University of Macau

Abstract

FUZZY CONTROL ON DOUBLE INVERTED PENDULUM

by Lei Kam Kin, Michael

Thesis Supervisor: Professor Chen Wei Ji
Electrical and Electronics Engineering

The inverted pendulum system has long been considered an intriguing problem for control theory and its application. The stabilization of such a system is a primary challenge for researchers in this field because the degree of difficulty of each problem depends on the type of the chosen system and the feasibility of the controller designed for that specific system.

In this thesis, the fuzzy logic is adopted to control the double inverted pendulum. Fuzzy logic systems are knowledge-based or rule-based systems. The heart of a fuzzy logic system is a knowledge base consisting of the so-called fuzzy **IF-THEN** rules. The triangular membership function is used in the fuzzification interface. In the knowledge base, the Mamdani inference is used to manipulate the **IF-THEN** rules and produce the conclusion. The fuzzification method is the center of gravity. The fuzzy control system consists three uncoupled fuzzy controllers that respond for Link2, Link1 and Cart respectively. These controllers are nonadaptive fuzzy controllers.

The trial-and-error approach is used in the design and implementation of the fuzzy control system. The mechanical behavior of the double inverted pendulum is studied. The structure of the fuzzy controller is designed. The parameters of the fuzzy controller are chosen based on the behavior of inverted pendulum. The fuzzy rules are constructed according the intuition and the experience. The quantities are applied to the real time implementation in the double inverted pendulum platform. The

performance of the pendulum system is not satisfactory firstly. The rules are fine-tuned or redesigned in a number of trial-and-error cycles until the performance is satisfactory. Finally, the double inverted pendulum is stabilized in upright position successfully. The purpose of this paper is to find a simple way of fuzzy control for the double inverted pendulum system. The advantages of the method are easy to implement, no mathematical model is needed and can get a not bad result. This method is useful for the nonlinear systems with uncertainty. This is the first time for this method applied to control the double inverted pendulum.