Accident Analysis using Microscopic Simulation and Surrogate Safety Assessment Model

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Abstract: **Safe movement of vehicle through the various roads is an issue of National concern. Every year the density of vehicles is increasing and so the flow of vehicles on the roads and previously designed road network may not be able to cope with it due to the increasing demand of traffic across the country. Assessment of traffic safety is generally based on the use of historical accidental data records, which are reactive in nature it is like waiting for the accidents to occur and then applying their countermeasures. With this background, systematic approach is made for most dangerous unsignalised intersections using VISSIM and SSAM softwares. The traffic data is collected through video cameras from which field PET values are measured and the same road network is given as input in VISSIM to calculate simulated PET values using SSAM software. These values were then compared for the assessment of traffic safety. The primary objective of this study is to assess the level of traffic safety at an uncontrolled intersection using micro simulation modeling under mixed traffic condition by devising a unique strategy of measuring proximal safety indicator, Post Encroachment Time (PET).**

Key Words: **Accidents analysis, VISSIM, SSAM, PET, Corel software.**

I. INTRODUCTION

In India, the accident rates are increasing every year with the increase of vehicle and human population. Predicting the exact cause for the road accident is complex. Studies were done relating the factors like traffic volume, speed, road characteristics, road geometrics etc., with road accidents. Measures to rectify those factors might be difficult or very expensive in the field by means of its implementation and monitoring. This study focus analyzing road accident data and to find out the common behavior of road accidents and its variation with respect to time, location, nature of accident, weather condition, type of accident, modes involved, type of junction etc., with the help of some software s like VISSIM, SSAM.

1.1 Objectives:

The main objectives of the study can be listed as follows

- To create a road network model of selected study area using the VISSIM software.
- To simulate the model created and extract the trajectory file (with *trj* extension) from Vissim software and to identify and analyze the conflicts from trajectory file using SSAM software.
- To calculate the Post Encroachment Time (PET) values from field data by overlaying grids on traffic accidents video using the softwares Autodesk MAYA and Corel Video studio Pro.
- To compare the PET values of both from field and simulation.

1.2. Study Area: Hisar-Delhi Bypass Road

Hisar is the fifth largest city of Haryana state and it is located at 29.09°N 75.43°E in western Haryana. National Highway-9 passes through the Hisar District of Haryana. Two unsignalised intersections 4 lane 4-legged road which is at distance of 4km from the centre of the city and 4 lane 3-legged intersection at a distance of 9.5 km distance from 4-Legged intersection were selected as study area for this project.

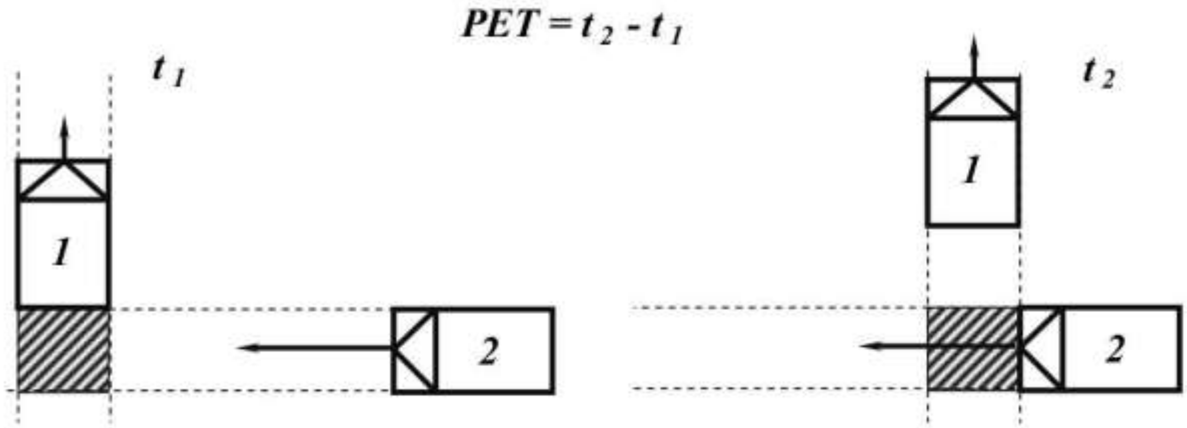
The two intersections are identified as block spots and one of the most dangerous intersections in India. More number of conflicts was observed at these intersections and the traffic data including accidents data.

