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Study of traffic for sustainable transportation using image processing

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Abstract- A sustainable condition for this planet is one in which there is stability for both social and physical systems, achieved through meeting the needs of the present without compromising the ability of future generations to meet their own needs. Over a last decade, planning authorities in developing countries moved from conventional approach to integrated approach in urban planning activities. Transportation planning and management needs accurate and timely spatial and non-spatial information like network, capacity, speed etc. Collecting microscopic data is difficult under heterogeneous traffic conditions. In this paper, an attempt is made to study a microscopic analysis of traffic data using video image processing software TRAZER. This system can automatically analyze traffic videos and provide macroscopic traffic characteristics such as classified vehicles flows, average vehicle speeds and average occupancies and microscopic characteristics such as individual vehicle trajectories, lateral, and longitudinal spacing. TRAZER underlying ability to detect, track and classify vehicles makes it useful in collecting traffic data under varying traffic conditions.

Key words: Microscopic data, heterogeneous traffic data collection, video image processing, trazer

I. Introduction

One of the fundamental measures of traffic on a road system is the volume of traffic using the road in a given internal of time (1). It is termed as flow and it is expressed in vehicles per hour or vehicles per day. Knowledge of the vehicular volume using a road network is important for understanding the efficiency at which the system works at present and the general quality of service offered to the road uses(2). Empirical traffic data are the basic input in any traffic management scheme and in analyzing traffic flow models(3). Very limited empirical data are available for this purpose. For collecting data under heterogeneous traffic conditions several types of equipments are used. Recently, video images processing systems (VIPS) – techniques are being used. The advantages of video film based method are to device continuous and regular record of traffic flow.

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. In this paper, an attempt is made to study a microscopic analysis of traffic data using video image processing software TRAZER. The rest of this paper is organized as follows. In Section II video shooting methodology and TRAZER software is discussed. Section III Discus about the Analysis and Result using TRAZER software and Section IV gives Conclusion for this paper

II. Video shooting Methodology and TRAZER : Software

A. Video shooting Methodology

The camera with the tripod step should be placed in an appropriate location to shoot the video. The location ref (Fig1) can be selected based on the following parameters

(i) Angle
(ii) Focus
(iii) Zoom
(iv) Lighting Condition
(v) Shutter Speed
(vi) Height

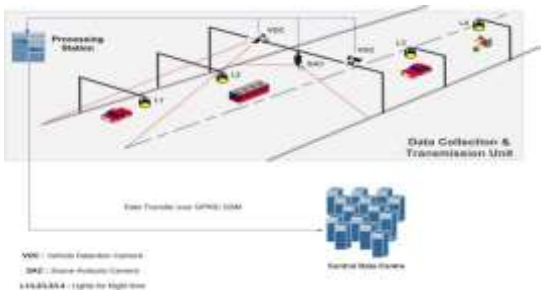

Fig 1 Video shooting methodology

Angle

Camera should be placed above the central lane and should look straight middle of the road. The tripod can be placed maximum one lane left /right to the central lane which comes down to around ± 15 degrees. The Horizontal view angle must be adjusted in such way that the camera covers the width of the road. The vertical view angle should be set such that it cover 20-25 meters from camera. The camera should be placed at a height of 10-12m (Height of fly over).

Focus

Focus determines the sharpness of the vehicles in the video. To get the Sharpe image of the vehicles the camera should be focused. This is normally done by using the focus ring in the

profession cameras near the front of the lens housing.

Zoom

Zoom determines the magnification of the vehicle. More the zoom, bigger the vehicles look the zoom factor should be determined visually such that the vehicles are not too big or too small.

Lighting condition

The video should be shot with sufficient lighting. In the case of bright lighting care should be taken such that light doesn't fall on the camera directly. The lighting conditions changes with the time of the day and iris is adjusted.

Shutter speed

Shutter speed determines the sharpness of moving objects. High shutter speed means more sharp objects and less motion blur. So when shooting a video of vehicle moving with high speed the shutter speed should be high. A camera has its shutter set to 1/60, each frame will be exposed for 1/60 second.

Height

A video camera with the above discussed shooting methodology is placed on the fly – over bridge which is in right angles to the subject approach exactly on the centre line of the road.

