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ANTI-SWAY AND MOTION PLANNING CONTROL OF OVERHEAD CRANES

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Abstract. *Overhead cranes are usually operated manually to move heavy loads. Fast and smooth movements of the loads are the main objectives of crane operations. However, both the objectives always contradict with each other, so that it is hard to achieve positioning and swing control simultaneously by using conventional methods. This paper presents the adaptive fuzzy sliding mode controller (AFSMC) to regulate the crane position and hoist (lower) the loads while keeping the load swing small. A motion planning scheme is also presented to illustrate the tracking control performance. Besides, this work presents the adaptable slopes of sliding surface to improve the system insensitivities to the uncertainty and disturbance. The stability of proposed AFSMC is also provided. Several experiments demonstrate the precise positioning of trolley, high speed hoisting (lowering) of the loads, and small loads swing during the crane operations.*
Keywords: Overhead cranes, Positioning and swing control, Fuzzy sliding mode control, Motion planning, Adaptable slope

1. **Introduction.** Overhead cranes are a common mechanism to move heavy loads or hazardous materials in industry. Usually, a crane, consisting of a trolley, driving motors and flexible wires, is operated manually. However, the crane operator often requires intensive training and practice. It is because the crane operation normally induces load swing, which may lead to accidents or damages of load. Besides, restraining the load swing and precisely positioning the trolley simultaneously by the crane operator are very difficult due to the fact that the load and flexible wire will exhibit nonlinear swing behavior.

A crane is a typical example of nonlinear underactuated system. It has fewer control inputs than its number of degrees of freedom. In general, there are two main issues concerned in the topic of crane control. One is fast movement of the trolley with good accuracy and the other is minimum load swing for the consideration of safety. However, due to the inherent underactuated property, it cannot control the load swing directly. Implementing the anti-swing, positioning and resisting disturbance methods with fewer actuators are also difficult. These issues have motivated many researchers to develop several algorithms for the crane controls.

Many researches have been published. Among them, an implicit gain-scheduling method was presented to control the crane [1]. Auernig and Troger [2] used minimal time control to minimize the load swing. Some researchers also used the dynamic model by Lagrange equations to evaluate the optimal speed or path reference that minimized the load swing