IMPACT OF *EVALUATION OF INFRARED BASED AUTOMATIC VEHICLE COUNTERS CUM CLASSIFIERS (AVCC) UNDER INDIAN TRAFFIC CONDITIONS*

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ABSTRACT

The National Highway Development Programme (NHDP) undertaken by the Government of India envisages four and six lanning of highways of Golden Quadrilateral, East-West and North-South corridors and other important roads on Public Private Partnership (PPP) basis. In order to have continuous monitoring of the revenue collected from the toll on these highways, it is essential to have accurate and automatic counting of different categories of vehicles at the same time it has to be cost-effective if they are to be employed on a wider network. Since ages the collection of data on traffic volume, speeds and other traffic characteristics are mainly depend on the manual methods. Over the years intrusive type counters have developed which have their own limitation as they are intrusive nature in installation. Gradually the state of art volume counters such as non-intrusive counters have been developed in the recent past. Under this category infrared based traffic counters have received more attention as they are more versatile for all types of weather conditions. In this paper, these infrared based Automatic Vehicle Counters cum Classifiers (AVCC) are evaluated for their suitability under Indian traffic conditions. In order to do this, traffic counting was carried out using AVCC equipment and as well as videography method covering different types of locations ranging from low traffic volume to high traffic volume including the multilane intercity corridors and compared the traffic counts from both the methods. The study result shows that the AVCC are capable of achieving about 95 percent accuracy on road corridors where in time headway between successive vehicles is about three seconds and above. The accuracy on urban corridors carrying traffic volume in less than three seconds time headway dips to as low as 70-75 percent.
Keywords: Infrared 1, Automatic Vehicle Counters cum Classifiers 2, Mixed traffic 3

INTRODUCTION

Technology has been driving the developments in the realm of transportation from the times of Industrial Revolution to the present day Digital Revolution. Transportation is a major force behind economic development and the well being of people around the world. The Tenth Five Year Plan (2002-2007) of the Government of India projects GDP growth rate of 8% per annum and an industrial growth of 10 percent per annum and subsequently identified transport infrastructure as a major constraint on accelerated growth (World Bank, 2004). The relative share of total freight and passengers movements has continued to drift towards the road transport in the last decade. India has more than 3.3 million kilometers of roads which by international comparisons provides a relatively dense network.

The travel demand is continuously on the increase. This has become very severe with the heavy concentration of population in a few metropolitan cities in the country and gradually the increase in urbanization. The propensity to own private vehicles and the necessity for their use has generated huge volume of traffic and parking demand in metropolitan cities. Faster economic growth, especially in non-traditional sectors and higher personal incomes will undoubtedly propel the growth in road transport and increase the demands on the road network. Unless, major reforms as well as investments are made, road infrastructure will be an impediment to economic growth and social development. This aspect has been realized by the Government of India and continuing its journey in respect of upgradation of the National Highway road network popularly called as National Highway Development Program (NHDP) initiated in 1998 with the principal goal of providing high speed corridors connecting the various metropolitan cities of the country. NHDP undertaken by the Government of India envisages four and six lanning of Golden Quadrilateral, East-West and North-South corridors and other important roads on PPP basis. These policies require continuous monitoring of traffic growth and its composition. Further, Ministry of Road Transport and Highways (MoRTH) has declared several stretches of National Highways under the NHDP as toll roads and moreover the MoRTH in its Model Concession Agreement (MCA) has made it mandatory to adopt the traffic census on daily and monthly basis for continuous monitoring of toll revenues for Built-Operate-Transfer (BOT)/ Built-Own-Operate-Transfer (BOOT)/ BOT annuity/ Design-Built-Operate-Transfer (DBOT) etc. of PPP mode projects. In order to continuous monitoring the revenue collected from these toll roads, it is essential to have accurate and automatic counting of different categories of vehicles. The automatic counting should be cost-effective if they are to be employed on a wider network. There are different types of automatic counters and therefore the need arises to evaluate such automatic counters for their efficacy especially in Indian conditions before employing them.

The present study is focused on evaluation of automatic vehicle counters cum classifiers (AVCC) under Indian traffic conditions by collecting data from different road sections. An overview of intrusive and non-intrusive type vehicle counters has been discussed in the next section. In section 3 data collection along with field setup has been presented. Evaluation of AVCC system has been discussed by comparing the data from videography in Section 4 and finally conclusions from the present study given in Section 5.

TRAFFIC DATA COLLECTION TECHNOLOGIES: AN OVERVIEW

Generally, traffic count technologies can be split into two categories: the intrusive and non-intrusive methods. Intrusive Technologies refer to traffic data measured by the means of detectors located along the roadside. The intrusive methods basically consist of a data recorder and a sensor placing on or in the road. Non-intrusive techniques are based on remote observations. Though manual counting is the most used method, new technologies have recently emerged which seems very promising. Figure 1 shows the broad classification of intrusive and non –intrusive technologies which are further discussed in the next section briefly.

Intrusive Technologies

Pneumatic road tubes: Rubber tubes are placed across the road lanes to detect vehicles from pressure changes that are produced when a vehicle tyre passes over the tube. The pulse of air that is created is recorded and processed by a counter located on the side of the road. The main drawback of this technology is that it has limited lane coverage and its efficiency is subject to weather, temperature and traffic conditions. This system may also not be efficient in measuring low speed flows.

Piezoelectric sensors: Sensors are placed in a groove along roadway surface of the lane(s) monitored. The principle is to convert mechanical energy into electrical energy. Indeed, mechanical deformation of the piezoelectric material modifies the surface charge density of the material so that a potential difference appears between the electrodes. The amplitude and frequency of the signal is directly proportional to the degree of deformation. This system can also be used to measure weight and speed.

Magnetic loops: It is the most conventional technology used to collect traffic data. The loops are embedded in roadways in a square formation that generates a magnetic field. The information is then transmitted to a counting device placed on the side of the road. This has generally short life expectancy because it can be damaged by heavy vehicles, but is not affected by bad weather conditions. This technology has been widely deployed in Europe (and elsewhere) over the last decades. However, the implementation and maintenance costs can be expensive.