TRAZER : Software

TRAZER is a revolutionary new technology to classify traffic for planning purpose. Unlike competing technologies, it uses the same techniques as used by humans to identify objects like vehicles, that is the power of sight with cutting edge electronic cameras as its eyes and server class PC as its brain it provides an extremely robust platform to do traffic counting ref (Fig.2)

Fig 2 microscopic data analysis using TRAZER

Trazer is speedily designed for Indian conditions and can handle multiple Lane dense traffic and does not assume lane discipline and works perfectly with slow moving or even stationary traffic and gives 95-100% result even in the large number of classes of vehicles.

Tambaram - Study Area

One of the largest Municipalities in Chennai Metropolitan city- **Tambaram** 12.9300° N, 80.1100° E ref (Fig.3) which forms the Gate way to the Southern India.The administrative boundary under Tambaram municipality is shown in (Fig.4). The acute Traffic problems here have significant effects on mobility, economic development, environmental quality, government finance and the quality of life. Wise planning is needed to help and create high quality transportation facilities and services at a reasonable cost with minimal environmental impact and to enhance economic activity.

Fig.3Tambaram map

Fig.4 Tambaram municipality

TRANSPORT NETWORK

Tambaram has a good geographical transport network ref (Fig.5). It has both the train and road modes of transport which daily carries a large volume of traffic and caters to the needs of people. Tambaram Road network inventory is discussed in Table 1.

Fig.5 Tambaram Road network

Table 1 Inventory of Road Network

Road Name	Width	Lanes	Footpath		Land Use	Encroachment
			L	R		
GST Road	21	6	1	2	Com	Moderate
Velachery Road	18	6	1.5	1.5	Mixed	Low
Mudichur Road	7.5	3	-	-	Mixed	Moderate
Camp road	9	4	1.5	1.5	Residential	Moderate
Gandhi road	7.5	2	1.5	1.5	Mixed	High
Rajaji road	7.5	2	-	-	Com	High

Data Acquisition by video surveillance Method

The Practice is recommended by the Indian Road congress for the traffic census on urban road in IRC SP19-2001. The traffic volume content is taken in an urban Arterial Road (G.S.T Road) Ref (Fig 7) near Tambaram railway station

and Sub arterial road (Velachery Road and Mudichur Road) and for collector street (camp road,Gandhi road,rajaji road)for the period of 8.00A.M to 12.00 A.M and to 4.00 P.M. to 8.00 P.M for three consecutive day in the middle of the week (namely Tuesday, Wednesday, Thursday) The days are selected that there is no abnormal traffic conditions like a seasonal fair.Data extracted from the film using TRAZER software are discussed in detail in the following sections.

III. Analysis and results

A detailed discussion on the data collected using TRAZER is necessary to know its accuracy and usefulness.

Data Analysis From TRAZER :

The data collected from the video surveillance is stored and analyzed at central Data centre unit. The data storage will be done in a database setup on a server class machine with 5TB RAID hard disk ref (Fig 6).

A specific advantage of the TRAZER for mixed traffic is its ability to track vehicles, even when there is a lateral movement. It could also track vehicles, even under dense traffic condition. Trajectories obtained from TRAZER are smoothened using as local regression techniques. Velocities and acceleration values are obtained by performing first and second order differentiation on the trajectory equation. Since the trajectories of all vehicles are available, it is possible to measure the lateral and longitudinal spacing maintained by different vehicles w.r.t to nearest neighbor vehicle. Whenever the vehicles are coring an imaginary line drawn on the road, classified flow, speed and occupancy data are obtained. Occupancy measured in this study is the time taken by any vehicle cross the imaginary line.

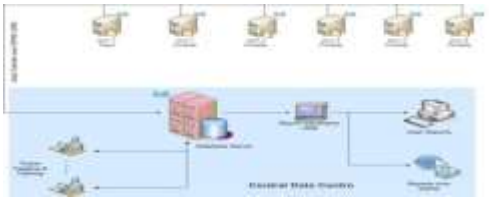

Fig. 6 central data center.

Features related:

Each vehicle is associated with a feature vector of five dimensions. In an offline analysis phase the features are computed for vehicles falling into various categories. According to (Fig 7) The features used in the system are shape features and for extracting these features it uses system known as hierarchical image process. The features for some vehicles are shown in (Fig 8).

