Traffic Control at Signalized Intersections based on Pedestrians' Group Psychology Crossing Behavior

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Abstract—the intersection is the key node to urban traffic, also the traffic accident taking place frequently in cities. The safety of traffic disadvantaged group, which is pedestrian, is obvious. The behavior of violating traffic laws to cross the road is not only the key factor of traffic disorder，but also the main cause of pedestrians traffic accident. Therefore, it is necessary to find out the rule and reasons of violating the traffic laws to cross roads, and put forward the new idea to prevent and correct the improper behavior.

Keywords-Pedestrians' group psychology; Traffic accident; Traffic control; Signalized intersection

I.   INTRODUCTION (*HEADING 1*)

Walking is one of the most important people to travel, the proportion of urban pedestrian traffic accounted for 40% ~ 60% of total residents travel [1, 2]. Intersection as the convergence of different traffic junction, there is a possibility to squeeze each other vehicular and pedestrian collision or collision, and the most likely to pedestrian flow at the intersection, illegal crossing the road [3]. Pedestrian crosswalks are exposed to the risk of road vehicles traveling direction, connecting the entire system is an important part of various parts of the walk, but also the entire walking system is the most secure, the most important aspects[4,5].

The main street there is a pedestrian crossing the street needs, safety should also be across the street had to determine the main pedestrian street [6]. Therefore, it is necessary to eliminate the interference of other safety factors across the street, focusing on the psychological characteristics of pedestrian traffic analysis itself, because the latter is the basis of the intersection of pedestrian safety research. Especially in China, the mixed traffic flow is an important feature of urban traffic, the study of psychological characteristics of pedestrian traffic, to reduce pedestrian accidents, pedestrian safety, improve intersection capacity and reduce traffic delays is significant [7].

II.   PEDESTRIAN CROSSING TRAFFIC CHARACTERISTICS

Pedestrian safety in road traffic safety is an important part of the safety awareness of pedestrians and motor vehicle drivers is more than weak. In the intersection, pedestrian violations very prominent phenomenon is induced traffic congestion and pedestrian cross signal violations over the main street intersection herd mentality Pass accident.

According to statistics, about one-third of the total number of road traffic accidents with pedestrians directly related to accounting, road traffic accidents in our country, the way of foot traffic death toll was about 25% of the total number of deaths in accidents. In the past decade, the number of traffic fatalities caused by pedestrian violations accounted for about 20% of the total number of deaths accidents, pedestrian accidents highly visible intersection onset can not be ignored, for providing a safe pedestrian crossing across the street environment is imminent. In this paper, across the street from the pedestrian perspective herd mentality around signalized intersection pedestrian crossing the street in violation of the traffic signal behavior, conduct research intersection pedestrian safety issues.

Parking way control and deceleration control can greatly reduce the time delay of the main road vehicles, but they may cause delays secondary road vehicles are large; signal control can effectively reduce the secondary road vehicle delay, but the inevitable result of the main road car certain vehicles delay. Therefore need to by comparing the intersection control mode before and after the change of the size of the average delay time, to determine whether should use the intersection signal control mode.

Those who are able to pass key traffic capacity and signal distribution of the whole intersection design plays a role in determining the flow of traffic. By the critical traffic flow definition, if given enough time critical traffic lights traffic, to meet the capacity requirements, then pass the requirements of other anisotropic traffic flow naturally satisfied, so the key traffic is relatively poor traffic condition. Critical traffic is mainly based on comparison results necessary to pass time of each flow required to determine. Determine the critical traffic is equivalent to finding the "longest closed path traffic signal phase and the corresponding Diagrams", the so-called critical path. At present, in the calculation of parking / deceleration control research of intersection delay time aspects of the way although many, but truly practical is more, complexity and the intersection of traffic condition, so the park / deceleration mode of contrast and signal control mode intersection average delay time control main way still remain at the qualitative analysis level.

