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**USE OF VIDEO DETECTION SYSTEMS FOR COLLECTION OF VEHICLE ACTIVITY
DATA IN EMISSION MODELING**

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Transportation data from advanced traffic management systems (ATMS) can be used as input to evolving transportation emissions models and can provide data for ongoing model improvement efforts (such as validating travel demand and traffic flow models). ATMS allow real-time vehicle activity data to be collected from urban transportation systems through video detection. The video detection systems, such as Autoscope, use machine vision technology to count, classify, and determine the speed of individual vehicles. A freeway or arterial camera transmits the real-time traffic image to a video detection hardware/software package. The vehicles (represented by a change in background pixel shading) are counted by the software as they cross established count lines on the computer video screen. The computer software then classifies the vehicle data based upon computed vehicle length, and estimates vehicle speeds over set distances. In addition, the detection software can compute flows, density, level of service, and other traffic engineering measures based upon the video-processed counts, speeds, and default variables in the software. The accuracy of video detection systems is dependent upon the system and factors such as camera height, location, view angle, and a multitude of environmental factors such as light levels, rain, fog, and wind.

This paper examines the vehicle activity input variables available from video detection systems within the context of the existing and evolving emissions modeling process. A commercially available video detection system (Autoscope) is employed to collect data from freeway segments in Atlanta, Georgia. Video-processed data are analyzed to determine the accuracy of algorithms for computing counts, classifications, speeds, level of service, and accelerations. Video-processed counts and classifications, aggregated over various time periods, are compared with manual observation of the videos. Video processed speeds are compared with random observed speeds (using laser rangefinders). The projected use of these data in MOBILE5a, MOBILE6, and GIS-based modal emissions models are discussed. Then, the implications of these data on emissions model output accuracy are examined. Outcomes of this research will be used to: formulate procedures for the automated collection of vehicle activity data, identify limitations of data in the modeling process, and to assess the impact of using ATMS data on the accuracy of emissions estimation.

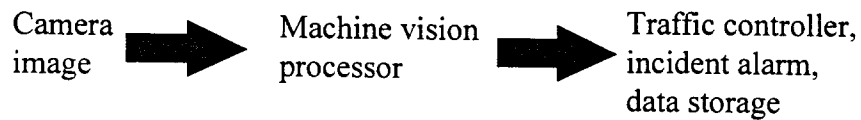
Use of Video Detection Systems for Collection of Vehicle Activity Data

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What is Video Detection?

- Traffic surveillance systems which use machine vision to estimate traffic activity
- Combination of cameras, computers, software and connections

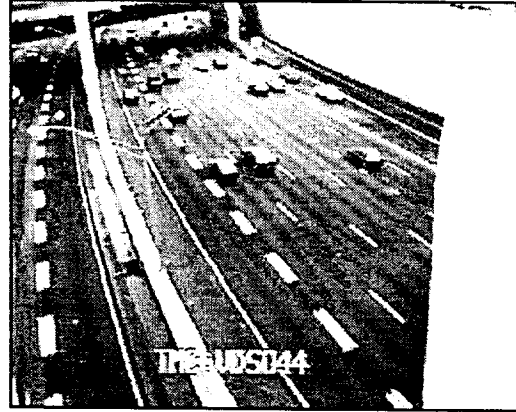


How Does Video Detection Work?

- A “virtual” traffic counter placed on the video image with specialized software
- Change in greyscale values of background pixels is recorded as an event
- Counts identified by change in background
- Speed and vehicle length computed by time within speed trap (in combination with count detector)

DOT Mounted Cameras

- Camera located on high mast fixture
- Height = 35' to 100'
- Angle of view, based on camera location and width of road
- 300+ cameras in Atlanta area
- Only 2 of 4 major interstates equipped with cameras