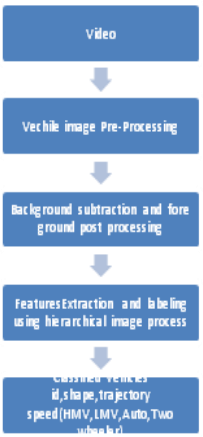

Fig.7 procedure for image process

Fig 8 Vehicle Extraction

Average vehicles volumes:

This format stores vehicles counts per each interval. The interval size and vehicle categories are configurable. Table 2,3 shows the volume of traffic on arterial road(G.S.T road).Table 4,5,6,7, shows the volume of traffic on sub arterial road (Velachery road , Mudichur Road), and Table 8 gives the volume count in collector street such as camp road, Gandhi road, Rajaji road

GST Road

The Table 2 and 3 gives the total no of vehicle passing in the G.S.T road during peak hour and non- peak hour. since it is a arterial road the capacity of the road is 7500 pcu /hour. The average vechile crossing the G.S.T road during the peak hour is 4500pcu/hour. The v/c ratio is lesser than 1and ranges between **0.5- 1.1** in the peak hour at present. This Ratio is expected to double by 2026 as this road is a major highway which connects Chennai City to southern Tamil Nadu.

Table 2: GST road towards Chrompet

S.n	Timing	LMV	Auto	HMV	TW	Total
Peak hours						
1.	8-9 am	1172	291	338	1989	3790
2.	9-10 am	1253	328	266	2412	4259
3.	4-5 pm	1445	224	435	2115	4219
4.	5-6 pm	1509	254	309	1943	4015
5.	6-7pm	1683	246	298	2360	4587
6.	7-8 pm	1691	231	384	2265	4571
Non peak hours						
7.	10-11 am	1157	287	289	1844	3577
8.	11-12 am	1065	242	257	1689	3253

Table 3: GST road towards Vandalur

S. n	Timing	LMV	Auto	HM V	TW	Total
Peak hour						
1.	8-9 am	558	209	419	1721	2907
2.	9-10 am	782	258	224	2444	3708
3.	4-5 pm	510	247	222	802	1781
4.	5-6 pm	785	221	253	1058	2317
5.	6-7 pm	1108	263	288	1620	3279
6.	7-8 pm	1602	237	345	2488	4672
Non peak hour						
7.	10-11 am	875	216	223	1851	3165
8.	11-12 am	823	199	277	1512	2811

Velachery Main Road

Table 4 and table 5 shows the number of vehicle count in both peak hours and non peak hours. The v/c ratio ranges between **0.5- 0.8** in the non peak hour to peak hour. This Road will see Heavy Traffic within the Next 5 years due to the development seen in Selaiyur, Madipakkam, Pallikaranai, Kelambakkam, ECR and OMR. This road is one of the major roads which connect the Eastern coastal areas to Tambaram.

Table 4: Velachery road towards Tambaram

S.n	Timing	LMV	Auto	HMV	TW	Total
Peak hours						
1.	8-9 am	490	236	230	1280	2236
2.	9-10 am	574	249	217	1061	2155
3.	4-5 pm	398	214	184	910	1706
4.	5-6 pm	421	224	211	874	1730
5.	6-7 pm	558	231	247	1088	2124
6.	7-8 pm	569	224	260	1167	2220
Non peak hours						
7.	10-11 am	440	195	196	760	1591
8.	11-12 am	405	201	200	866	1672

Table 5: Velachery road towards Madippakam

S. n	Timing	LMV	Auto	HMV	TW	Total
Peak hours						
1.	8-9 am	564	229	235	1084	2112
2.	9-10 am	595	246	279	1195	2315
3.	4-5 pm	386	217	190	794	1587
4.	5-6 pm	400	232	223	811	1666
5.	6-7 pm	578	240	271	1109	2198
6.	7-8 pm	502	226	294	1214	2236
Non peak hours						
7.	10-11am	433	219	201	976	1837
8.	11-12am	429	223	214	735	1601

Mudichur Road

The table 6 give the volume of traffic in both peak hour and non peak hour. The capacity of the road is 2000pcu/hour. The average number of vehicle during peak hour is 2500pcu. The v/c ratio ranges between **1.23 – 1.1** in the peak hour .This road has a lot of HMV especially Lorries. This State highway will be a Major route connecting the Outer Ring Road area to Tambaram. As a Result Traffic is expected to increase manifold on this Road in the next 5-6 years and will become a Arterial Road in the long term.