Under normal circumstances, the signalized intersection pedestrian crossing includes the following aspects:

Pedestrian crossing situation reaches → judgment → implemented across the street. Specific process is shown as Figure 1.
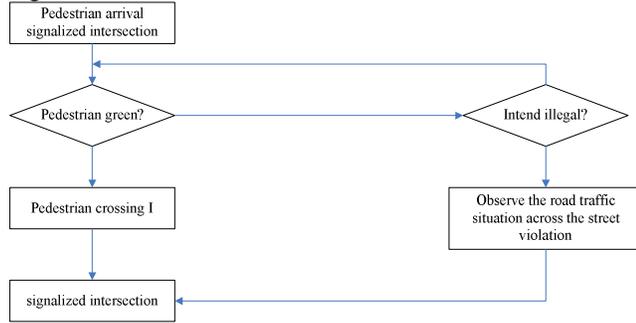

Figure 1. Specific process shown

III. THE REASON ILLEGAL PEDESTRIAN CROSSING

China's urban roads in random pedestrians cross the street, not in the specified place across the street, violation of traffic control signals are common occurrences. Pedestrians crossing illegally interfering the normal passage of vehicles, leading to the intersection of health into a "disorder - poor security and inefficient - to extend the signal cycle - pedestrian violations increase - order even more confusing," the vicious cycle. Some cities try using forced management approach, and even control the illegal and not acceptable pedestrian impose administrative detention, but with little success and unsustainable.

Once deregulation, and immediately return to the status quo. The reason, the following main points:

1) lack of existing norms enough attention to pedestrian traffic; regarding pedestrian crossing traffic laws, there are still some blind spots and errors, such as the most basic definition of pedestrians crossing the street color.

2) China has not yet established a sound system of traffic safety education and awareness, lack of traffic safety education sectors has led to traffic participants lack basic traffic knowledge, modern city traffic awareness and literacy also needs to be improved.

3) the intersection of transportation facilities planning and design and construction management concept yet to be different levels of pedestrian crossing the road to give a different position, extreme or only safeguard the interests of motor vehicles starting at the expense of pedestrians, or from the perspective of maintaining the weak indulgence pedestrian violations; intersection ubiquitous pedestrian crossing facilities imperfect, as long pedestrian crossing distances, lack of road to stop the central space, the lack of pedestrian protection facilities, pedestrian red long time and so on.

$$d = d_e + d_r = \frac{C(1-\lambda)^2}{2(1-y)} + \frac{x^2}{2q(1-x)} \qquad (1)$$

$$d = d_e + d_r = \frac{C(1-\lambda)^2}{2(1-y)} + \frac{N_s \cdot x}{q} \qquad (2)$$

$$H = CD = \frac{q \cdot t_R}{S - q} \cdot S = \frac{q \cdot C \cdot (1-\lambda)}{1 - y} \qquad (3)$$

In the steady state theory, while also taking into account the random fluctuations due to the vehicle arrival rate, individual signal cycle after the green light will appear excess retention team, but the excess number of stranded vehicles is not in a certain growth down, but after the one or two signal cycle and then back to the equilibrium state of stranded vehicles the original. So the steady state theory to the individual signal cycle lights after the end of the excess retention team as a random process. The fixed number theory is on the contrary, it is the supersaturated block as a certain situation was analyzed, without considering the random arrival of vehicles blocked level effect.

The research object of fixed number theory is that, when the intersection entrance over saturated traffic conditions, mathematical expressions of delay time and the number of stops and the lane intersection. Fixed number theory to establish some basic assumptions need to be:

The import road vehicle average arrival rate stable during the whole period of time;

The entrance section of the traffic capacity of the whole time constant;

At the onset of the time of the queue length is zero;

In the whole time, supersaturated queue length of the vehicle with the growth of time linear increase.

IV. PEDESTRIAN CROSSING THE PSYCHOLOGICAL AND BEHAVIORAL CHARACTERISTICS

Compared with vehicle traffic, pedestrian traffic is more freedom and flexibility, the typical pedestrian crossing psychology include:

1) Saving convenience psychology. Knowing that should obey the traffic rules, but for the sake of temporary convenience, shorten walking distance, reduce travel fatigue, rapid arrival, intentional violations, arbitrary cut corners or forced through a red light.

