International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 02 | Feb-2018 www.irjet.net p-ISSN: 2395-0072

STUDY OF INTERACTION BETWEEN PEDESTRIAN AND VEHICLE AT UNDESIGNATED URBAN MID-BLOCK SECTION

Meetkumar R. Patel[1], Prof. Rena N. Shukla[2], Haresh D. Golakiya[3]

[1]Final year M.E. Student, Civil Engineering Department, L.D. College of Engineering, Ahmedabad, Gujarat, India
[2]Prof. Civil Engineering Department, L.D. College of Engineering, Ahmedabad, Gujarat, India
[3]Assistant Professor, GEC Dahod, Gujarat, India

Abstract - *With the help of development of technology, a growing number of traffic flow detection and analyses have been conducted by using video data. Time to collision (TTC) and post-encroachment time (PET) are two major parameters used to indicate the severity and probability of a potential collision and to capture an imminent vehicular accident. However, micro level pedestrian-involved collisions are less studied because they are hard to observe or record. This paper review various techniques which are used for safety assessment of pedestrians and study of interaction between vehicles and pedestrians. Time difference to collision (TDTC) parameter as a variation from TTC and PET is defined to fit the pedestrian-involved potential collisions/conflicts, analyze the interaction behavior between pedestrian and vehicles and assess the safety of pedestrians and vehicles at selected study locations.*

Key words: Pedestrians, Conflict, TTC, PET, TDTC.

1. INTRODUCTION

India accounts for more than 200,000 deaths because of road accidents, according to the Global Road Safety Report, 2015 released by the World Health Organization (WHO).

Since 2003, number of road accident in urban area in India are increased at rate of 8% according to MoRTH annual publication of 'road accidents in india-2016' total percentage involvement of pedestrians in fatal road accidents is about 20% which make pedestrian crossing being high-risk location.

Pedestrians are an integral part of the urban transportation system and they will remain as one of the most important mode of transport in urban environment. Moving on foot will continue to be feeder mode between any particular trip origin and final destination.

Very short trip lengths within urban environment would be more appreciated by walking compare to taking bus or taxi so long as facilities are being provided. Provision of adequate and safe pedestrian facilities in urban setting would arguable encourage more people to walk, thus increase the pedestrian traffic.

Intersections and mid-block sections are the two basic elements of urban transportation system that cater the requirement of vehicles and pedestrians respectively.

In countries like India traffic controls and space allocations are generally biased toward vehicular traffic and pedestrians requirements are not given due consideration. So interaction between pedestrians and vehicles frequently happen at road intersections and at mid-blocks. The pedestrian is often most vulnerable of all transportation system users. Accident between pedestrians and vehicles are examined in term of severity and numbers of collision happened between two road users.

The analysis of pedestrian – vehicle interaction based on 'conflict' is more suitable compare to study based on 'collision' because conflict occur more frequently compare to collision.

1.1 CONCEPT OF VEHICLE AND PEDESTRIAN INTERACTION

The majority of activities in urban areas are pedestrian oriented like shopping, recreational activities, bus stop, medical facilities, schools, etc. This increase the concentration to pedestrians rapidly. Road carries the mix traffic volume there by it may cause problems to pedestrians like delays to pedestrians crossing the road cause inconvenient to movement of vehicles and accidents involving the pedestrians, delays to pedestrians crossing the road cause inconvenient to movement of vehicles and accidents involving the pedestrians, Motorist do not care to stop or slow down speed of Vehicles at pedestrian crossing.

When length between two consecutive major intersections is more than 300 m, mid-block road crossings are provided according to IRC-103. It may be controlled or uncontrolled.

1.2 TRAFFIC CONFLICT INDICATORS

The concept of traffic conflict was proposed by Perkins and Harris (1967). According to him traffic conflict is any potential accident situation leading to the occurrence of evasive actions such as braking or swerving. This

definition is redefine and internationally accepted definition is given by 'an observable situation in which two or more road users approach each other in space and time for such an extent that there is a risk of collision if their movements remain unchanged.'

There is a set of indicators that continuously describe the process of conflict and may be used to classify its severity. The purpose is to see if it is possible to find a potential conflict point. This potential conflict (hazard) point is defined as the intersection of the pedestrian's and vehicle's predicted trajectories. The set includes several time-based indicators and the speed of the road users.

Time-to-collision (TTC) is described as the 'time that remains until a collision between two road users would have occurred if the collision course and speed difference are maintained.'