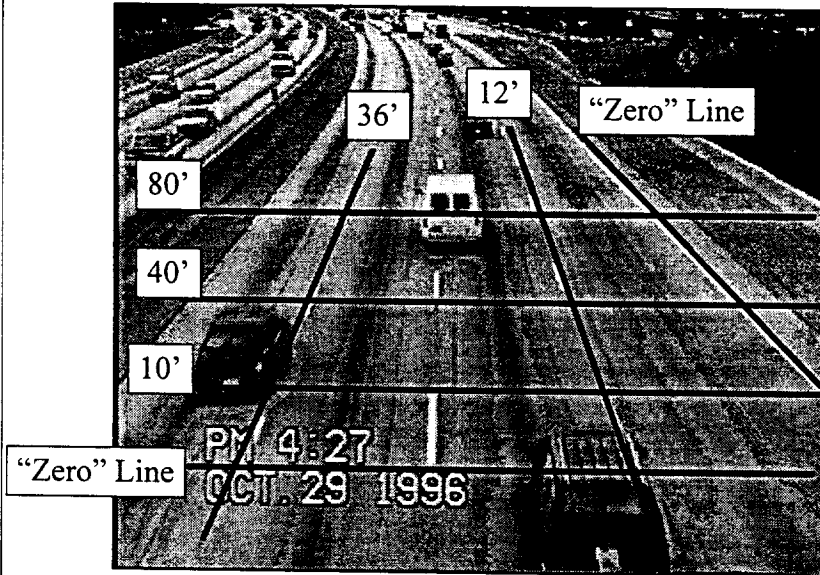


Tripod Mounted Video Camera

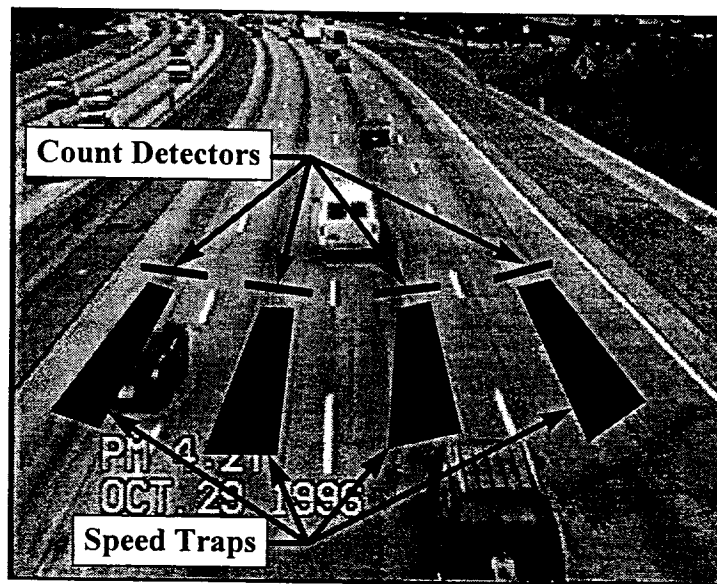
- Video camera on cross street overpass
- Height = 30' to 50'
- Locations limited for data collection
- Angle of view nearly horizontal



Field of View Calibration



Layout of Detectors



Traffic Parameters

Automated Video Processing:

- Number of vehicles, speed of vehicle, and length of vehicle

Computed:

- Vehicle classes (based on length, not axles or weight)
- Flow (veh per hr) & Density (veh per mile)
- v/c ratio (capacity of segment assumed, usually 2200 vphpl)
- Level of service (based on v/c or speed cutpoints)

VDS Data in Transportation and Air Quality Models

- Evaluate free-flow speeds as inputs in models
- Evaluate BPR curve v/c assumptions used in route choice, travel time, average speeds estimates
- Develop spatial and temporal variations in volume, speed, and vehicle class distributions
- Develop link-by-link variations in volume, speed, and vehicle class distributions
- Validate VMT estimation from HPMS
- Provide feedback for calibration and validation phases of transportation modeling process

Comparison of Vehicle Speeds

Video Detected Speeds

Software averages
vehicle speeds over a
fixed interval (10 sec.
to 1 hr.)

Calculates speeds of
every vehicle and
aggregates over time
interval

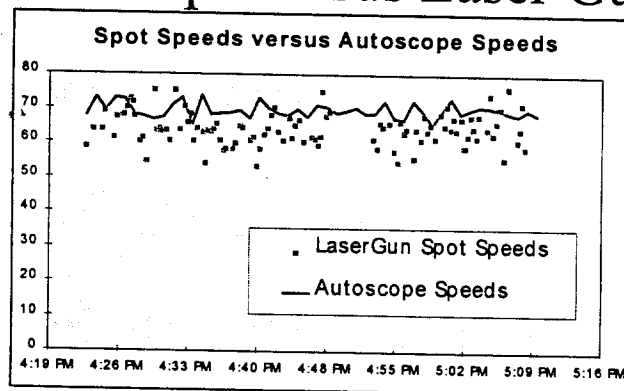
Measured Speeds

Random sample of spot
speeds of vehicles in
each lane

10-20% sample of all
vehicles in lane

Laser rangefinder
measured speeds of
vehicle classes

Speed Comparison Autoscope versus Laser Gun



■ Spot Speeds

- Mean=64.1 mph
- Min=53.1 mph
- Max=76.0 mph

■ Autoscope (1 min. average)