II. METHODOLOGY

Application of safety indicators is more reliable and efficient alternative for the safety assessment of traffic accidents. The method used in this study is to first calculate PET values from the field, then simulate and model in micro simulation software VISSIM and use simulation to identify and predict interdependencies of the vehicle characteristics and evaluate traffic safety at unsignalized intersections

Post Encroachment Time (PET):

PET is "the time between moment (t1) when the first vehicle exits the conflict spot and moment (t2) when the second vehicle enters the conflict spot", defined by 't2−t1'.

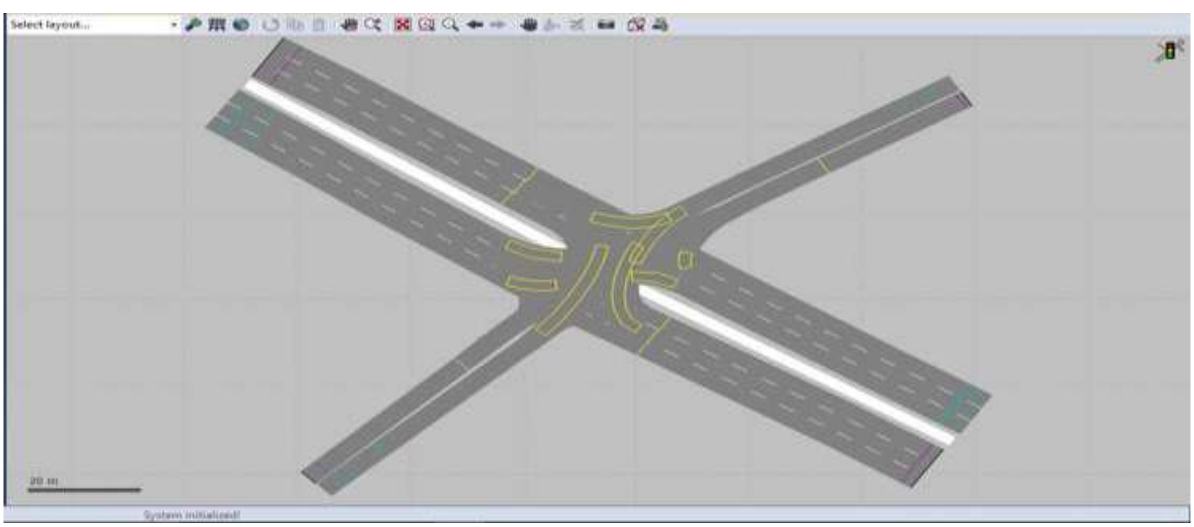


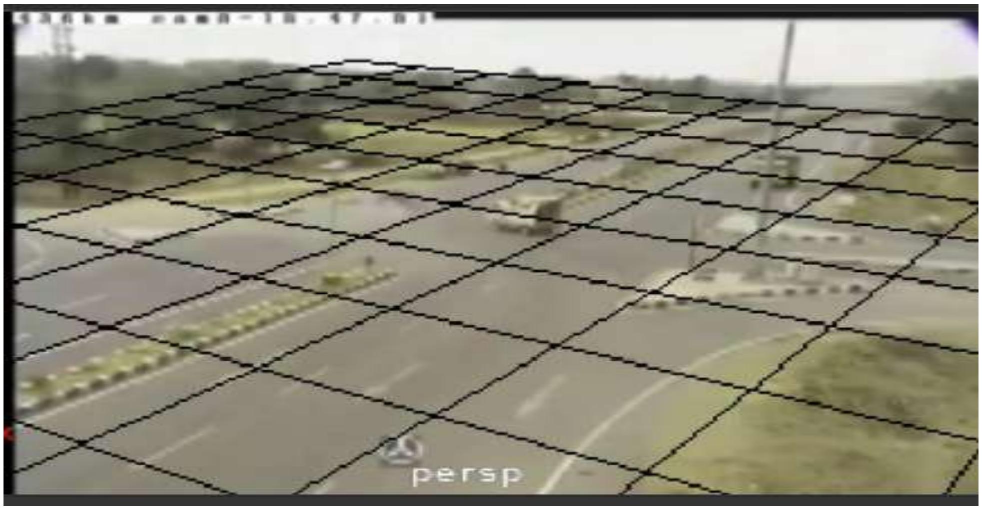
Extraction of Post Encroachment Time from field data:

The grids have been created manually using Autodesk Maya 3D animation software. These grids were then converted into a transparent picture and then overlaid into the video using Corel Video Studio Pro X6 software. After this, the video is run at frame rate of 6 frames per second. The least count of this is 0.01 seconds, which gives more accurate results. While running frame by frame, when a possible conflict occurs, time t1 i.e. when a rear end of one vehicle leaves a grid and time t2 i.e. when a front end of another grid are noted, and PET values are calculated as t2- t1

Post Encroachment Time from simulation:

The first step is to create a road network model of existing intersection in the traffic simulating software i.e., VISSIM. The road network is created with the background of the intersection extracted from Google maps so that the dimensions of the road and channelization have been obtained and the same have been applied in the simulation model. VISSIM has inbuilt features that can be partially considered as assumptions of the simulation model for real time data. It follows Poisson's distribution for the arrival process with exponential inter arrival times. It uses a psychophysical car following model and a rule based algorithm for lateral movements.