Non-Intrusive Devices Technologies

Manual counts: It is the most traditional method uses trained observers gather traffic data that cannot be efficiently obtained through automated counts e.g. vehicle occupancy rate, pedestrians and vehicle classifications. The most common equipments used are tally sheet, mechanical count boards and electronic count board systems.

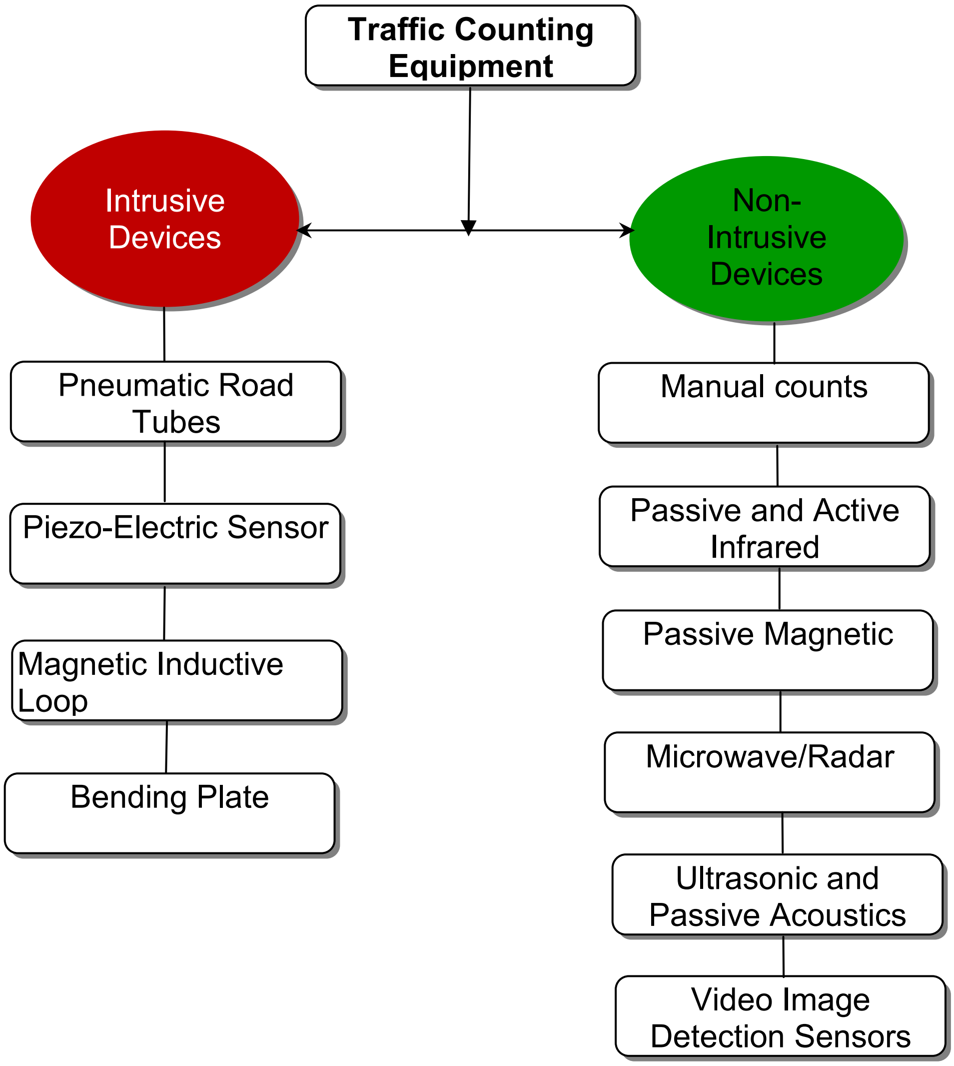


Figure 1. Broad Classification of Traffic Counting Technologies

Passive and active infra-red: The presence, speed and type of vehicles are detected based on the infrared energy radiating from the detection area. The main drawbacks are the performance during bad weather and limited lane coverage.

Passive magnetic: Magnetic sensors are fixed under or on top of the roadbed. They count the number of vehicles, their type and speed. However, the sensors have difficulty in differentiating between closely spaced vehicles in operating conditions.

Microwave radar: This technology can detect moving vehicles and speed (Doppler radar). It records count data, speed and simple vehicle classification and is not affected by weather conditions.

Ultrasonic and passive acoustic: These devices emit sound waves to detect vehicles by measuring the time for the signal to return to the device. The ultrasonic sensors are placed over the lane and can be affected by temperature or bad weather. The passive acoustic devices are placed alongside the road and can collect vehicle counts, speed and classification data. They can also be affected by bad weather conditions (e.g. low temperatures, snow etc.).

Video image detection: Video cameras record vehicle numbers, type and speed by means of different video techniques e.g. trip line and tracking. The system can be sensitive to meteorological conditions. Table 1 gives a summary of advantages/disadvantages of each technology.

From Table 1, it can be seen that the state of the art of traffic counting devices is changing rapidly, there is a new focus in the industry to develop reliable, non-intrusive devices that are easy to use and cost effective to operate. However, there is much to be learned through the experiences of those who have evaluated these devices. Table 2 presents the suitability ranking stated for different traffic counting and classification technologies by World Bank (May, 2006).

