MECHATRONICS BOOK SERIES
SELECTED PAPERS FROM ICOM'01, ICOM'05 AND ICOM'08

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Design and Implementation of Fuzzy Logic Controller for Intelligent Gantry Crane System

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ABSTRACT

Gantry crane is a machine that moves payload from one point to another point. Recently, most of gantry cranes use open loop system to control position while anti-swing control is done manually by skilful operators. Therefore, skilful operators are needed to be trained in order to operate the gantry crane efficiently and safely. The performance of the gantry cranes are heavily depends on their experiences and capability. This may not be practical to control the gantry crane because human skills are restricted by fatigue problem and will affect the performance of the gantry crane. In addition, it is well known that open loop system is sensitive to the parameter variations and disturbances. To overcome the above-mentioned problems, feedback control is adopted in this paper. Fuzzy logic controllers are proposed for gantry crane system. Fuzzy logic control is designed based on information of the skilful operators. The effectiveness of the proposed controller is evaluated experimentally using a lab-scale gantry crane. The experimental result shows that fuzzy logic controllers have produced good result for anti-swing controller.

1. INTRODUCTION

Gantry cranes are widely used in industry for transporting heavy loads and hazardous materials in shipyards, factories, nuclear installations, and high building construction. The crane should move the load as fast as possible without causing any excessive movement at the final position. However, most of the common gantry crane results in a swing motion when payload is suddenly stopped after a fast motion [1]. The swing motion can be reduced but will be time consuming i.e. reduce facility as well as productivity Moreover, the gantry crane needs a skilful operator to control manually based on his or her experiences to stop the swing immediately at the right position. Furthermore to unload, the operator has to wait the load stop from swinging. The failure of controlling crane also might cause accident and may harm people and surrounding.

The swing motion can be reduced and stopped without using the controller. However, it will be time consuming and eventually reduce the facility and productivity of the gantry crane system. Even though the skillful operators operate the crane, they will still face some constraints such as fatigue problem. This phenomenon can cause inconsistent performance of the gantry crane systems and might cause accident. Various attempts to control gantry cranes system based on open loop system were proposed. For example, open loop time optimal strategies were applied to the crane by many researchers [2-4]. They came out with poor results because open loop strategy is sensitive to the system parameters (e.g. rope length) and could not compensate for wind disturbances. Another important open loop strategy is the input shaping introduced by Karnopp [5], Teo [6] and Singhose [7]. Even though they claimed that input shaping is good in controlling the open loop system but it still faces sensitiveness to the external disturbances and parameter variations.

In order to overcome the problems, this paper introduces an intelligent gantry crane system. The proposed intelligent gantry crane is realized by adopting fuzzy-based feedback controllers. The proposed fuzzy-based controllers consist of position as well as anti-swing controllers. Fuzzy logic control was designed based on information of the skillful operators. The performance of the proposed intelligent gantry crane system is evaluated experimentally on a lab-scale gantry crane. The