Table 6: Mudichur road towards Tambaram

S. n	Timing	LM V	Auto	HM V	TW	Total
Peak hours						
1.	8-9 am	543	258	295	1211	2307
2.	9-10 m	608	266	305	1357	2536
3.	4-5 pm	340	269	280	865	1754
4.	5-6 pm	376	230	297	810	1713
5.	6-7 pm	487	253	315	1085	2140
6.	7-8 pm	453	244	329	1133	2159
Non peak hours						
7.	10-11 am	500	233	256	954	1943
8.	11-12 am	408	241	267	765	1681

Collector roads

The table 7 gives the volume of traffic in the collector street such as camp road, Gandhi road and Rajaji road . the average volume of traffic is 1200 pcu/ hour. The capacity of the road is 1500pcu/hour. The v/c ratio comes to be around 0.5-0.8 during the peak hour.these road are develepoing as mixed residential and hence in future more vehicle is expected.

Table 7: Data for Collector roads

S.n	Timing	LMV	Auto	HMV	TW	Total
Camp road						
1.	10-11 am	117	131	20	972	1240
Gandhi road						
1.	11-12 am	145	79	21	969	1214
Rajaji road						
1.	1-2 pm	219	136	43	844	1242

Vehicle Trajectory :

. The trajectory includes Vehicles images location and as well as its mapped on road location. The trajectory is very fine grained and is updated every 40 milli seconds ref (Fig -9). The Table 8 gives the vehicle trajectory such as average speed, occupancy of four category of vehicle HMV,LMV,Auto,TW for every 40 milli Seconds.

Fig 9 Vehicle trajectories

Table 8 Vehicle trajectories

S. No.	Date/ StartTime	Date/ EndTime	Average Velocity			
			LMV	AUTO	HMV	TW
1	2012-04-04 00:00:00	2012-04-04 00:01:00	68.75	60.82	74.86	57.84
2	2012-04-04 00:01:00.0400	2012-04-04 00:02:00.0400	97.62	0	62.5	49.33
3	2012-04-04 00:02:00.0800	2012-04-04 00:03:00.0800	76.79	0	50.07	54
4	2012-04-04 00:03:00.1199	2012-04-04 00:04:00.1199	68.83	48.64	51.01	41.99
5	2012-04-04 00:04:00.1600	2012-04-04 00:05:00.1600	92.4	47.38	90.65	78.25

Some of the vehicle trajectories obtained over a certain road length are

- Real time vehicle classification HMV, LMV, Three Wheelers, Two Wheelers in both day and night.
- Flow statistic: Vehicle flow at particular time velocity of traffic, quell a length etc.
- Lane wise automatic red light (traffic stoppage) detection.
- Extensive vehicle trajectory log (time + vehicle ID, Vehicle Location in image world co-ordination

The proposed approach is applied on test sequence representing 30 minutes of real video, in which the ground truth was obtained manually. Vehicle's counting is performed for each lane and classification is done using the objects size histogram. Results of counting and classification are shown respectively in Table 9.

Table 9 accuracy of object detection, classification, and vehicle trajectory

Ground Truth	Detected objects	Accuracy detection	Acc. Classification	Acc. vehicle trajector
115	110	96%	92%	93%

IV. **Conclusion**

Microscopic data collection under mixed traffic condition is one of the difficult tasks faced by the research community. Several data collection system that was tried in the past proved to be inefficient for mixed traffic. Image processing based data collection systems such as TRAZER is useful in collecting vehicle trajectory data over a certain road length. The TRAZER help in Real time Data that can be analysis.TRAZER is the image processing based system which caters specifically to the heterogeneous traffic of the developing countries. We have presented a comprehensive review of TRAZER software techniques for vehicle detection and vehicle trajectory in the Tambaram area, Sudurban at chennai..The research always seems tailored to local environment which makes the proposed method only useful in specified environment. This fact reflects from the side the diversity, complexity of real traffic scenes. To deal with higher demand in ITS and more complex traffic scenes, the methods are required to percept and self – adapting to the surroundings, and the robustness of algorithm needs to be improves.

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