Table 2 Suitability Ranking for Traffic Counting and Classification Technologies

Equipment Class	**Suitability Ranking (1-5) 1- Low, 5- High**
Video Image	4.1
Radar	3.8
Pneumatic Tube	3.8
Active infrared	3.6
Passive Infrared	3.6
Passive acoustic	3.6
Ultrasonic	3.6
Induction Loops	3.3
Magnetic	2.9

Form the above Table 2 it can be seen that the video image sensing was rated as high accuracy, however the Video Image sensors has its own limitations which is shown in Table 1. From the global experience it is recommended to learn from the experiences of those who have installed and operated these devices in the field. Though the reports provide valuable practical information, experience can only be gained from working directly with the equipment. In the recent past the state of art volume counters such as non-intrusive counters have been developed gradually. Under this category infrared based traffic counters such as AVCC etc. have received more attention as they are more versatile for all types of weather conditions. In a low-mounted infrared sensor system known as the Infra-Red Traffic Logger (TIRTL) is mounted in this AVCC instrument, which will be used for axle based vehicle classification. In next section the working principle of AVCC based on low-mounted infrared sensor system have been discussed.

Table 1 Comparison of Commercially available Traffic counting sensor technologies

Technology	Strengths	Weaknesses
Inductive Loop	• Large experience base • Provides basic traffic parameters (e.g. volume presence, occupancy, speed, headway and gap) • Insensitive to inclement weather such as rain, fog and snow	• Installations requires pavement cut • Decreases pavement life • Installation and maintenance require lane closure • Wire loops subject tom stresses of traffic and temperature. • Multiple detectors usually required to monitor a location • Detection accuracy may decrease when design requires detection of a large variety of vehicle classes
Magnetometer (Two-axis fluxgate magnetometer)	• Less susceptible than loops to stresses of traffic • Insensitive to inclement weather such as snow, rain and fog • Some models transmit data over wireless RF link	• Installation requires pavement cut • Decreases pavement life • Installation and maintenance require lane closure • Installation requires pavement cut or boring under roadway • Cannot detect stopped vehicles unless special sensor layouts and signal processing software are used
Magnetic (Inductions or search coil magnetometer)	• Can be used where loops are not feasible (e.g. bridge decks) • Some models are installed under roadway without need for pavement cuts. However boring under roadway is required • Insensitive to inclement weather such as snow, rain and fog • Less susceptible than loops to stresses of traffic	• Installation requires pavement cut or boring under roadway. • Cannot detect stopped vehicles unless special sensor layouts and signal processing software are used
Microwave Radar	• Typically insensitive to inclement weather at the relatively short ranges encountered in traffic management applications • Direct measurement of speed • Multiple lane operation available	• CW Doppler sensors cannot detect stopped vehicles
Active Infrared (Laser radar)	• Transmits multiple beams for accurate measurement of vehicle position, speed and class • Multiple lane operation available	• Operation may be affected by fog when visibility is less than 20 ft (6m) or blowing snow is present • Installations and maintenance, including periodic lens cleaning, require lane closure
Passive Infrared	• Multizone passive sensors measure speed	• Passive sensor may have reduced sensitivity to vehicles in heavy rain and snow and dense fog • Some models not recommended for presence detection
Ultrasonic	• Multiple lane operation available • Capable of over-height vehicle detection • Large Japanese experience base	• Environmental conditions such as temperature change and extreme air turbulence can affect performance. Temperature compensation is built into some model • Large pulse repetition periods may degrade occupancy measurement on freeways with vehicle traveling at moderate to high speeds
Acoustic	• Passive detection • Insensitive to precipitation • Multiple lane operation available in some models	• Cold temperatures may affect vehicle count accuracy. • Specific models are not recommended with slow moving vehicles in stop-and-go traffic.
Video Image Processor	• Monitors multiple lanes and multiple detection zones lane • Easy to add and modify detection zones • Rich array of data available • Provides wide-area detection when information gathered at one camera location can be linked to another	• Installation and maintenance, including periodic lens cleaning, require lane closure when camera is mounted over roadway (lane closure may not be required when camera is mounted at side of roadway) • Performance affected by inclement weather such as fog, rain and snow; vehicle shadows vehicle projection into adjacent lanes; occlusion; day-to-night transition; vehicle / road contrast, and water, salt grime, icicles, and cobwebs on camera lens • Reliable night time signal actuation requires street lighting

FIELD INSTALLATION

At first the AVCC is approximately aligned in line with the Transmitter (TX) to Receiver (RX) as shown in Figure 2 and 3. Once it is approximately aligned, using the 'eye piece' the Transmitter (TX) and Receiver is aligned exactly to match the line sight of both eye pieces. Once the Transmitter (TX) and Receiver aligned the computer is connected to the Receiver (RX) it shows the instrument is connected as shown in Figure 4. Once the instrument is getting connected, beam strength can be checked as shown in Figure 4.