TTCi = (Xi-1(t)-Xi(t)-Li)/(Vi(t)- Vi-1(t)), where Vi(t)>Vi-1(t)

Post-Encroachment time (PET) is defined as the "time lapse between end of encroachment of turning vehicle and the time that the through vehicle actually arrives at the potential point of collision."

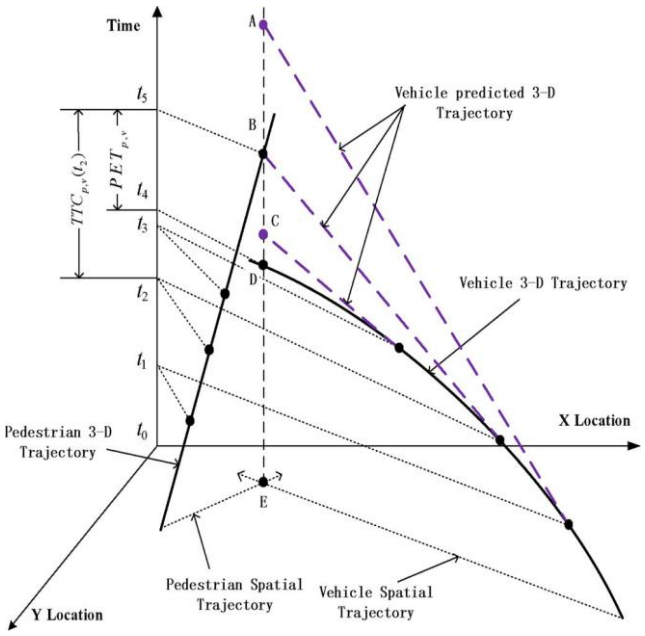

Figure 1 Trajectory of Pedestrian and Vehicle

Time difference to collision (TDTC) value at an instant t is defined as the time difference between a pedestrian and a vehicle traveling to the potential conflict point if their speed vectors remain.

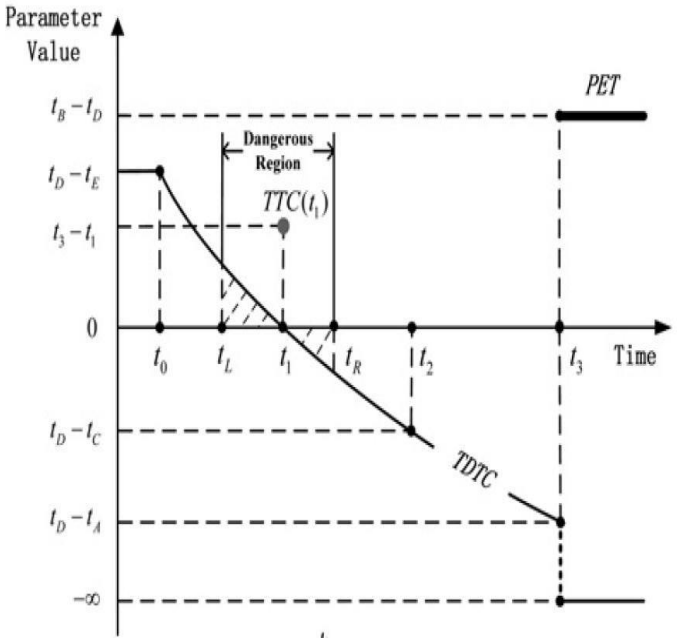

Figure 2 TTC and TDTC Calculation Graph

2. AIM OF THE *S*TUDY

The main aim of this study is to assess the safety of pedestrians at pedestrian crossing locations in urban areas where no due consideration is given to facilities for pedestrian and design and facilities are biased toward vehicular traffic.

3. CRITICAL LITERATURE REVIEW

The following are the previous research review based on application of engineering project.

Ning-Bo Cao et.al(2017) conducted study to make model to estimate spatial variations of overflow pedestrian trajectories. By video tracking, only trajectories of overflow violation pedestrians are collected. To estimate the spatial distribution of violation pedestrian crossing positions, Weibull distribution is applied at three cross-sections, then, the spatial distributions of overflow violation pedestrians' trajectories are gained by connecting crossing positions at three cross-sections. After using two sample *t*-tests for the difference of crossing positions at three cross-sections at a 95% confidence level, there is no significant difference according to analysis result.