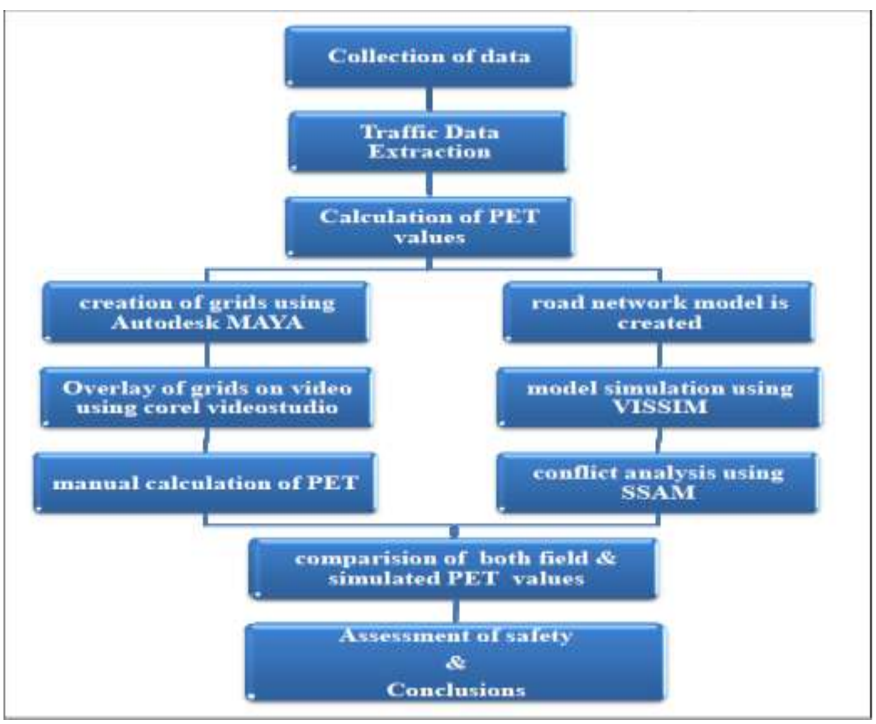


Calibration:

After building the road network, the model is calibrated by assigning vehicle in puts from all the four directions from the values obtained in field data. Speed ranges are assigned to vehicles in each vehicle type. Reduced speed areas have been used at the intersections. The vehicle dimensions may be adjusted according to the Indian traffic. After calibrating the model and running the simulation a couple of times, driver behavior characteristics were changed in order to get the simulated values compare dto the field values. The shapes of obtained were satisfactory. Hence, the simulation model was calibrated and validated.

Conflict analysis using SSAM:

After simulating the model, the trajectory file (with the VISSIM software. This extracted trajectory file obtained from VISSIM serves as input for SSAM software. SSAM operates by processing data describing the trajectories of vehicles driving through a traffic facility (e.g., a signalized intersection conflicts. SSAM calculates surrogate measures of safety corresponding to each vehicle interaction satisfy the criteria to be deemed an official conflict. A table of all identified conflicts and their corresponding surrogate safety measures is then presented to the user.



Flow Chart

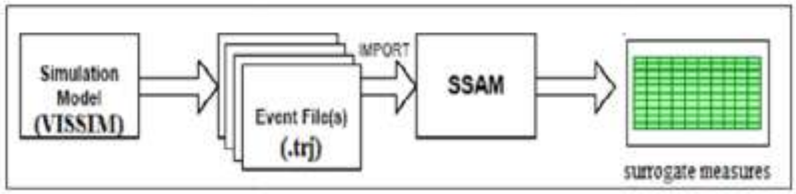


Fig 4.4 – SSAM workflow

III. RESULTS AND DISCUSSIONS

Results:

After obtaining the PET values, the frequency distribution of both field and simulated PET values are calculated and tabulated as follows.