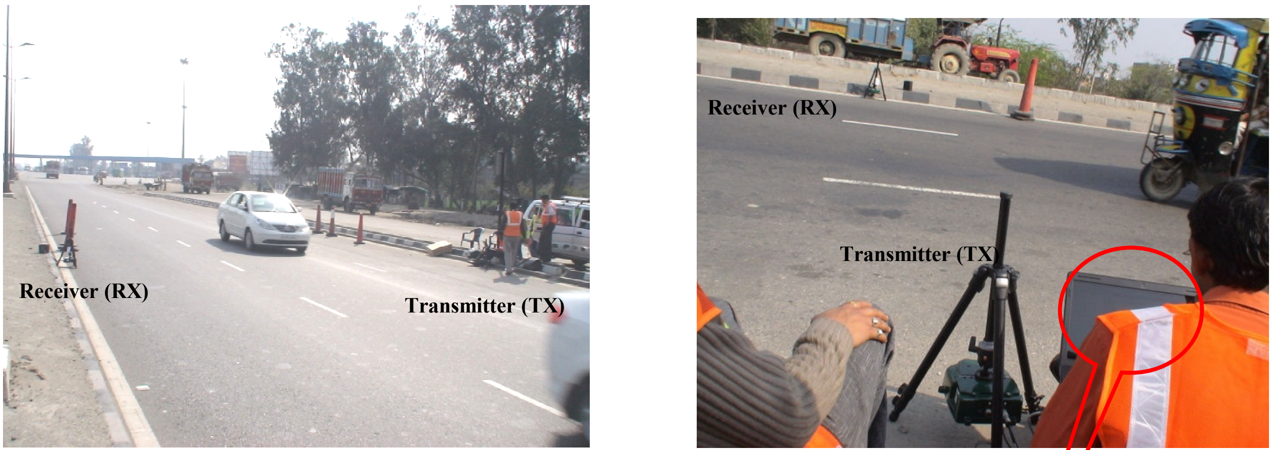
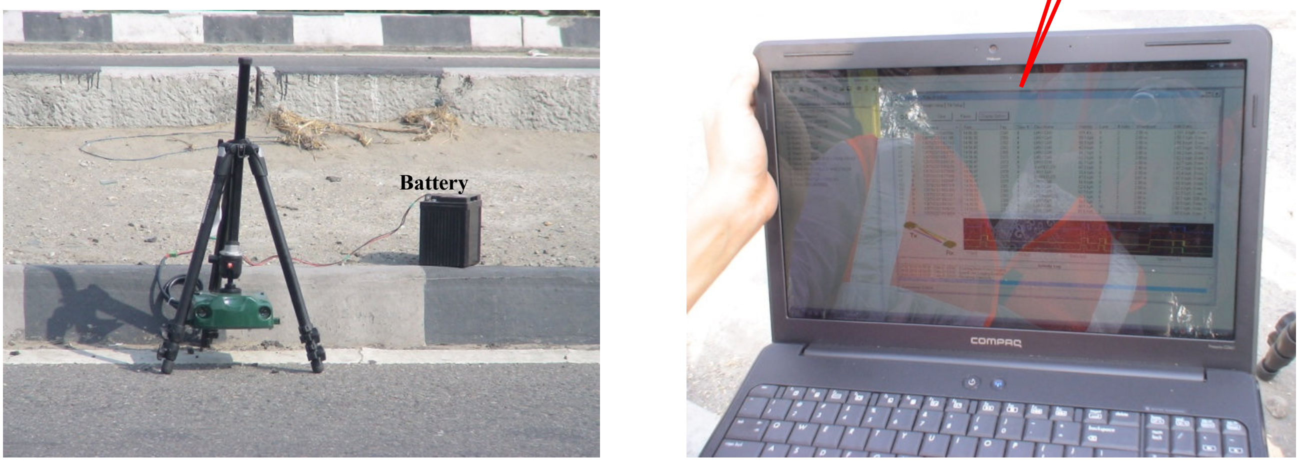


Figure 2 AVCC Components and Field Setup



Receiver (RX) setup

Data monitoring from the Transmitter (TX)

Figure 3 Data Collection and Monitoring using AVCC.

The *Alignment* display box graphically illustrates the current strength of the four beam pathways at the receiver, as shown in Figure 4. The same information is presented in the *Status* page of the *AVCC Admin* window. It is important to note that while viewing the *Alignment* that vehicle data cannot be classified. In order to view the *Alignment* the application must be *Connected*, *Automated Tasks* must be disabled, and no file transfer (configuration or log) may be occurring with AVCC receiver. The *Alignment* screen may be displayed by selecting: *AVCC Admin* in *View Alignment*.

Each of the columns represents infra-red light measured in relative units transmitted by the AVCC transmitter and received at AVCC receiver. The optimal alignment of the transmitter and receiver is represented by the 4 columns being of equal number of units at as high a value as possible. In practise the absolute level, and therefore the height of the columns, is dependent on the distance between the transmitter and receiver. Typically beam intensity levels of between 40 and 50 units are required for best operation over 2 to 4 lanes, assuming AVCC units are within 2 metres of the edge of the road. The intensity of all four beams should ideally be within 1 unit of each other.

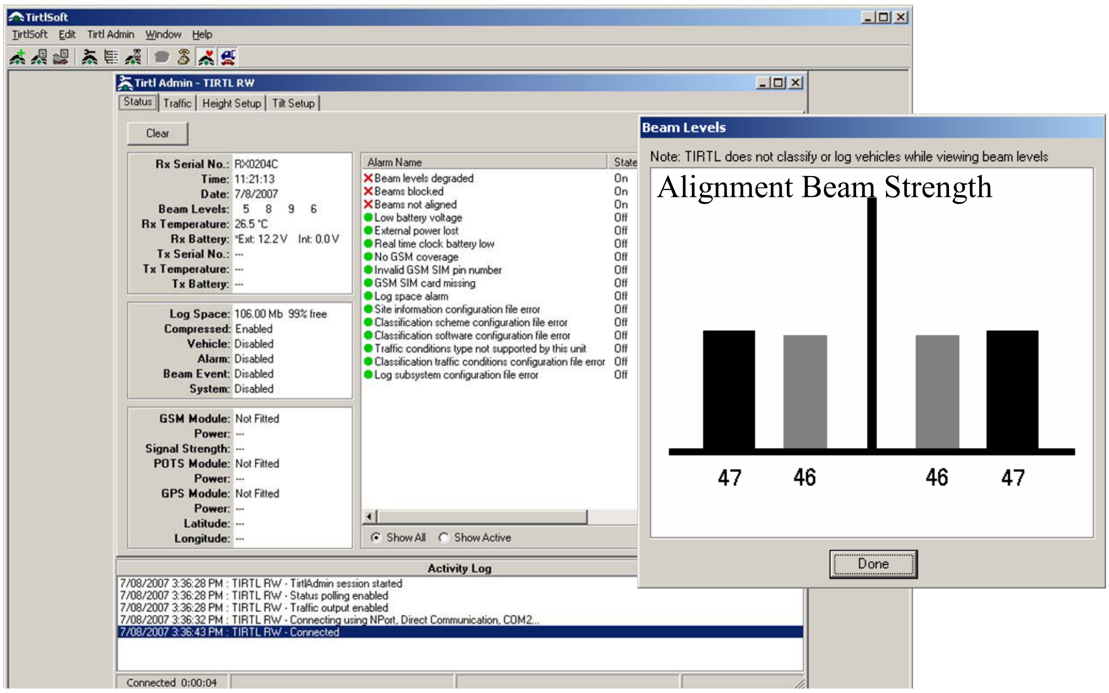


Figure 4 Connected Message on the Screen and Beam Strength.

