

A Review of Research on Pedestrian-vehicle Conflict in Non-signal-controlled Road Sections

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Abstract: Pedestrian crossings, as the main traffic facilities for pedestrians crossing the street, play an important role in ensuring the safety of pedestrians crossing the street. However, there are many places on domestic crosswalks without signal control, which leads to the interaction between vehicles and pedestrians on the crosswalk, which will not only cause traffic congestion, affect the normal traffic order, but also cause traffic accidents. It is of great significance to improve the traffic efficiency to strengthen the understanding of the seriousness of the conflict between people and vehicles in the non-signal control section, and to prevent the accident of drivers and pedestrians.

Keywords: No-signal control, Human-vehicle conflict, Review.

1. Introduction

In recent years, with the rapid development of my country's economy and the gradual expansion of the urban area, the travel demand of urban people and the number of domestic motor vehicles have increased rapidly. According to the statistics of the public security department, as of the end of March 2022, the number of motor vehicles has reached 402 million, of which 307 million are cars. There are 487 million motor vehicle drivers, including 450 million car drivers. Among the fatalities caused by traffic accidents, pedestrians have the highest fatality rate, reaching 29.7% [1]. In fatal accidents, most of the deceased in the United States and Europe are passengers, while in China, more than 60% of the deceased are pedestrians and other vulnerable traffic groups [2]. It is the weaker side in this conflict. Not only do they have no protective equipment, but the road infrastructure is more inclined to the use of motor vehicles. This is also very likely to cause conflicts between pedestrians and vehicles, which are often manifested in no-signal control sections.

1.1. Theoretical Basis of the Collision Between People and Vehicles in the Non-signal Control Section

1.1.1. Description of the Conflict Between People and Vehicles in the Non-signal Control Section

A pedestrian crossing without signal control refers to an area where there is no safety signal light, and there is interweaving and conflict between motor vehicles and pedestrians. It is an important part of the road traffic network. Since pedestrians crossing the street and motor vehicles crossing the zebra crossing are intertwined at the same time, the pedestrian crossing has become a high-incidence location for people-vehicle conflicts. In addition, compared with the signal control part, pedestrians and drivers compete for the right of way due to the lack of indication and guidance of signal lights, which greatly threatens the safety of pedestrians and drivers, as shown in Figure 1.

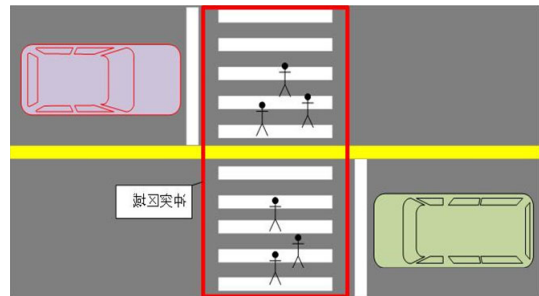


Figure 1. No-signal control pedestrian-vehicle conflict on a pedestrian crossing

1.2. Conflict Characteristics of People and Vehicles on Non-signal Control Sections

Uncertainty, severity and avoidability are the most basic characteristics of human-vehicle conflict.

Uncertainty: The individual psychological characteristics of the driver are uncertain when a pedestrian and a motor vehicle collide in a certain period of time, and some external factors such as driving environment, road environment, pedestrian psychological factors and pedestrian behavior characteristics will lead to the conflict between people and vehicles results are different.

Severity: When there is a conflict between people and vehicles, the traffic accidents caused by the conflict between people and vehicles have different degrees of severity. According to the different degrees of severity, the conflicts between people and vehicles can generally be divided into no conflict, general conflict and serious conflict, in which traffic accidents occur. Conflicts are generally serious conflicts.

Avoidability: Pedestrians and drivers will also increase their energy and focus on looking around at crosswalks, and try to avoid conflicts as much as possible out of survival instinct. Relevant studies have shown that the acceptance behavior of pedestrians through the gap in the street at the pedestrian crossing on the non-signal-controlled road section (pedestrians look for the vehicle gap at the right time when crossing the road) also affects the safety of pedestrians, and drivers will also choose to observe that there are no pedestrians accelerating at the pedestrian crossing. Pass through the human-shaped crosswalk [3].

2. Human-Vehicle Conflict Research

2.1. Research Status at Home and Abroad

Li et al.[4] proposed a fuzzy cellular automata (FCA) model to explore the impact of pedestrian-vehicle collisions on safety and efficiency at two-lane roundabouts. Through the specific index research of efficiency and safety performance, it is shown that the circular vehicle can run smoothly under the condition of low traffic flow, but when the traffic flow reaches a certain level, the circular system is prone to traffic congestion.