2) Herd mentality. A man crossing the road, usually walked gingerly press the crosswalk lights indication; when many people at the same crossing, if one person taking the lead through a red light or cut corners, other pedestrians will follow suit, resulting in the situation of law is not responsible for the public .

3) Group psychology. Seen is a barrier to pedestrian counterparts, resulting in a psychological sense of security blind.

4) Chances. Some pedestrians think that even in the face of conflict and vehicles, the vehicle will take the initiative to avoid, do not hit pedestrians or pedestrians hit probability is very small; case of danger, they can also quickly and safely escape. So, even if their illegal crossing, there will be no danger.

According to the vehicle in the car / deceleration control rules way intersection, affect the vehicle on the main road is almost not affected by vehicle secondary on the road, and vehicles on the road between the minor must wait until the

vehicle on the main road appear large enough to cross the gap, to pass. Therefore, reduction in the park / way control mode, the maximum capacity of the intersection of the main road is similar to the saturated flow; traffic capacity and maximum intersection of secondary road depends mainly on the main road, the neutral number according to the main road traffic can be as minor road vehicles through provides the calculated secondary road the maximum number of vehicles can pass.

Organizational of pedestrians crossing the street illegally available classical theory - theory of planned behavior (Theory of Planned Behavior, TPB) to explain, TPB basic model architecture shown in Figure 2. Pedestrians crossing the street illegal behavior are directly or indirectly due to attitude, subjective norm, perceived behavior control and a series of causes.

A) attitude that pedestrians on illegal street attitude, partly based on the pros and cons of pedestrians on the illegal crossing to produce results, such as "whether to save time?", "Whether accidents will happen? How is serious accident?" And so on.

2) Subjective norm refers to pedestrians respect for laws and regulations, identity and compliance awareness, as different people "is not necessarily to comply with laws and regulations," the answer is not exactly the same.

3) Cognitive behavioral control, mainly referring to pedestrians crossing the street on the possibility of violation and the degree of difficulty understanding their own factors affected pedestrians, traffic and environmental factors, such as whether there are other pedestrians crossing the street illegally, whether refuges, whether there police presence and so on.
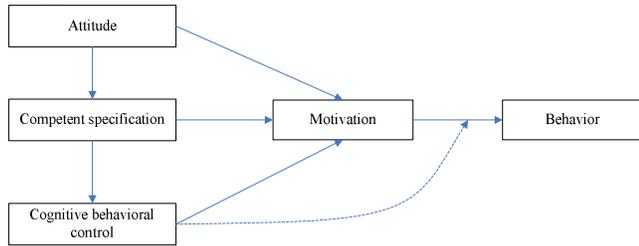

Figure 2. Basic framework of TPB

V. PEDESTRIAN CROSSING TRAFFIC ORGANIZATION AND CONTROL MEASURES

1) The difference between the different processing pedestrian traffic of people and vehicles under the right of way. Right of way is to pedestrians and motor vehicles and road class existence in close contact. The vehicle has absolute priority in the fast road right of way on the road and below grade roads; pedestrians have the right of way of absolute priority. From the expressway, trunk roads, secondary roads to slip right of way in order to reduce motor vehicle, pedestrian right of way in order to improve. Right of way is to be based on the size of vehicles, considering the extent to how to meet the needs of pedestrians crossing the street and to determine the appropriate pedestrian traffic organization and control strategies.

$$L_d = \frac{\sum_{i=1}^{n_1} N_i + \sum_{j=1}^{n_2} M_j}{n_1 + n_2} = \frac{\sum_{i=1}^{n_1} i \cdot (q \cdot C - S \cdot t_G) + \sum_{j=1}^{n_2} (n_1 \cdot (q \cdot C - S \cdot t_G) - j \cdot S \cdot t_G)}{n_1 + n_2} \quad (4)$$

$$= \frac{(1 + n_1) \cdot (q \cdot C - S \cdot t_G) \cdot n_1 \div 2 + (n_1 \cdot (q \cdot C - S \cdot t_G) - S \cdot t_G) \cdot n_2 \div 2}{n_1 + n_2}$$