After the receiver and transmitter are connected, automatically the traffic counting will scroll on laptop screen as shown in Figure 5. After that laptop may be disconnected the traffic data is logged into the memory of the AVCC. After survey is finished the traffic log data is down loaded from the AVCC memory either at field or after coming to office. The retrieved data from the AVCC can be exported into Excel form as shown in Figure 6.

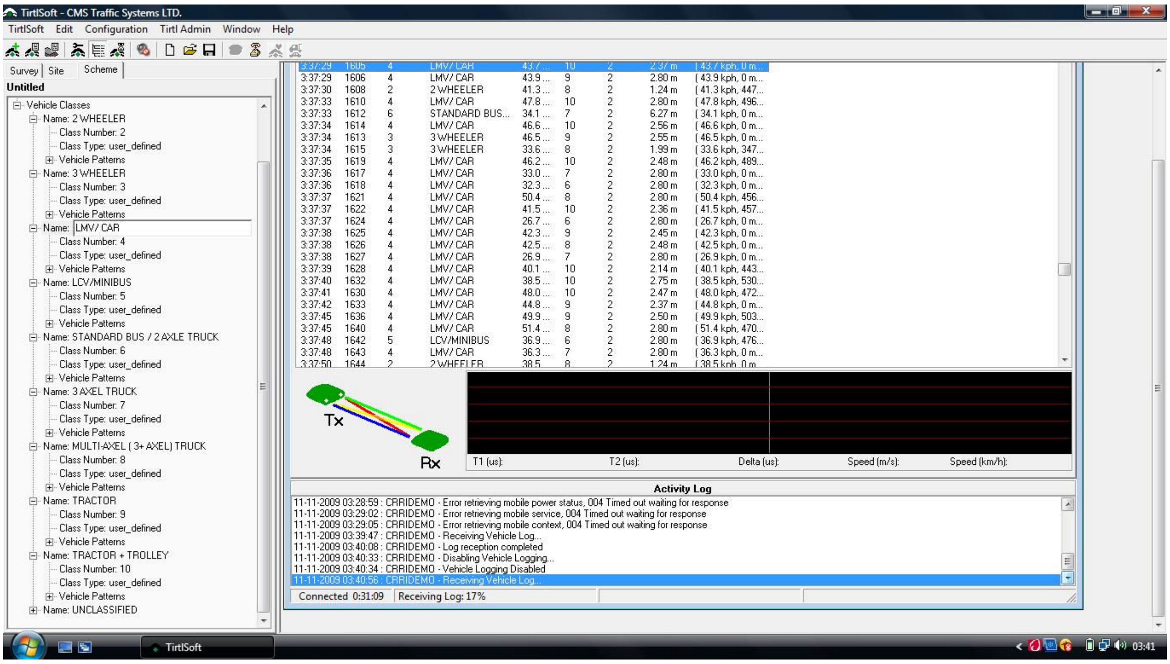


Figure 5 Traffic Counting Scroll on Laptop Monitor Screen

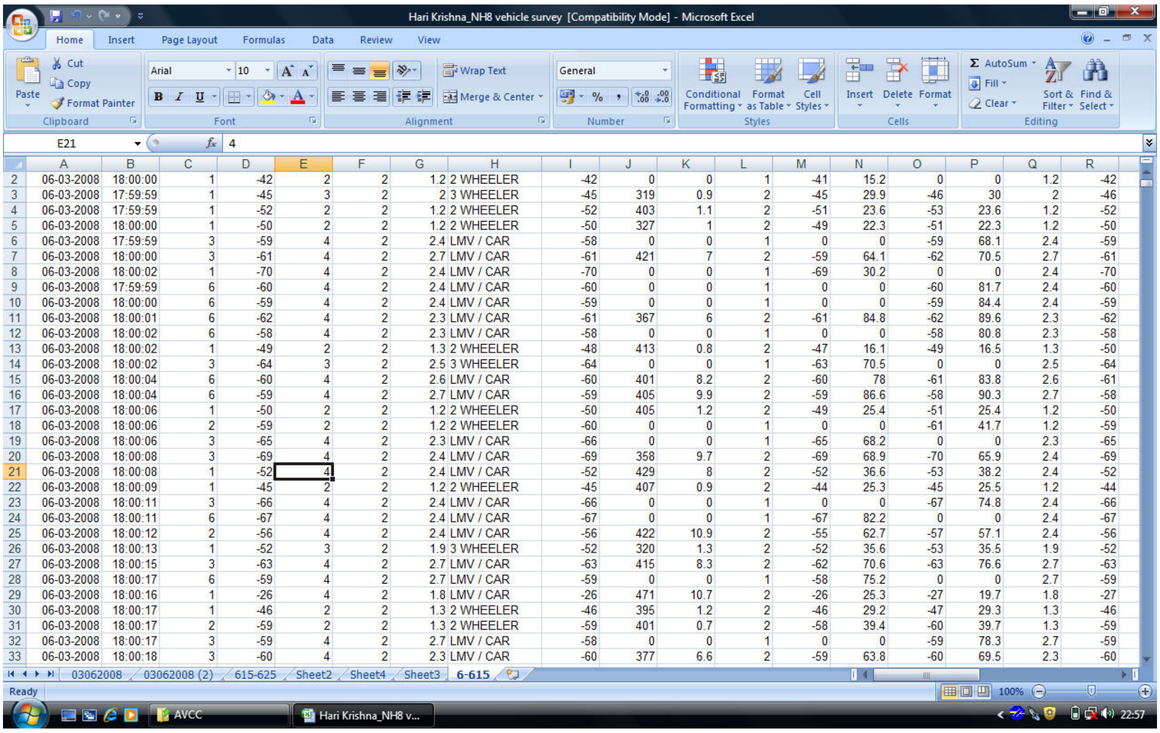
FIELD DATA COLLECTION AND EVALUATION

To evaluate the efficacy of the equipment for Indian traffic conditions, data collection was carried out at three different locations as given below:

- NH-2 near Bahadurgargh
- NH-2 in front of CRRI 2nd Gate
- Delhi-Gurgaon Expressway on NH-8

The data collected at above given locations and however data was collected twice on different days at CRRI 2nd Gate on NH-2 and Delhi-Gurgaon Expressway on NH-8 using AVCC equipment and videography as well.