Payam et al.[5] proposed a pedestrian-vehicle interaction and collision avoidance mechanism modeling framework based on Markov Game (MG). Pedestrian-vehicle collisions in mixed traffic environments are extracted using computer vision algorithms. The reward functions of pedestrians and vehicles are recovered by a multi-agent adversarial anti-reinforcement learning method, and the optimal policies and collision avoidance mechanisms of road users are predicted by multi-agent actor-critical deep reinforcement learning. The results show that the multi-agent modeling approach has advantages in predicting road user behavior, collision avoidance mechanism, and time to post-violation (PET) compared to the baseline single-agent model.

Xu Lunhui et al. [6] analyzed the influencing factors of decision-making behavior of both parties and constructed a gain-loss matrix by studying the interaction between pedestrians and motor vehicles crossing the street. Cumulative prospect theory and herd effect optimization model are introduced to optimize the decision probability and revenue function; the results show that four different evolution results can be formed: "people give cars", "cars let people", "people and cars give each other" and "people and cars collide".

Jiang Pei [7] analyzed the behavior differences of pedestrians from the perspectives of different ages and genders according to the main characteristics of pedestrians, and analyzed the vehicle speed and avoidance behavior through vehicle characteristics. Analyze the behavior of people and vehicles under different lanes through road characteristics. OP regression analysis is used to analyze the factors and causes that significantly affect the severity level of the collision between people and vehicles in the non-signal control section.

Tang Peng et al. [8] analyzed the pedestrian's crossing trajectory, crossing time, motion yaw rate, and non-motor vehicle's crossing expansion rate and arrival law on the non-signal control section. and put forward corresponding problems and measures.

Zhang et al. [9] used detection and tracking techniques in computer vision to extract pedestrian and vehicle features from video data. An LSTM (Long short Memory) neural network is proposed to predict pedestrian-vehicle collisions 2 s ago. The established model achieves 88.5% accuracy at a signalized intersection, and the results show that the proposed model is expected to be implemented in different locations. Furthermore, the proposed model can also be used to develop a collision warning system in a connected car environment.

Chen Zhongnian [10] analyzed the actual crossing behavior and crossing mode selection of pedestrians and bicycles on the non-signal control section, and used the average method and the Raff method to obtain the critical crossing clearance value and test it, which is the critical crossing clearance index for the non-signal controlled intersection. Provide theoretical

reference value.

Sheykhfard et al. [11] studied the conflict between pedestrians and vehicles by using active methods and passive methods. The results of the active method showed that dangerous behaviors are the most important factors that threaten pedestrian safety, such as illegal speeding, non-compliance with traffic laws, and illegal overtaking by drivers, and illegally crossing the road. Furthermore, risk perception and decision-making processes are the most important link linking road users' attitudes and behaviors in dangerous driving situations. Research through passive methods can identify the causes of crashes, understand road user attitudes towards safety, and identify road user behavior patterns in specific situations, while active methods can provide a more detailed understanding of road user behavior and attitudes. The extrapolation of the results will help to better understand the behavior of road users and provide a basis for research on advanced driver assistance systems (ADAS).

2.2. Discussion on the Current Research Status

The current research on non-signal-controlled road sections mainly considers the different characteristics of pedestrians and vehicles at crosswalks. The main characteristics of pedestrians include different ages, gender, behavior differences, pedestrian crossing time, and crossing trajectories. The main characteristics of vehicles are vehicle speed, avoidance behavior analysis, etc., and then the analysis and modeling of pedestrian and vehicle conflicts are carried out in combination with the characteristics of pedestrians and vehicles. Using fuzzy cellular automata model to explore the impact of human-vehicle conflict on safety and efficiency, using detection and tracking technology in computer vision to extract pedestrian and vehicle features from video data, an LSTM neural network is proposed. The running average method and the Raff method provide theoretical reference value for the critical crossing gap at the unsignalized intersection, but more optimized algorithms are needed to make the social model of the unsignaled controlled intersection more socially adaptive. Active methods and passive methods are used to carry out Human-vehicle conflict research, active methods to understand the behavior and attitudes of road users, and passive methods to identify the causes of car accidents and provide a basis for future driving systems.

3. Summary

In this paper, by reviewing a large number of documents on people-vehicle conflicts, and deeply understanding the results of many domestic and foreign scholars on people-vehicle collisions on non-signal-controlled road sections, this paper summarizes this article. It is mainly summarized from the following aspects:

(1) Understand the seriousness of current traffic accidents through relevant data, and realize that there is a serious contradiction between motor vehicles and pedestrians for the priority to use the road, which is also the main reason for the conflict between people and vehicles.

(2) Objectively describe the characteristics of human-vehicle conflict, mainly including uncertainty, severity and avoidability, which are the most basic characteristics of human-vehicle conflict.

(3) The research results of other scholars have been learned from relevant research at home and abroad. At present, research is mainly carried out through the characteristics of

pedestrians and vehicles, building models, and using algorithms. With the continuous development of Internet technology, in the future, through traffic big data It is an inevitable trend to consider more comprehensive parameters related to pedestrians and vehicles to study related methods such as , machine learning and so on.

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