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CONCEPT OF SFP CONTROLLER FOR MECHANICAL SYSTEMS

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Abstract. *This paper develops a novel speed-follows-programming (SFP) controller for nonlinear mechanical systems. The controller enables either the velocity or the position of the mechanical system to be accurately controlled via the specification of appropriate programming speed (PS) curves. To facilitate the use of the SFP controller in practical commercial and industrial applications, a simplified SFP control scheme (SSFP) is also proposed. The validity of the two control schemes is demonstrated via their application to the control of an inverted pendulum system. The simulation results confirm the ability of the two schemes to control the velocity or position of the pendulum system in accordance with the specified PS curves. In addition, it is shown that the controllers enable the pendulum to be driven toward the same target position using different approach speed strategies. The performance of the two controllers is compared with that of a fuzzy PDC controller. It is shown that while all three schemes provide an effective control capability, the SFP and SSFP controllers have a simpler structure than the PDC controller, and therefore result in both a lower design and implementation cost and a reduced computational overhead.*
Keywords: Controller, Mechanical systems, Nonlinear systems

1. **Introduction.** Designing a control scheme for linear systems is relatively straightforward since many established techniques are available for ensuring that the controlled system satisfies the desired response requirements. However, designing controllers for nonlinear systems is highly challenging, and invariably requires the use of sophisticated control methods [1-7]. Conventional (i.e. hard computing) control techniques such as PID (proportional-integral-derivative) control, pole placement through state feedback control, linear quadratic regulator (LQR) control and so on, are intended primarily for the control of linear systems. However, even linear systems may be disturbed by additive noise, or may lack state information, and thus the efficacy of such control techniques is inevitably limited to a certain extent. Therefore, researchers have proposed more sophisticated methods such as linear quadratic Gaussian (LQG) controllers which contain the linear quadratic estimators [10,11] to solve the optimal linear filtering problem. The literature also contains many proposals for the control of nonlinear systems, including adaptive control [2,6], robust control [15], variable structure (sliding-mode) control [3-6] and so on. Moreover, recent advances in computer technology have led to the emergence of new soft computing methods such as fuzzy logic [1,2,5,6,14], evolutionary algorithms [1] and neural networks [7,12] which are suitable for the solution of a variety of complex optimization