Chapter 11
The Development of Parameters and Warning Algorithms for an Intersection Bus–Pedestrian Collision Warning System

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ABSTRACT

This study presents the conceptual design of an intersection bus-pedestrian collision warning system for bus drivers approaching an intersection. The basic parameters of the proposed design concept include the bus drivers' perception-reaction time, the emergency deceleration rate of the bus, and pedestrian walking speed. A bus driving simulation was designed and conducted to analyze bus drivers' responses to unexpected pedestrians crossing unsignalized intersections or signalized intersections during a green light interval for parameter analysis. The timings of auditory warnings and visual warnings, the locations for vehicle detectors and pedestrian detectors, and the locations for visual warning devices were also developed after analyzing the experimental results. The experimental results also highlight some important characteristics of bus driving behavior at intersections. Moreover, bus drivers really pay attention to the warning messages. Finally, this study develops and discusses some warning algorithms.

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INTRODUCTION

Intelligent Transportation Systems (ITS) are designed to solve problems such as traffic accidents, congestion, and environmental impact by applying advanced information, communications, electronics, mechanics, and control technologies to transportation management and traffic systems (Chang & Chen, 2001; Sussman, 2005). The rapid development of information and communications technologies has made it possible to apply advanced techniques to solve traditional traffic problems. The recent development of ITS in advanced countries not only enhances service quality for most road users, such as vehicle drivers, but also improves transportation problems for road vulnerable individuals, such as pedestrians. Using ITS technologies to guarantee the safety of pedestrians at intersections has become an important issue because intersections are the places where pedestrians can easily conflict with vehicles (Fontaine & Gourlet, 1997; Najm, Smith, & Smith, 2001; Sarkar, Van Houten, & Moffatt, 1999). To improve pedestrian crossing safety at intersections, traffic engineers usually design pedestrian phases in signal timing plans. However, some intersections in rural areas cannot be signalized due to installation costs and vehicle delay issues. Therefore, protecting pedestrians who are crossing the roads from accidents at unsignalized intersections is a major concern for traffic engineers and government authorities trying to improve road safety. One way to provide the crossing pedestrians with the higher right of way at unsignalized intersections is to enact traffic regulations that force drivers to stop to allow pedestrians to cross the road. Regulatory signs can also be installed ahead of an unsignalized intersection to remind drivers to yield to crossing pedestrians. Examples of these signs in the Manual on Uniform Traffic Control Devices (MUTCD) (2003) include "Yield Here To Pedestrians" signs (R1-5, R1-5a) and "In-Street Pedestrian Crossing" signs (R1-6, R1-6a). Another way to grant pedestrians the right of way is to develop an intersection pedestrian collision warning system (IPCWS). An IPCWS is a pedestrian protection system that integrates advanced detection technologies, warning devices, and collision warning systems to provide timely alert messages to drivers and pedestrians for collision avoidance at intersections. This system can be used to prevent vehicles from colliding not only with pedestrians legally crossing the road at unsignalized intersections, but also pedestrians illegally crossing the road at signalized intersections.

To improve pedestrian safety at unsignalized crossings, much research has been devoted to analyzing intersection or mid-block warning devices for collision avoidance. Fitzpatrick et al. (2006) summarized the major evaluation findings for various pedestrian crossing management methods at uncontrolled locations, including traffic signals and red beacon displays (Fairfax, 1999; Glock, Nassi, Hunt, & Fairfax, 2000; Hendrickson, 1988; Voss & Parks, 2001), flashing beacons (Huang, 2000; Van Winkle, & Neal, 2000), in-roadway warning lights (Evans, 1999; Godfrey & Mazzella, 1999; Huang, 2000; Huang, Hughes, Zegeer, & Nitzburg, 1999; Prevedouros, 2001; Tobin, 1999), motorist warning signs and pavement markings (Van Houten & Malenfant, 1992; Van Houten, Malenfant, & McCusker, 2001; Van Houten, McCusker, Huybers, Malenfant, & Rice-Smith, 2002), and crosswalk pavement markings (Gibby, Stites, Thurgood, & Ferrara, 1994; Herms, 1972; Jones & Tomcheck, 2000; Knoblauch, Nitzburg, & Seifert, 2001; Knoblauch & Raymond, 2000; Zegeer, Stewart, & Huang, 2002). The research team found that a combination of crossing treatments is likely to be more effective for pedestrians and motorists at high-volume and high-speed roadways and intersections. In addition, flashing beacons activated by a pushbutton or an automated sensor are more effective for motorists than continuously flashing