$$= \frac{(q \cdot C - Q \cdot C) \cdot n_1^2 + (q \cdot C - S \cdot t_G) \cdot n_1 + (q \cdot C - Q \cdot C) \cdot n_1 \cdot n_2 - S \cdot t_G \cdot n_2}{2 \cdot (n_1 + n_2)}$$

$$= \frac{(q - Q) \cdot n_1 \cdot C}{2}$$

2) Trade-offs to reduce vehicle-pedestrian conflicts and increase the wait time relationship. Transportation designers to reduce vehicle-conflict, often take some measures, such as the complete separation of pedestrian traffic and turn on the signal control settings and other pedestrian phase, the starting point is to improve pedestrian safety. However, these measures will actually increase pedestrian red light in time to some extent, but induced a pedestrian violation, reduce pedestrian safety, shown in Figure 2. Right of way is to pedestrians and motor vehicles and road class existence in close contact. The vehicle has absolute priority in the fast road right of way on the road and below grade roads; pedestrians have the right of way of absolute priority. From the expressway, trunk roads, secondary roads to slip right of way in order to reduce motor vehicle, pedestrian right of way in order to improve. Right of way is to be based on the size of vehicles, considering the extent to how to meet the needs of pedestrians crossing the street and to determine the appropriate pedestrian traffic organization and control strategies. Therefore, we must weigh reduce vehicle-pedestrian conflict and increase the relationship between waiting time and avoid pedestrian traffic organization and control strategy backfired. Such as Figure 3, Figure 4.
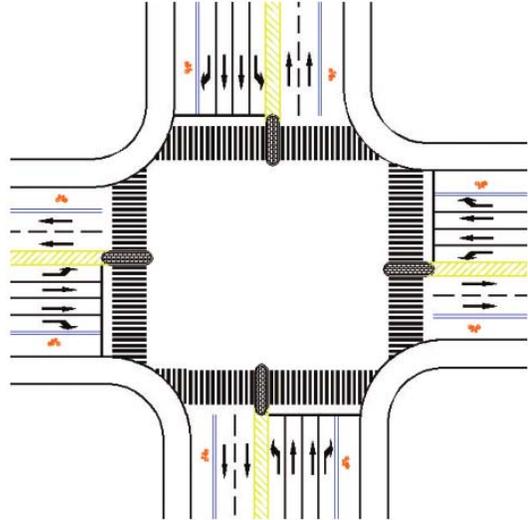

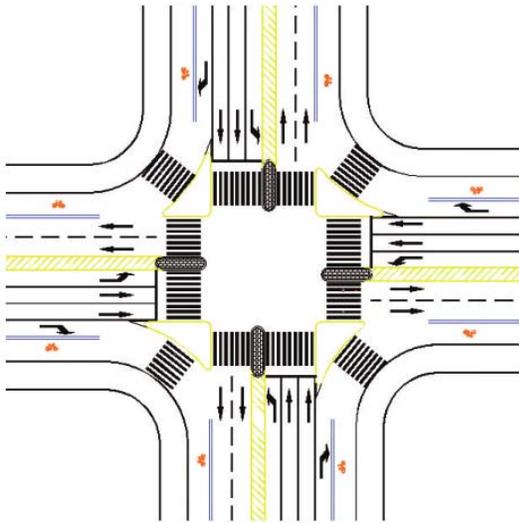Figure 3.   without triangular islands

Figure 4.   with triangular islands

The traffic police command and control requirements into the vehicles in the intersection according to the traffic police command gesture in turn pass. Compared with the traffic signal control mode, command and control of the traffic police is a more primitive mode of traffic control, but because of our intersection vehicles mixed OK very prominent phenomenon, city residents traffic awareness is very weak, a lot of drivers and pedestrians at intersections (especially in some special cases below) on the signal lights and traffic signs simply ignored, free running and crossing the road, so the traffic police command and control a very effective control method is still. The traffic police command and control is conducive to the treatment of sudden events, for temporary traffic flow fluctuation appears has the very good guiding function, mainly used in the following some special cases: (1) the fault occurrence of traffic signal system; (2) the intersection of traffic accident, the serious traffic jam; (3) during the large scale activities or road construction.