- Mean=69.6 mph
- Min=64.1 mph
- Max=75.1 mph

Sample Video Detection Speeds versus Laser Gun

	Lane 1		Lane 2		Lane 3		Lane 4	
	LRF	VDS	LRF	VDS	LRF	VDS	LRF	VDS
Mean	61.7	67.4	64.1	69.6	68.8	69.2	74.3	71.8
Minimum	51.3	57.4	53.1	64.1	57.6	64.6	62.1	65.7
Maximum	73.6	72.6	76.0	75.1	77.8	71.7	84.4	75.7

Comparison of Volume

Video Detected Counts

Software sums volumes over a fixed interval (10 sec. to 1 hr.)

Bins volumes into 3 classes based on length of vehicle when attached with speed counter

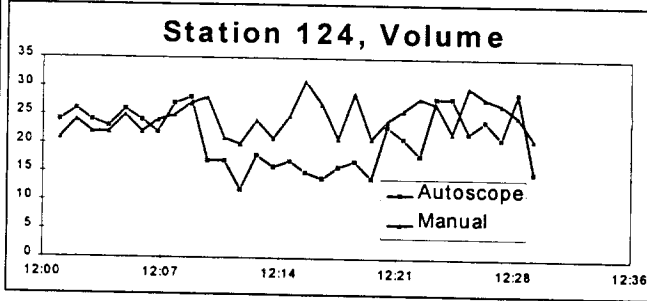
Actual Volume

Manual counts of vehicles at 1 minute intervals

Classification of vehicle based on 3 classes:

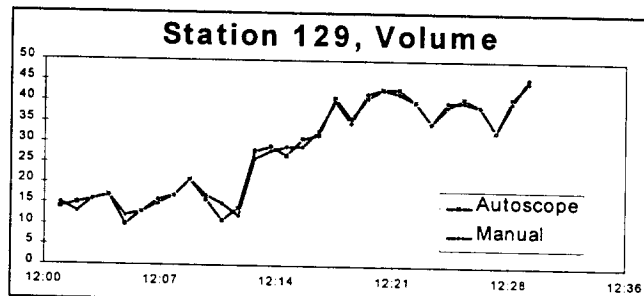
- LDV
- Single Unit Trucks
- Double Unit Trucks +

Sample Traffic Volume from Video



Station 124
125+ feet from camera
Vehicles in adjacent lane obstruct counts

Station 129
75 feet from camera
Unobstructed by adjacent traffic



Sample Differential of Autoscope from Manual Counts

Lane	Distance to counter	% Difference
Aux. Lane 1	135	-6.23%
Aux. Lane 2	118	20.74%
Lane 1	102	33.33%
Lane 2	90	12.90%
Lane 3	86	6.23%
Lane 4	75	2.29%
HOV Lane	72	1.70%
All Lanes		8.63%

Camera in Median

Lane	Distance to counter	% Difference
Lane 1	70	-1.61%
Lane 2	76	0.66%
Lane 3	83	-2.73%
Lane 4	91	9.02%
Lane 5	100	7.85%
Lane 6	110	7.04%
All Lanes		3.16%

Camera in Shoulder

Summary of Speed and Volume Comparison

SPEED

VDS average speeds -2.5 mph to +6.5 mph
 Speeds only compared to tripod mounted video
 Averaging reduces speed variation, and impact s/a profiles in omitting high-end activity

VOLUME

Segment volume (all lanes) varied 8.9% to 3.2%
 Lane by lane variation at 57.9% to 0.2%
 Volumes by class varied to extremes due to low percent of trucks

Influencing Factors in Detection

Camera Height

- Computation of speed and length
- Obstructions from surrounding traffic
- Detection of gaps between closely following vehicles

Camera Angle

- Obstructions of adjacent traffic
- Detection of gaps between vehicles (tripod mounted video camera)

Influencing Factors in Detection (cont.)

Calibration Area

- Sensitive for computed speed of vehicle and length of vehicle
- Does not affect total counts

Traffic Conditions

- Slow moving vehicles
- Large trucks

Environmental Conditions

- Rain, fog, wind
- Nighttime (light levels)

Conclusions

- Accuracy of Autoscope counts, speeds, and classifications can vary significantly as a function of camera height, angle, site conditions, etc.
- ATMS cameras require development of specific setup and operating protocols
- Classification counts may not be as reliable
- Quality assurance plans for use of video-based data in emissions inventory development must be developed