

AUTOMATIC VEHICLE CLASSIFICATION SYSTEM Modular System Design

FEATURES

Tell us the vehicle classes that you want to sort to and we will create the AVC design for you. Our modular single lane AVC system approach allows the use of a variety of proven sensors to create a custom design to meet your specific requirements. And it is all available now.

Our system provides automatic vehicle classification over a wide range of vehicle speeds (0-100 mph including backups). The system can be configured to provide for detection of any or all of the following characteristics.

- Axle count/position/weight
- Trailer/hitch presence
- Primary vehicle and trailer lengths
- Height and width profiles
- Dual tire detection
- Velocity

TDS can provide a standalone AVC processor or integrate the software into your lane controller.

Unique classification correlation software easily accommodates new fare schedules and class structures.

The system also can provide special lane position messages to assist your lane logic algorithms.

USES

Tag/transponder validation in automatic toll collection lanes.

Collector validation in manual toll collection lanes.

Preclassification in smart card lanes to allow for automatic real time fare determination.

Vehicle class statistics (bus, car, truck, motorcycle, number and placement of axles, length, width, height).

ADVANTAGES

Ease of installation & maintenance.

High classification accuracy (>99.5%).

Ease of fare schedule modification/upgrade.

Compatible with latest real time operating systems including Lynx, Linux and Windows 2000.

Expandable to include other lane controller functions including the Transport Data Systems license plate capture system. Together they form the basis for your lane operations.

OPERATIONAL PHILOSOPHY

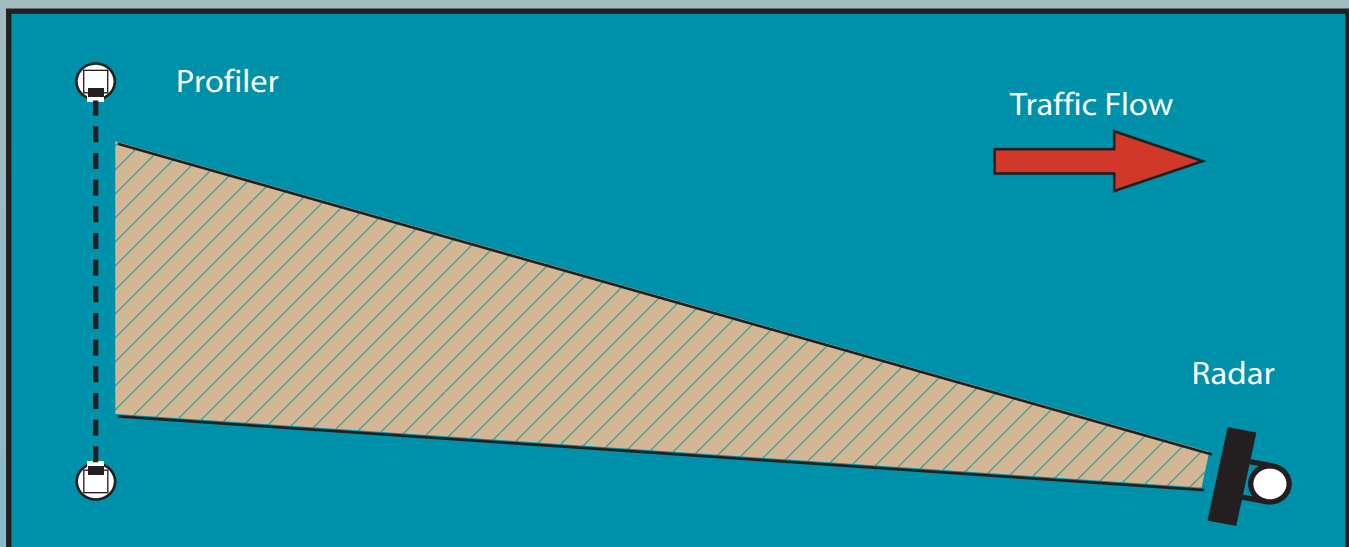
The Automatic Vehicle Classification System is a pattern recognition system which implements a classification correlation engine to categorize vehicles. It records key vehicle features such as length, axle location/weight, and a lateral matrix depiction as the vehicle passes through the profiler. The record is then passed to the classification correlation engine. This record is then compared with a reference vehicle feature set until a correlating classification is determined.

The vehicle detection process is initiated when the profiler reports sufficient penetration to indicate the presence of a vehicle. During periods when no

The axle positions and weights (if required) are determined by examining the axle detection system outputs. These are recorded in the lateral matrix depiction.

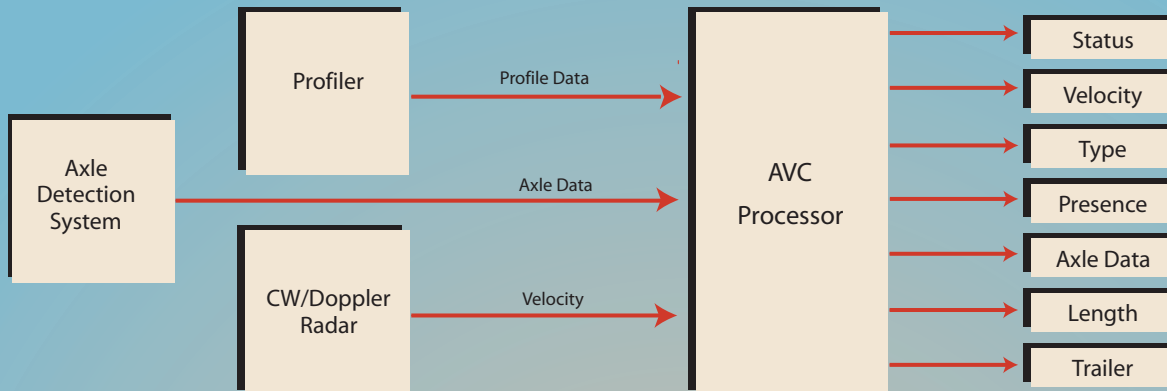
The length of the vehicle is determined from the number of individual data sets that are recorded.