Despite its overall control effect, comprising a plurality of intersection, arterial road coordinate control and coordinated control should be more advantage than single point control of each intersection, but according to the critical factors influencing China's urban intersection signal control, combining the development of road traffic control theory, point control mode should be cause enough attention or. First, China's urban intersection condition is complicated, the mixed traffic flow is very serious, the intersection between large distance and mutual influence is not very obvious, appropriate uses intersection point control; secondly, point control mode is a basic form of control traffic signal control, is the foundation to realize the line of control and surface control; thirdly, point control has the advantages of simple equipment, investment and maintenance convenient and practical significance; finally, the research point control gradually thorough, the use of modern intelligent control technology has achieved research results concern.

Induction control is based on the vehicle detector to the intersection traffic flow condition; signal makes the intersection in each direction control method adapted to display time of traffic demand. Induction control of vehicle random arrival adaptability is larger, can make the vehicle at the stop line as little as possible to stop, so as to ensure the smooth flow of traffic effect. Induction control with good real-time performance, strong adaptability, applicable to vehicle flow variations are large and irregular, primary and secondary phase difference, the need to reduce car traffic trunk road disturbance situation, however the existence of poor coordination, not easy to realize the on-line control of the shortcomings. For example, for the detection of coil is embedded in the half induction control roads, secondary roads vehicle may affect the green wave coordinated control of the main trunk.

Traffic signal timing is the final goal of getting the signal distribution optimization parameters: traffic signal phase and phase sequence, signal cycle length, green signal ratio of each phase signal. Traffic signal control scheme not only guarantees the good results can be achieved in practical application, but also must consider the actual conditions of various constraints. Design of signal timing in timing of intersection, there are two kinds of design ideas: a train of thought is, first of all parameters are optimized and checked according to the practical constraint conditions and service level requirements, if does not conform to the constraint conditions and service level requirements, then the need for timing parameters even for optimization and adjustment of the corresponding the intersection of lane canalization and traffic signal phasing scheme; another idea is to first list various practical constraints, then the parameters with these constraints optimization. The end result idea that before a may not be optimal, but simple calculation method; after a train of thought that the results more scientific, but the optimization process is relatively complex, suitable for the application of computer software for calculation. Taking into account only for single intersection signal timing design principle to carry on the elaboration, thus the following a train of thought as an example, introduces the design process of the timing signal control scheme.

Intelligent control is a kind of has the function of learning, abstraction, reasoning, decision-making, control technology and make appropriate adaptive responses to the changing environment, in which some control rules based on fuzzy control, has strong real-time performance, robustness and independence, the design is simple and practical, convenient combination of thinking and experience, provide the way to another feasible for traffic signal control. However, the control strategy of intelligent control is more complex, the need for supporting the corresponding detection device.

If the vehicle is more minor road, at reasonable parking / deceleration way control settings for traffic signal control, can make the main road and secondary road vehicle on a continuous and compact through the intersection, thus increasing the whole intersection traffic capacity, improve the road traffic, to reduce the secondary road vehicles parking and delay. If the secondary vehicles on the road is very few, at this time is not reasonable will park /

deceleration way control settings for traffic signal control, will be due to minor road vehicles a few main road vehicles and to increase the number of unnecessary red time, thereby greatly increasing the main road parking and delay, vehicle reduce intersection utilization, even intersection traffic easily in the lower upper (or lower traffic volume time interval) induced traffic accidents, this is because when the main road to encounter a red light while parking driver for quite a long time did not see a car on the minor road traffic, they tend to run a red light incident caused intentionally or unintentionally thus, induced traffic accidents.

VI. CONCLUSION

Through the Internet, mobile media to establish the exchange of information and ideas between educators and college student's feedback, strengthen and improve the utilization and management of new media on campus, innovative methods of ideological and political education to improve the ideological and political level education. Should promptly assess the ideological and political education of college students use the content and effects of the Internet, mobile phones and other new media tools by college students on the campus Web site hits and student assessment and feedback as the ideological and political education of workers in the use of new media, the main reference standards, Students take advantage of new media for the conduct of appropriate and reasonable regulation, to avoid the erosion of bad information on college students, new media form a good moral atmosphere.

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