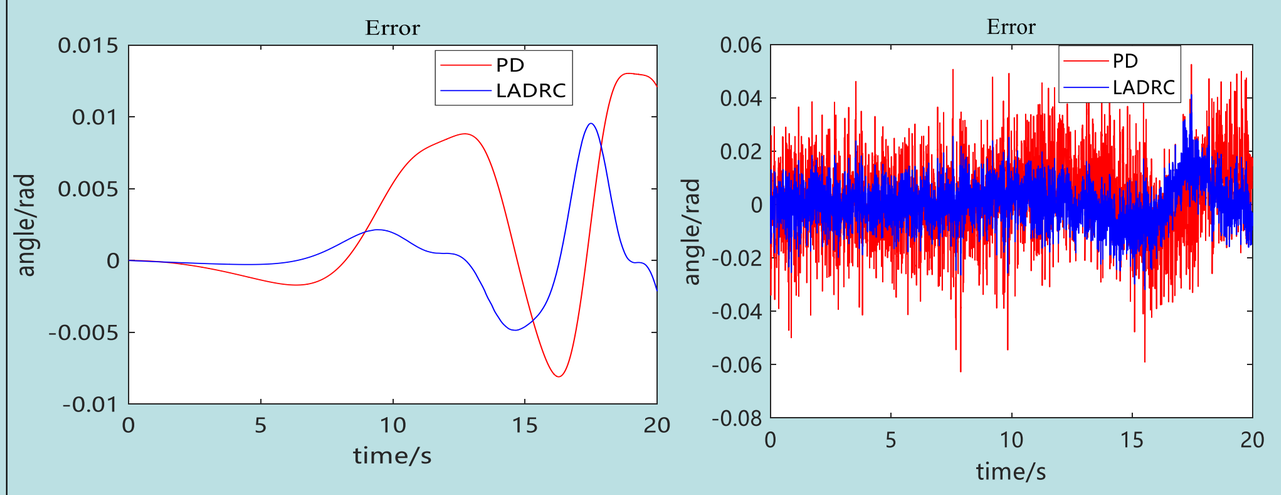


Fig. 4. LADRC and PD tracking error of hip joint

Summary

In this paper, we use LADRC to track the gait trajectory of the lower limb exoskeleton rehabilitation robot. We utilize the extended state observer to estimate the unmodeled dynamics and external disturbances of the system, in order to transform the nonlinear system into a linear system, and design a linear state error feedback control law (LSEF). The control effect of LADRC strategy is verified by simulation and compared with PD control, The results show that the control strategy used in this paper has better tracking effect and strong anti-interference ability.