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COMPACT CEREBELLAR MODEL ARTICULATION CONTROLLER FOR ULTRASONIC MOTORS

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Abstract. *This paper presents a compact cerebellar model articulation system for the position control of ultrasonic motors. Since the ultrasonic motors possess a time-variant and heavy nonlinearity and a variable dead-zone characteristic, it is difficult to create a precise model of ultrasonic motors. To overcome this problem, robust adaptive control technique is often utilized for the control of ultrasonic motors. However, it requires solving complicated mathematical equations to find the adaptive control law. Moreover, due to the variable dead-zone characteristic, on-line adaptive control technique needs more complicated algorithms to overcome the influence of dead-zone. As a result, the real-time control realization often needs a high-cost microcomputer to calculate the complicated mathematical equations or algorithms. Based on the proposed compact cerebellar model scheme, the appropriate control input can be generated only by calculating the sum of two activated memory cells. Therefore, the simplicity of mathematical equations reduces the computation loading of the controller and eliminates the need for the high-cost microcomputer. Simulation and experiment results are provided to verify the effectiveness of the proposed method.*

Keywords: Cerebellar model articulation system, Ultrasonic motors, Position control

1. **Introduction.** The ultrasonic motor (USM) has many useful characteristics [1-4], such as high torque, high holding torque, low speed operation, and compact in size. As a result, the USM is suitable for the use of accurate-control devices, such as optical equipments and accurate machines. However, the interior temperature of the USM increases with working time, the friction parameters of the USM are changed with temperature, and the USM has a variable dead-zone characteristic in control input. Due to these characteristics, it is difficult to create a precise model and to design the controller for the USM.

To solve the above problem, some position control schemes [5-13] for unknown and variable dead-zone [9-13] have been proposed. In [13], two backstepping robust adaptive control algorithms have been presented for nonlinear plants with unknown dead-zone. Besides, some robust adaptive control algorithms for the USM have been proposed, such as backstepping technique [14], PI controller [15], adaptive fuzzy-neural network controller [16], recurrent fuzzy neural network controller [17], wavelet neural network controller [18], and fuzzy-neural network controller [19]. Since these robust adaptive control algorithms need to calculate complicated mathematical equations or algorithms, the realization of these equations or algorithms needs the use of high-cost microcomputers, such personal computers and digital signal processors (DSPs). In practice, the ultrasonic motor is often applied to the accurate and small instruments or equipments, and the real-time controller