Anush Konayakanahalli Chandrappa et.al. (2016) conducted study to investigate pedestrian related safety aspect in urban area by estimating two parameters, post-Encroachment time (PET) and Threshold waiting time (TWT) for pedestrian during crossing road. To calculate PET, the video was played and a mark on the road was identified and taken as the reference point. The time difference between two different classes of road users

moving over the reference point was recorded. The results indicate that at least 15% of the total number of pedestrians crossing the road had the chance of a serious accident with a vehicle. An ANOVA test was carried out to check whether the difference in PET between the intersection and the midblock section was statistically significant.

Xiaobei Jiang et.al. (2015) conducted study Focusing on the vehicle–pedestrian conflict, by identification of field observation, conflict situation and TTC calculation, a trajectory-based data matrix is created for understanding the entire conflict process. According to video frame, the position point of road user can recorded to form trajectory. In conflicts, the trajectory of conflict participant can reflect their movement during entire process. The global polynomial model was applied to transform the image coordinates to road coordinates. TTC for both samples fit the Weibull distribution, and slight differences can be found in the relationship analyses. For both countries, 3.0 and 1.0 s can be recommended as the average TTC and minimum TTC, respectively.

Yingying Zhang et.al. (2013) tries to extract data of road user movement from video data in order to analyses the conflict between pedestrian and vehicle and to evaluate pedestrian safety performance during conflicts. The time difference t collision (TDTC) parameter is used to fit the safety analysis on pedestrian-involved conflicts.

$$\text{TDTCi(t)} = \frac{X_{p.v}(t) - X_{p.i}(t)}{\dot{X}_{p.i}(t)} - \frac{X_{p.v}(t) - X_{v.i}(t)}{\dot{X}_{v.i}(t)}$$

In order to describe the whole conflict process of an angled pedestrian–vehicle conflict, both the two-dimensional (2D) spatial information and the time information are shown together in a 3D coordinate system. X-Y axes show spatial locations of the road users, and the Z-axis shows the time. The parameters most related to pedestrian safety are located using a sensitivity test, and a scene-based pedestrian safety performance evaluation model is built. The model can correctly detect nearly 94.4% of possibly dangerous traffic scenes.

Karim El-Basyouny et.al. (2013) conducted study to establish relationship between traffic conflict and collision for the purpose of using traffic conflict data as surrogates to collisions for safety analysis. To establish relationship between traffic conflict and collision two-phase model was proposed. First phase lognormal model is used to predict conflict using the data like traffic volume, area type (urban/suburban) and road geometry related variables and in second phase, conflicts-based negative binomial (NB) safety performance function (SPF) is then employed to predict collision. The scaled deviance and Pearson $\chi 2$ goodness of fit measures indicated that shows that proposed NB model has adequately fitted the present data.

Yingying Zhang et.al (2012) conduct study to attempts to surrogate safety measures to analyze the pedestrian–vehicle interaction/conflict by using video data. Two major parameters, Time to collision (TTC) and Post Encroachment time (PET) are used to indicate the severity of a potential collision and to capture an imminent vehicular accident. Pedestrians and vehicles crossing behaviors is classified in two category wise vehicle pass first (VPF) and pedestrians pass first (PPF). Now the parameter TDTC is used to classify these crossing behaviors in different safety levels, based on which pedestrian safety has been discussed and performance of that parameter has been tested. From micro-level data collected of pedestrian-vehicle interaction, parameter TDTC has been defined and based on which pedestrian safety has been discussed and performance of that parameter has been tested. Result shows that about 80% of the interaction cases classified by the TDTC parameter have the same result with the independent observation. If TDTC is combined with vehicle speed, the classification result can be improved.

Yingying ZHANG et.al. (2012) studied the vehicles – pedestrian interaction characteristics in mixed traffic situation. 100 group of V&P interaction cases were collected with help of videography survey. The comparison was made based on the cases between Vehicle-Pass-First (VPF) and Pedestrian-Pass-First (PPF) and among different safety scenes. Results shows that the distance and speed values are different from the cases between VPF and PPF, and the TDTC values are related to safety.

Cafiso et.al (2011) conducted study on Crosswalk Safety evaluation using a Pedestrian Risk Index as Traffic Conflict Measure, This PRI links probability and severity of collision between pedestrian and vehicles. Role of impact speed was also introduced in PRI formula. The application of the Pedestrian Risk Index (PRI) method showed that this indicator is effective to highlight modifications in driver behavior due to safety improvements at a crosswalk.