Frequency distribution of field PET:

Conflicts	PET
Car-car	0.53
Lorry-bike	2.14
Car-bike	0.68
Bus-bike	1.21
Lorry-bike	1.01
Bus-lorry	0.50
Van-car	0.57
Bike-mini truck	1.63

The frequency distribution of field PET values is tabulated in below table

Lower limit	Upper limit	Mid point	Conflicts frequency	% relative frequency	Cummulative % frequency
0	0.4	0.2	0	0	0
0.4	0.8	0.6	4	50	50
0.8	1.2	1.0	2	25	75
1.2	1.6	1.4	1	12.5	87.5
1.6	2.0	1.8	1	12.5	100
2.0	2.4	2.2	0	0	100

ssam (unsaved)

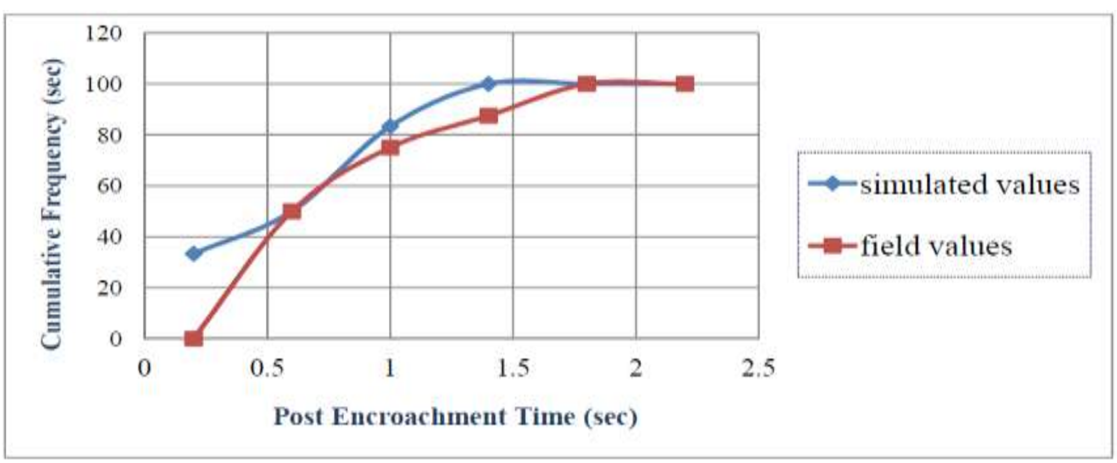
FILTER APPLIED

trjFile	tMinTTC	xMinPET	yMinPET	TTC	PET	MaxS	DeltaS	DR
hiway acc2_...	31.00	283.94	12.63	1.30	1.50	6.77	5.82	-0.49
hiway acc2_...	100.90	282.42	11.54	0.70	0.30	8.61	5.78	-0.22
hiway acc2_...	168.40	285.09	13.96	1.00	0.50	7.95	4.26	-0.14
hiway acc2_...	401.20	295.71	23.65	0.90	1.10	7.84	13.20	-0.96
hiway acc2_...	477.30	301.39	28.68	0.10	0.20	8.60	12.37	-1.12
hiway acc2_...	537.40	288.60	16.27	0.90	1.10	6.83	10.91	-0.25

The frequency distribution of simulated PET values is tabulated in below table

Lower limit	Upper limit	Mid point	Conflicts frequency	% relative frequency	Cummulative % frequency
0	0.4	0.2	2	33.33	33.33
0.4	0.8	0.6	1	16.67	49.99
0.8	1.2	1.0	2	33.33	83.32
1.2	1.6	1.4	1	16.67	100
1.6	2.0	1.8	0	0	100
2.0	2.4	2.2	0	0	100

After obtaining both the field and simulated PET values, they were compared with cumulative frequency curves. The graphs are plotted as shown in Fig. From the figure, it is obtained that field and simulated values are almost same and model is accurate. This is also an indicator that the model has been calibrated and validated.



Discussions:

- Prospective conflict zone can be identified by using Post Encroachment Time method.
- The PET values obtained by manual method are nearly equal to the PET values obtained by using Micro-simulation tool. Hence micro-simulation tools can be considered reliable for assessment of traffic safety.
- The study of on effect of traffic volume indicates that the increase in traffic volume in major as well as minor road will result in decrease in the mean PET values.
- Speed enforcement measures can be used to minimize chances of crashes at intersections.

IV. FUTURE SCOPE

This study is an initial work and opens the door for several future studies. In the future research might explore more strategies, such as impact of speed restriction measures on level of service, could be evaluated using the micro-simulation tool.

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