



Application of fuzzy control method in a tunnel lighting system

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ABSTRACT

In order to meet the requirements of driving safety and energy-saving of lighting in tunnel, a fuzzy control method is adopted to design the tunnel lighting control system. A fuzzy control model for the tunnel lighting control system is established with tunnel exterior environment luminance, traffic volume and vehicle speed information as inputs and tunnel interior light luminance as output. Membership functions of environmental parameters and fuzzy control rules are designed based on “Specifications for the Design of Ventilation and Lighting of Highway Tunnels (China)” and experts’ relevant experiences. The tunnel exterior environment luminance fit-curve and the tunnel interior luminance fit-curve are constructed by experimental data with the fuzzy control model on sunny days. Errors between theoretical luminance data and simulation luminance data with the fuzzy control model are less than 5%. Comparison between luminance data from fit-curves and luminance data from original curves (no light-tuning or class light-tuning) shows that the fuzzy control system has a notable energy-saving effect (saving more than 50% energy to no light-tuning and more than 20% to four-steps light-tuning), and nice adaptability.

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1. Introduction

Tunnels are important parts of highway transport, and the operating cost of tunnel traffic is huge. How to reduce operating costs of the tunnels with good safety performance has become a focus issue that the transport department is be concerned with. Tunnel lighting is essential for the tunnel system, its quality directly affects driving safety, it is also the largest energy consumption unit in the tunnel’s engineering [1]. In the mountainous regions of China, most tunnel lighting systems have been at a low level and high energy consumption stage for a long period of time because of the restriction of geographical locations and limit of economic conditions. China has advocated vigorously to build an economic society and it is imperative to improve the quality of tunnel lighting systems [2]. In this paper, a tunnel lighting control system is designed using a fuzzy control method to adjust tunnel interior luminance constantly in accordance with the changes of tunnel exterior environmental luminance, traffic volume and driving speed to meet the demands of tunnel lighting, which ensures driving security in the tunnel and saves the energy of tunnel lighting greatly.

2. Vision problems of tunnel lighting

Unlike road lighting, lighting is also needed in tunnels during the daytime, and the lighting problems are more complex than night lighting. Like road lighting, a certain luminance level for pavement, traffic volume, driving speed and other factors needed to be considered in tunnel lighting and the luminance level should be synthetically determined by the driver’s safety and comfort, especially in the tunnel entrance and corresponding sections of the tunnel where human visual adaptation must be considered. According to the CIE (Commission International d’Eclairage) technical report, “when driver’s approach, enter

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