Aliaksei Laureshyn et.al. (2010) proposed a framework for organizing all traffic encounters into a severity hierarchy based on some operational severity measure. This paper elaborates on how to improve the calculation of the existing indicators like Time-to-Collision, Time Gap and Time Advantage for all types of approach angles and complement them with speed and Time in order to estimate the severity. This will be a considerable contribution to increasing knowledge of the traffic safety process and understanding road users' trade-offs between safety and efficiency in traffic.

Michiel M. Minderhoud et.al. (2001) described two new safety indicators based on the time-to-collision notion suitable for comparative road traffic safety analyses. Such safety indicators can be applied in the comparison of a do-

nothing case with an adapted situation. These improved safety indicators are TET (Time Exposed Time to collision) and TIT (Time Integrated Time to collision). Calculation of the TET indicator requires collection of the position and speed of all vehicles entering and leaving the specified road section, from which trajectories and time-to-collision profiles can be established. TIT indicator uses the integral of the time-to-collision profile of drivers to express the level of safety. The occurrence of small TTC-values, which can hardly be measured at a single cross-section of the roadway, will include in this parameter.

4. SUMMARY

For assessment of safety data collection is done with help of videography. From that video required data are extracted. Extracted data contain x-y coordinates at every instant of time. With that data 3D trajectory is plotted and potential conflict point is derived and change in velocity and direction is also derived which will helps in find conflict indicators like TTC, PET and TDTC. The values of these parameters will provide some supplement guidance for pedestrian safety to describe and analyze the pedestrian–vehicle interaction behavior and assessment of safety level of each interaction case as well.

ACKNOWLEDGEMENT

I would like to thank to my Guide Prof. Rena N. Shukla, Professor, Civil Department (Transportation Engineering) L.D.C.E, for his moral support, constant unceasing encouragement, critical evaluation, suggestion, constant untiring guidance and affection during the entire span of my post-graduation study.

REFRENCES

[1] H Anush Konayakanahalli Chandrappa , “Estimation of Post-Encroachment Time and Threshold Wait Time for Pedestrians on a Busy Urban Corridor in a Heterogeneous Traffic Environment: An Experience in Kolkata”, Asian Transport Studies, Volume 4, Issue 2 (2016), 421–429.

[2] Aliaksei Laureshyn, “Evaluation of traffic safety, based on micro-level behavioural data: Theoretical framework and first implementation”, Accident Analysis and Prevention 42 (2010) 1637–1646 2010 Elsevier.

[3] Cafiso, S., “Crosswalk Safety evaluation using a Pedestrian Risk Index as Traffic Conflict Measure”, 3rd International Conference on Road Safety and Simulation, September 14-16, 2011, Indianapolis, USA.

[4] karim El-Basyouny, “Safety performance functions using traffic conflicts”, Safety Science 51 (2013) Elsevier.

[5] Michiel M. Minderhoud , “Extended time-to-collision measures for road traffic safety assessment”, Accident Analysis and Prevention 33 (2001) 89–97 Elsevier.

[6] Ning-Bo Cao, “Modeling the Variation in the Trajectory of Crosswalk Overflow Violation Pedestrians in China and Countermeasure”, Hindawi, Mathematical Problems in Engineering, 2017, Article ID 3483809, 14 pages.

[7] Xiaobei Jiang, “Intercultural Analyses of Time-to-Collision in Vehicle–Pedestrian Conflict on an Urban Midblock Crosswalk”, Ieee transactions on intelligent transportation systems, vol. 16, no. 2, april 2015

[8] Yingying Zhang1, “Scene-based pedestrian safety performance model in mixed traffic situation”, Published in IET Intelligent Transport Systems, doi: 10.1049/iet-its.2013

[9] Yingying Zhang, “Pedestrian Safety Analysis in Mixed Traffic Conditions Using Video Data”, IEEE transactions on intelligent transportation systems, vol. 13, no. 4, December 2012.

[10] Yingying ZHANG, “Vehicle - pedestrian interaction analysis in mixed traffic condition”, Published in ICTIS 2011 © ASCE 2011 on page 552 to 559.

[11] Irc -103 2012.

[12] Jeffery Archer, Methods for the Assessment and Prediction of Traffic Safety at Urban Intersections and their Application in Micro-simulation Modelling, pp 65.

[13] http://www.pedbikeinfo.org