The data collected using AVCC and Video recording system at all these five locations was retrieved after coming to Lab and analysed based on vehicle types. The comparison of traffic counts for different vehicle types from AVCC and Video recording are presented in Table 3. From the Table 3 it can be seen that the accuracy is as high as 99 percent at Bhallabgarh on NH-2 in Delhi to Mathura (Four-lane divided) direction in terms of total vehicles. However vehicle type accuracy became low as it sometimes misclassified Autos to LMVs because of slighter axle difference between some of Autos and LMVs. The accuracy at remaining locations on NH-2 in front of CRRI gate (Six-lane divided) and on NH-8 Delhi - Gurgaon Expressway (Eight-lane divided) was observed to be about 65 percent accuracy. This is due to heavy traffic volume prevails at these locations leading to low time headway between successive vehicles (less than 3 seconds). However, the accuracy was observed around 85 percent during the non-peak hours on NH8 Delhi - Gurgaon Expressway as the time headway between successive vehicles became more than 3 seconds. Further, the comparison of collected data from AVCC and Videography method was plotted for better understanding as shown in Figure 7.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
2	06-03-2008	18:00:00	1	-42	2	2	1.2	2 WHEELER	-42	0	0	1	-41	15.2	0	0	1.2	-42
3	06-03-2008	17:59:59	1	-45	3	2	2	3 WHEELER	-45	319	0.9	2	-45	29.9	-46	30	2	-46
4	06-03-2008	17:59:59	1	-52	2	2	1.2	2 WHEELER	-52	403	1.1	2	-51	23.6	-53	23.6	1.2	-52
5	06-03-2008	18:00:00	1	-50	2	2	1.2	2 WHEELER	-50	327	1	2	-49	22.3	-51	22.3	1.2	-50
6	06-03-2008	17:59:59	3	-59	4	2	2.4	LMV / CAR	-58	0	0	1	0	0	-59	68.1	2.4	-59
7	06-03-2008	18:00:00	3	-61	4	2	2.7	LMV / CAR	-61	421	7	2	-59	64.1	-62	70.5	2.7	-61
8	06-03-2008	18:00:02	1	-70	4	2	2.4	LMV / CAR	-70	0	0	1	-69	30.2	0	0	2.4	-70
9	06-03-2008	17:59:59	6	-60	4	2	2.4	LMV / CAR	-60	0	0	1	0	0	-60	81.7	2.4	-60
10	06-03-2008	18:00:00	6	-59	4	2	2.4	LMV / CAR	-59	0	0	1	0	0	-59	84.4	2.4	-59
11	06-03-2008	18:00:01	6	-62	4	2	2.3	LMV / CAR	-61	367	6	2	-61	84.8	-62	89.6	2.3	-62
12	06-03-2008	18:00:02	6	-58	4	2	2.3	LMV / CAR	-58	0	0	1	0	0	-58	80.8	2.3	-58
13	06-03-2008	18:00:02	1	-49	2	2	1.3	2 WHEELER	-48	413	0.8	2	-47	16.1	-49	16.5	1.3	-50
14	06-03-2008	18:00:02	3	-64	3	2	2.5	3 WHEELER	-64	0	0	1	-63	70.5	0	0	2.5	-64
15	06-03-2008	18:00:04	6	-60	4	2	2.6	LMV / CAR	-60	401	8.2	2	-60	78	-61	83.8	2.6	-61
16	06-03-2008	18:00:04	6	-59	4	2	2.7	LMV / CAR	-59	405	9.9	2	-59	86.6	-58	90.3	2.7	-58
17	06-03-2008	18:00:06	1	-50	2	2	1.2	2 WHEELER	-50	405	1.2	2	-49	25.4	-51	25.4	1.2	-50
18	06-03-2008	18:00:06	2	-59	2	2	1.2	2 WHEELER	-60	0	0	1	0	0	-61	41.7	1.2	-59
19	06-03-2008	18:00:06	3	-65	4	2	2.3	LMV / CAR	-66	0	0	1	-65	68.2	0	0	2.3	-65
20	06-03-2008	18:00:08	3	-69	4	2	2.4	LMV / CAR	-69	358	9.7	2	-69	68.9	-70	65.9	2.4	-69
21	06-03-2008	18:00:08	1	-52	4	2	2.4	LMV / CAR	-52	429	8	2	-52	36.6	-53	38.2	2.4	-52
22	06-03-2008	18:00:09	1	-45	2	2	1.2	2 WHEELER	-45	407	0.9	2	-44	25.3	-45	25.5	1.2	-44
23	06-03-2008	18:00:11	3	-66	4	2	2.4	LMV / CAR	-66	0	0	1	0	0	-67	74.8	2.4	-66
24	06-03-2008	18:00:11	6	-67	4	2	2.4	LMV / CAR	-67	0	0	1	-67	82.2	0	0	2.4	-67
25	06-03-2008	18:00:12	2	-56	4	2	2.4	LMV / CAR	-56	422	10.9	2	-55	62.7	-57	57.1	2.4	-56
26	06-03-2008	18:00:13	1	-52	3	2	1.9	3 WHEELER	-52	320	1.3	2	-52	35.6	-53	35.5	1.9	-52
27	06-03-2008	18:00:15	3	-63	4	2	2.7	LMV / CAR	-63	415	8.3	2	-62	70.6	-63	76.6	2.7	-63
28	06-03-2008	18:00:17	6	-59	4	2	2.7	LMV / CAR	-59	0	0	1	-58	75.2	0	0	2.7	-59
29	06-03-2008	18:00:16	1	-26	4	2	1.8	LMV / CAR	-26	471	10.7	2	-26	25.3	-27	19.7	1.8	-27
30	06-03-2008	18:00:17	1	-46	2	2	1.3	2 WHEELER	-46	395	1.2	2	-46	29.2	-47	29.3	1.3	-46
31	06-03-2008	18:00:17	2	-59	2	2	1.3	2 WHEELER	-59	401	0.7	2	-58	39.4	-60	39.7	1.3	-59
32	06-03-2008	18:00:17	3	-59	4	2	2.7	LMV / CAR	-58	0	0	1	0	0	-59	78.3	2.7	-59
33	06-03-2008	18:00:18	3	-60	4	2	2.3	LMV / CAR	-60	377	6.6	2	-59	63.8	-60	69.5	2.3	-60