The correlation process begins with a series of tests to determine the basic feature set of the vehicle. This feature set includes primary vehicle length, hitch location, maximum and height variance of the primary vehicle, axle number and locations. It may also include weight and width information



vehicle is being detected by the profiler, the processor monitors the profiler data looking for any indication of a vehicle presence. Once the profiler is penetrated, the processor uses velocity information from the Doppler radar to determine the position of the vehicle relative to the initial location point set by the profiler. Based upon this position, the profiler information is recorded at regular distance intervals (as opposed to time). A complete set of data points is transmitted from the profiler to the data processor at each sample distance. This process continues until the profiler no longer reports any indications of a vehicle. At this point the vehicle profile record is complete.

depending upon the sensors that are implemented. Other tests can easily be added to accommodate unique fare schedule requirements. Discrimination software is then able to determine which of a predetermined set of vehicles correlates with the sample data set. The record is then matched with a reference vehicle feature set. The output information is time tagged and transmitted to the user in near-real time for further correlation with other equipment located in the lane. Vehicle velocity, axle counts and length as well as system status data are also available for transmission to the user. A number of different messages are generated as the vehicle proceeds through the lane. These include the class message as well as the leading and trailing edges of the vehicle.



The Automatic Vehicle Classification System (AVC) is able to separate vehicles into various classes including trucks (with various axle counts), buses, motorcycles, and normal passenger vehicles. Additionally it can detect the presence of trailers associated with any of these vehicles. This is done without benefit of any type of cooperative transponder aboard the vehicle.

BASIC DESIGN

The basic building blocks of the system include a vehicle profiler, a high frequency CW Doppler radar, an axle detection system and a computer system for processing the sensor data. In its simplest form it provides the following information about a vehicle.

- Length of the vehicle(s) and hitch location
- Number of axles
- Relative position of the axles
- Maximum height, average height and height variations of the vehicle.

The system can be configured to detect axles using the bottom beams of a light curtain but that configuration will not do well in snow or heavy rain that can cause blockage of the bottom beams. TDS does not normally recommend this method of operation.

The selection of the profiler is dependent on both the class structure requirements as well as installation criteria.

PROFILER

The system can be delivered with one of two different profiler types, namely a light curtain or an overhead laser scanner. All of the profilers do an excellent job of separating vehicles and detecting hitches. The overhead scanner provides both height and width measurements on the vehicle. The light curtain provides a much more detailed lateral profile of the vehicle but does not provide any width information. The ten foot light curtain is used to solve the most difficult classification problems. A five foot light curtain is available for systems that are axle based and do not require additional profile information. The overhead scanner is typically easier to install but does require an overhead structure like a canopy for mounting.

AXLE DETECTION SYSTEM

The axle detection system provides information about each axle on the vehicle. The single axle sensor can be either a Sensorline fiber optic treadle or a set of Kistler Lineas quartz sensors. The fiber optic treadle provides an indication that a axle is passing through the profiling zone. The quartz sensor provides the same information but also transmits pressure data that when combined with the radar velocity provides an accurate measurement of the weight of the axle. To determine if a vehicle has dual tires, a smaller pair of the Sensorline fiber optic treadles are added to the design.

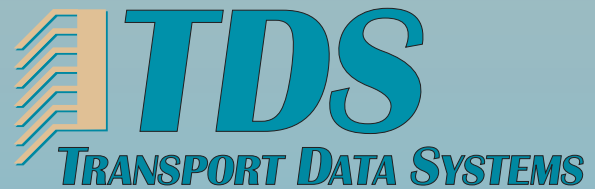
A key element in this design is the use of the CW Doppler radar. The radar provides velocity and distance information for multiple targets detected in the radar beam. The radar beam pattern is designed to cover a single lane when mounted 35 to 45 feet from the light curtain. This pattern size eliminates false detection of vehicles in adjacent lanes. The vehicle and range data provide the tracking module with the information necessary to pinpoint the location and speed of the vehicles in the lane. From the point in time when a vehicle penetrates the profiler until it exits the lane its exact position is tracked. As the position of the vehicle in the profiler changes the profiling module stores profile samples at regular distance intervals (6 inches for most applications) until the vehicle exits the profiler. The separation of the vehicles is provided by the profiler.

Radar signal processing techniques filter out all but the strongest signal. Coherent processing provides indications of both forward and reverse motion. The radar also employs a sophisticated multiple frequency scheme to eliminate interference between adjacent radars. The radar transmits a low level of radiated energy (300 mW) giving it an effective range of 150 feet. All of these features combined in a in a ruggedized

package make it the perfect velocity sensor for this application.

The AVC processor is an Intel based PC. The interface to your lane controller is available in serial form via RS-232 or RS-422. It is also available via a 10/100baseT network connection. For more information concerning this interface please refer to the Software Interface Specification located on the Support page of our website.

The AVC software can be implemented in your lane controller if you are running Linux, Windows XP or one of the real time Unix based operating systems such as Lynx or QNX.



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