Research of Fuzzy PID Elevator Control System Based on PLC

HongjiJin

Sichuan Information Technology College, Guangyuan 628017, China

28779404@qq.com

Keywords: elevator system; fuzzy-PID control; PLC

Abstract. This paper first introduces the necessity of the trend of development and technological change, through introduce the latest developments in AC speed regulation technology ondevelopment of elevator technology. Compared with the PID controller and fuzzy PIDcontroller anti-interference ability, the fuzzy PID controller is selected to control the strategyat the core of the elevator control system. Using advanced PLC programmable controller, the fuzzy PID control is realized. The results show that through the fuzzy PID, the elevator has good control performance, fast response short transition time and robustness.

1. Introduction

Elevator as an important means of transport in modern architecture, there is a big difference with the conventional means of transport. At the same time, the elevator has been widely used in people's daily life. So in order to achieve high quality operation of the elevator, effective elevator electric control technology must be used as a guarantee. The elevator technology development is also facing some problems. For example the elevator should be comfortable, efficient,safe-operated, energy saving and cheap.

Under such background, this paper aims to put forward a kind of control algorithm which is better than the traditional PID control, so as to improve the stability of the elevator operation speed and the accuracy of the leveling layer.

2. Fuzzy PID Method and Elevator Control System Modeling

2.1 Elevator Speed Curve

Beforethe elevator control system design is completed and put into operation, the elevator control indicators include three aspects:

(1) The efficiency of the elevator which means the speed;

(2) The comfort of elevator which means the stability;

(3) The leveling accuracy;

The operation process of all elevators can be summed up in three stages, start-up stage, stable operation stage and the stop stage.

Here, the main thing we discussed is the feeling caused by the change of elevator speed during the operation process. This feeling is called the riding comfort. This refers to the feeling of the elevator at the start up and deceleration stage. This feeling will change with the acceleration and deceleration. The greater the change is, the worse the riding comfort will be. However, if the design is only focused on the comfort of the elevator and its operating speed is ignored, it will greatly reduce the efficiency of the elevator. Therefore, it is required that the elevator should satisfy the comfort of the passenger, while ensuring the efficiency and accuracy of the elevator. Finally, the ideal elevator speed curve is proposed and the speed curve is shown in Figure 1.

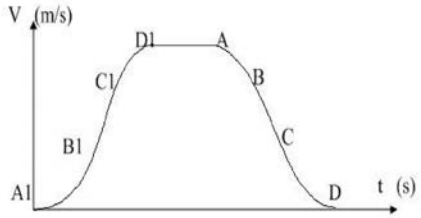

Fig.1 The ideal elevator speed curve

It can reduce the passengers' sense of being overweight and weightlessness during the process of starting and stopping.In this paper, the control system needs to be based on the above elevator speed curve to achieve the stable operation of the elevator. The passengers can avoid the sense of overweight and weightlessness to achieve the goal of a comfortable ride ladder.

2.2 Modeling of the Elevator Control System

(1) Permanent magnet synchronous motor model based on steady state

The mathematical model of the permanent magnet synchronous motor and frequency converter is very complicated, and it is difficult to establish.In order to facilitate the experiment, the mathematical model is simplified as follows：

$$G_1(s) = \frac{4}{75s^2 + 0.8s + 2.64}$$

(2) Inverter model

In engineering practice, the transfer function of inverter can be set as a small inertia link or a proportion link in the specific circumstances. In this paper, the inverter mathematical model is set as an inertia link. So the transfer function between the control voltage and the output voltage is shown as follows:

$$G_2(s) = \frac{U_d(s)}{U_k(s)} = \frac{K_s}{T_s s + 1}$$

(3) Elevator control system model

According to the analysis of the mathematical model of the elevator body in front of the elevator, the simulation model of the speed response can be established. Reducer can be simplified as a proportion link. The model of elevator control system is shown as follows:

$$G(s) = G_1(s) + G_2(s)$$

$$G(s) = \frac{20}{80s^2 + 0.5s + 2.64}$$

2.3 Fuzzy PID Method

The fuzzy controller applied in this paper is an intelligent controller, which is described by the rules of language and is composed of linguistic variables.The controller does not control by the precise mathematical model. The controller is robust and can be applied to nonlinear, time varying and delay systems.However, the fuzzy controller has a long response time and poor sensitivity in the control performance, so the fuzzy controller and PID controller are combined in this paper. Figure 2 shows the fuzzy PID control method.