Figure 6 Retrieved Data from AVCC is Exported into Excel Sheet

From the Figure 7, it can be clearly inferred that the matching between AVCC and Videography method is very high when the volume is low. When the volume is increasing, the volume counts from AVCC tend to reduce compared to Videography method as the points can be seen below the 45 degree line. This is mainly due to the heavy traffic volume and less time headway conditions. Some vehicles got missed by AVCC in heavy traffic conditions as one vehicle try to break the beam and before it makes the beam another vehicle would pass very adjacent to it in another lane. In such conditions, AVCC system ignores the second vehicle which passes adjacent to first vehicle and this phenomenon makes AVCC system to produce less volume counts than actual volume counts. Further, to reinforce the above fact it was proposed to see the relationship between error from AVCC and time headway. Using the collected data a relationship was estimated between headway and error from AVCC and presented in Figure 8. From the Figure 8, it can be observed that there is strong exponential relationship between time headway and error as the R^2 is more than 0.9. The error would increase exponentially by 40% with reduction of 1 second in time headway which can be seen from the Figure 8.

Table 3 (a) Comparison traffic data collected from AVCC and Videography surveys on NH 2

Vehicle Type	Bhallabgarh on NH2 (10 .00 -10.30AM) Delhi to Mathura on 7/6/2008				Infront of CRRI 2nd GATE starting time 6.46 -7.11 pm on NH-2,5/6/2008				Infront of CRRI 2nd GATE starting time 7.15 - 7.45pm on NH-2 Delhi to Mathura on 6/6/2008			
	Automatic Counters	Video recording	(Diff..)	% of Error Wrt.Video recording	Automatic Counters	Video recording	(Diff..)	% of Error Wrt.Video recording	Automatic Counters	Video recording	(Diff..)	% of Error Wrt.Video recording
2 wheeler	191	187	-4	**-2%**	464	802	338	**42%**	707	1180	473	**40%**
3 Wheeler	85	65	-20	**-31%**	192	178	-14	**-8%**	241	278	37	**13%**
LMV/CAR	299	316	17	**5%**	510	969	459	**47%**	833	1409	576	**41%**
LCV/MINI BUS	23	30	7	**23%**	12	20	8	**40%**	14	19	5	**26%**
Standar Axle	30	29	-1	**-3%**	33	55	22	**40%**	39	57	18	**32%**
3 Axle truck	7	7	0	**0%**	6	1	-5	**-500%**	15	0	-15	**-**
Multi Axle	0	0	0	**-**	5	0	-5	**-**	4	0	-4	**-**
Unclassified	12	0	-12	**-**	115	0	-115	**-**	120	0	-120	**-**
Tractor	6	17	11	**65%**	2	0	-2	**-**	4	0	-4	**-**
Tractor+Trailor	0	0	0	**-**	44	164	120	**73%**	1		-1	**-**
Cycles	8	7	-1	**-14%**	0	0	0	**-**	141	347	206	**59%**
Cycle Rickshaws	0	5	5	**100%**	0	0	0	**-**	0	15	15	**100%**
Total	661	663	2	**0.30%**	1383	2189	806	**36.82%**	2119	3305	1186	**35.89%**

Table 3 (b) Comparison traffic data collected from AVCC and Videography surveys on NH 8 Access controlled Expressway

Vehicle Type	NH8 Gurgaon to Delhi @ 16.450km.6.00 - 6.25pm				NH8 Gurgaon to Delhi @ 16.520km.2.40pm - 3.10			
	Automatic Counters	Video recording	(Diff..)	% of Error Wrt.Video recording	Automatic Counters	Video recording	(Diff..)	% of Error Wrt.Video recording
	No.of.vehicle	No.of.vehicles			No.of.vehicl	No.of.vehicles		
2 wheeler	854	1450	596	**41%**	931	1112	181	**16%**
3 Wheeler	184	86	-98	**-114%**	394	323	-71	**-22%**
LMV/CAR	1717	3102	1385	**45%**	1677	2251	574	**25%**
LCV/MINI BUS	14	62	48	**77%**	134	158	24	**15%**
truck /Bus	84	131	47	**36%**	85	90	5	**6%**
3 Axle truck	6	3	-3	**-100%**	24	32	8	**25%**
Multi Axle	6	0	-6	**-**	5	0	-5	**-**
Unclassified	0	0	0	**-**	106	0	-106	**-**
Tractor	0	0	0	**-**	8	10	2	**20%**
Tractor+Trailor	0	0	0	**-**	12	16	4	**25%**
Cycles	0	0	0	**-**			0	**-**
Cycle Rickshaws	0	0	0	**-**			0	**-**
Total	2865	4834	1969	**40.73%**	3376	3992	616	**15.43%**

