Analysis of Headway and Lane Change Metrics of Indian Drivers using Naturalistic Driver Study Techniques

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I. INTRODUCTION

In the field of traffic safety, parameters such as time to collision (TTC) and headway of time (TH) have been used extensively to determine the level of safety exhibited by drivers. These parameters are also the cornerstones of various advanced driver assist systems (ADAS) and crash avoidance systems (CAS) developed in recent times. This study attempts to study the TH and TTC maintained in Indian road conditions during car following. It also aims to explore the lane change (LC) behaviour exhibited by drivers on Indian roads. Parameters such as frequency of a LC, distance of the car/object in the front (FOD) and TH during LC were calculated. The data was collected using naturalistic driving techniques via an instrumented vehicle.

II. METHODS

An instrumented Nissan Xtrail (SLX-MT) was used to record the naturalistic driving data of seven drivers (five male and two female). The total distance of 8,380 km, which was divided equally between highway and urban roads. For the two female volunteers only urban data was logged. The vehicle was outfitted with front- and side-facing radars, GPS antenna, six cameras (covering four sides of the vehicle and one at driver face and one at driver feet), and a CAN analyser to record CAN bus data.

All of the data from the sensors were recorded via on-board DAD (data acquisition device) and were downloaded periodically and processed. The analysis focused on the headway distances maintained and the LC manoeuvres executed by the drivers. Headway of Time is defined as the time taken to reach the point on the road that is occupied by the object in front at the current velocity; TTC is defined as the time taken to crash into the front object given the velocities of the vehicle and front object.

Headway data were recorded for those instances where the driver braked at a deceleration≥ 0.1g. This corresponds to the driver adjusting the velocity of the vehicle or bringing the vehicle to a stop. Such manoeuvres are usually performed when the headways are less than those perceived safe by the driver. Additionally, instances where the TH was more than 10 s were ignored. The parameters studied were:

- TH maintained by the drivers;
- TTC maintained by the drivers.

In an Indian road context, LC cannot be defined as a crossing of the lane markers due to the absence of lane markers on many parts of roads and highways. We therefore define LC as the lateral movement of the vehicle to a distance greater than 1 m within a time period between 4 and 9 s. This definition is based on the video footage observed from the cameras installed on the vehicle. A detection algorithm was created to parse through the data to detect LC instances. The parameters studied were:

- LC frequency per km travelled;
- Front vehicle distance while executing a LC.

III. INITIAL RESULTS

The initial findings of the various metrics are tabulated in Table I.

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TABLE I
INITIAL RESULTS

	Highway	Urban
Mean TH (s)	1.64	1.96
Mean TTC (s)	7.06	7.36
Mean LC Frequency (LC/km)	2.36	4.95
Mean LC Frequency (LC/min)	3.54	2.48–4.13
Median FOD During LC (m)	13.6	11.6
Median TH During LC (s)	0.5	1.0–1.6

Time Headway and Time to Collision

Both the TH and TTC values were found to be high on urban roads as compared to highways. The mean TH observed on urban roads was 19.5% greater than on highways. The mean TTC value was closer, with urban values 4.3% higher than highway values. The greater vehicle velocities found on highways can be attributed to the lower values observed. Comparing the TH considered safe in other countries (US: 2 s; Germany: 1.8 s; and Sweden: 3 s) [4][7], we find it to be similar. On the other hand, the TTC values in the order of 7.0 s were found to be higher compared with 4–5 s used as a threshold value in many CAS [2]. Given the TH value, the difference in TTC can be attributed to large speed variability in the individual vehicles within a stream in Indian traffic.

Lane Change Frequency per km

The mean LC frequency on urban roads (4.95) was two times greater than that on rural highways (2.36). For an average velocity of 90 km/h on highways, the LC frequency translates into 3.54 LC/min. On urban roads the vehicle velocities ranged between 30 and 50 km/h [1] (excluding idling time), which gives a LC frequency equal to 2.48, 3.30 and 4.13 LC/min for 30, 40 and 50 km/h respectively.

Front vehicle distance during a lane change

The FOD maintained during LC was found to be 14.8% greater in the case of highways (median value: 13.6 m) compared to urban roads (median value: 11.6 m). The TH results all show low values compared to during the braking events and fall into the unsafe zone as *per* [3]. On highways, with the vehicle velocity at 90 km/hr, the TH value observed was 0.5 s. The urban TH values were higher, with 1.4, 1.1 and 0.8 s corresponding to 30, 40 and 50 km/h vehicle velocities respectively.

IV. DISCUSSION

The data collected gives a glimpse of the behaviour of vehicles on Indian roads. Initial studies indicate that the TH and TTC maintained by drivers in India is in line with what was measured in an OECD environment. The results obtained by this study give the driving behavioural statistics of a very select sample, therefore these results cannot be generalised. As such, this study is to be treated as a pilot study and as a base for future studies.

V. REFERENCES

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