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Development of a Recurrent Fuzzy CMAC with Adjustable Input Space Quantization and Self-Tuning Learning Rate for Control of a Dual-Axis Piezoelectric Actuated Micro Motion Stage

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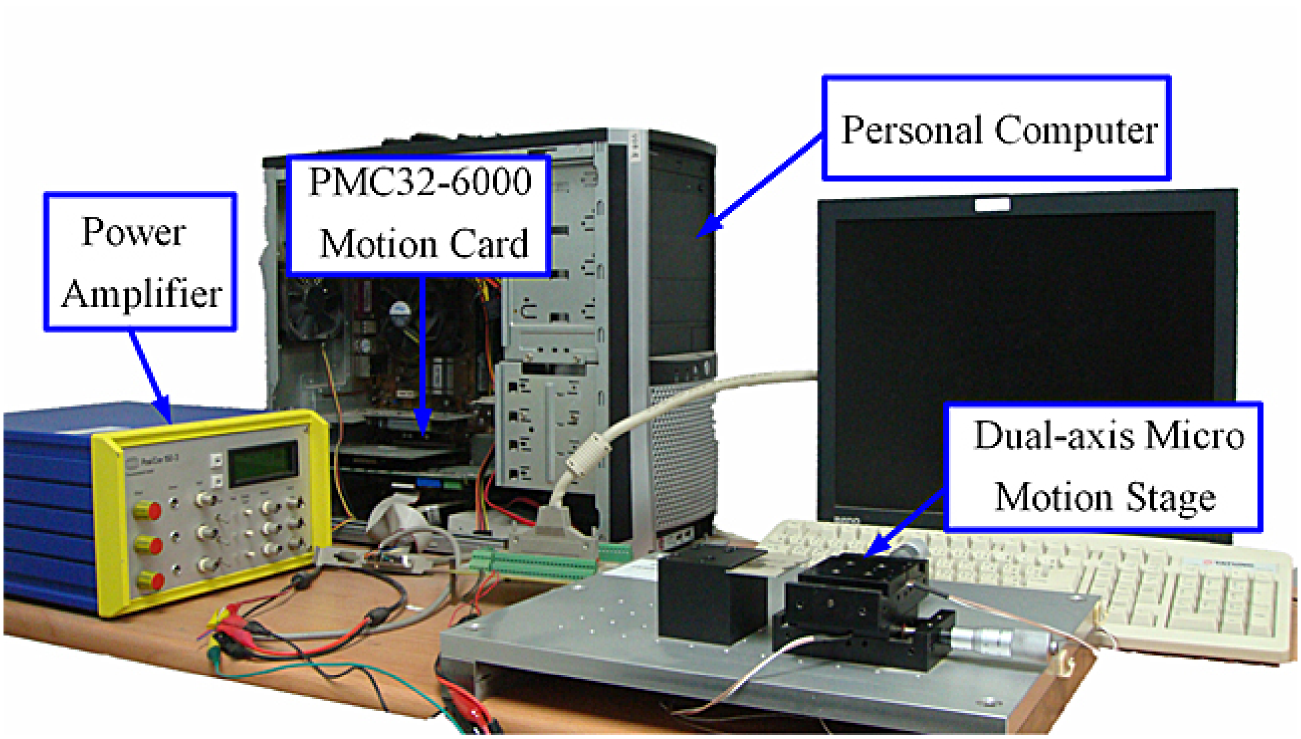
Due to attractive features such as small size, light weight, large force output, low energy consumption and fast response, piezo-actuated micro-motion stages have been widely used in precision industries. However, the motion accuracy of the piezo-actuated-motion stage is affected by creep phenomenon, high frequency vibration, the hysteresis effect, and more. In particular, the hysteresis effect between the input command and the output displacement may result in as much as a 15% loss in motion accuracy. Although many previous studies have proposed different methods to deal with the aforementioned problem, the performances of most approaches have fallen short of expectations. In order to overcome this difficulty, we have proposed a recurrent fuzzy CMAC approach which exploits the attractive characteristics of CMAC, such as simple structure, ease of implementation, online learning capability, and the fact that the plant model is not essential. By employing adjustable input space quantization and a self-tuning learning rate, the proposed control scheme can be applied to a variety of plants. Experimental results verify the effectiveness of the proposed approach.



Hardware setup of the dual-axis piezo-actuated micro-motion stage