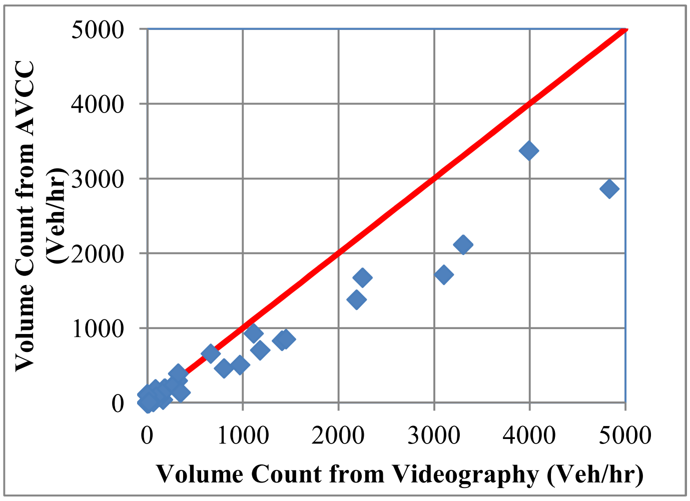


Figure 7 Comparison Traffic Data Collected from AVCC and Videography

From the experience of field setup, data collection and analysis the following points can observed:

i) The AVCC is capable of giving about 95 percent accuracy where the traffic flow time headway is considerably more than 3 seconds (mostly on intercity highways/state highways).

ii) Further the accurate alignment of receiver and transmitter is utmost important and slight deviation from the alignment will result in larger error which is observed on NH8 access controlled expressway.

iii) Under the typical urban traffic flow conditions the AVCC accuracy is about 70 percent with good accurate receiver and transmitter setup having four beam pathways strength above 48. Traffic stop and go situation may not give good accuracy as observed on NH-2 in front of CRRI. The location may be selected away from congested flow (stop-and-go) situations.

iv) Getting alignment of receiver and transmitter will take lot of time in the initial startup. Further possible problems with high crowns will take time to get connected because of AVCC adjustment in lieu of high crowns.

v) Since sometimes AVCC misclassify some of the vehicle types into another vehicle type (Auto into LMV/Car) because of slighter difference in range of axle base, to eliminate this error calibration said to require a “learning curve,” to redistribute the error.

vi) Performance in rain do not affected the traffic count, which is observed at Bhallabgarh on NH2 Delhi to Mathura.

vii) It is also very important to select the sections away from curves because at curves the line of sight of infrared beams of transmitter and receiver deviates at large resulting poor beam strength.

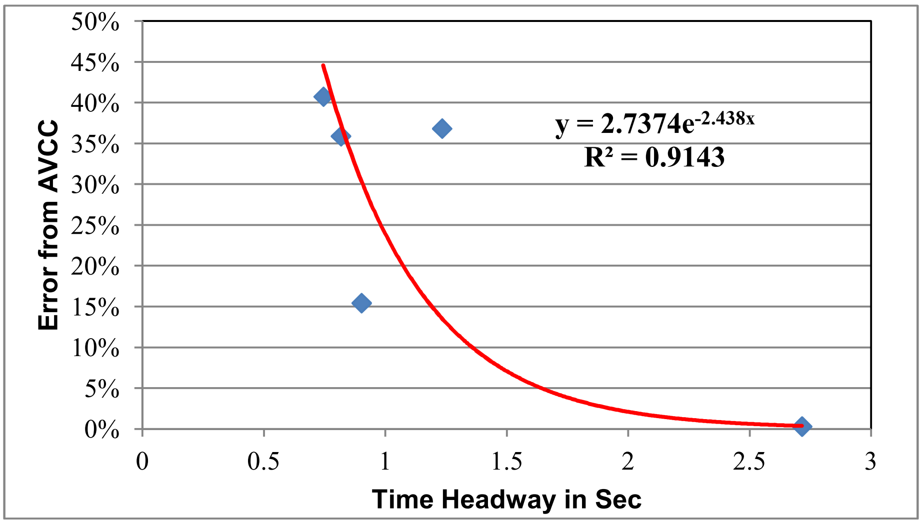


Figure 8 Relationships between Error from AVCC and Time Headway

CONCLUSIONS

In the past years intrusive type counters have developed which has their own limitation because of intrusive nature in installation. In the recent past gradually the state of art volume counters such as non-intrusive counters have been developed. The state-of-the-art of traffic counting devices is changing rapidly; there is a new focus in the industry to develop reliable, non-intrusive devices that are easy to use and cost effective to operate. However, there is much to be learned through the experiences of those who have evaluated these devices. From the global experience it is recommended to learn from the experiences of those who have installed and operated these devices in the field. The reports provide valuable practical information that can only be gained from working directly with the equipment. Further in India the entire PPP projects, daily and monthly basis data monitoring has become mandatory for monitoring of toll revenues collected. Considering the importance of non-intruding type, the infrared based Automatic Vehicle Counters cum classifiers (AVCC), which are more versatile for all types of weather conditions, the suitability of these counters to be necessarily evaluated under Indian traffic conditions. This paper mainly focused on traffic counting carried out using AVCC equipment and as well as traffic videography covering different types of locations ranging from low traffic volume to high traffic volume including the multilane intercity corridors and compared the traffic counts from both methods. From the field studied conducted, it can be concluded that AVCC is capable of giving good degree of accuracy (95%) in intercity highways/ state highways/ major district roads, where the expected time headway between the vehicles is expected to be more than 3 seconds. However in urban conditions it is expected to give accuracy between 65-75 percent accuracy depending upon the beam pathways strength and time head between the vehicles. Further it is to be mentioned that AVCC is capable of giving the spot speeds, lane occupancy etc. Under the present line of instruments AVCC may be best suits to our Indian traffic conditions considering the huge manpower cost (traffic enumerators cost) and lesser accuracy which was incurring on Manual counts. Further the accuracy of AVCC may further improved to a great extent by fine tuning the transmitter and receiver and good beam pathways strength.

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