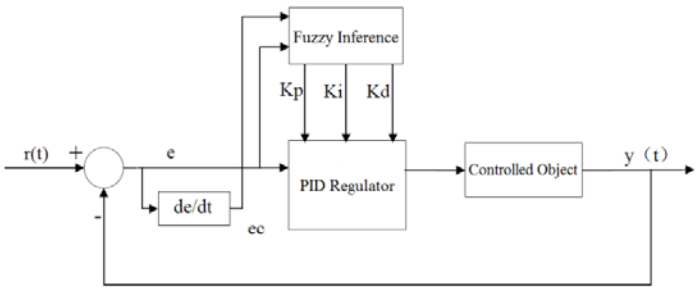

Fig.2 Fuzzy PID Control Method

3. PLC Implementation of Fuzzy Control Algorithm

Fuzzy control algorithm is the core of the fuzzy controller. Based on the actual production process and the operator's experience, the fuzzy control rule table will be listed. According to the final fuzzy inference rules, the corresponding control parameters will be determined. The control system is the core operation by PLC.

The two-dimensional fuzzy controller is currently widely used. This kind of fuzzy controller takes error change rate Δeand error e as theinput variables.The control volume U is taken as the output variable. Here, the fuzzy controller uses the S7-200 of SIEMENS PLC to realize. The system structure diagram is shown in Figure 3.

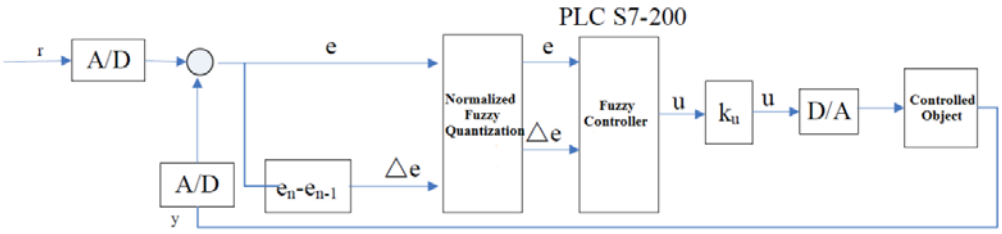

Fig.3 The system diagram in PLC

4. Result Analysis

The comparison results of fuzzy PID and PID are shown in Figure 4. According to the results, the performance of fuzzy PID based on PLC can be discussed. When the load is suddenly increased, the elevator with fuzzy PID control method can be timely adjust the system to effectively weaken the interference signals, and quickly re-enter a predetermined steady-state operating point. In this way,the passengers will feel more comfortable. However, the performance of PID control is slightly less excellent than the performance of the fuzzy PID control system.

The results show that after the elevator control system using fuzzy PID control strategy, it is very effective to improve the adaptive ability and robustness of the elevator. It is more satisfactory than the PID control method.

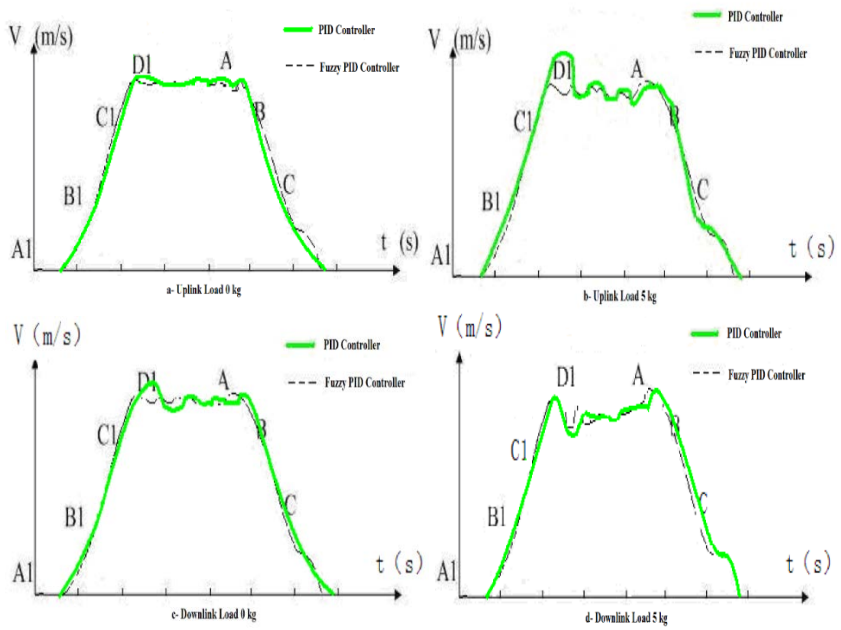

Fig.4 Comparison results of fuzzy PID and PID

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