

2 TYPES OF VEHICLE DETECTION

Vehicle detectors at a signalized intersection serve the singular purpose of informing the controller that a vehicle is (or is not) present on a particular approach to an intersection at any point in time. The controller uses this information to regulate the assignment of green time among competing movements at the intersection.

The detector configuration is specified in terms of type, shape, length and setback from the stop line. These four parameters are all related to the physical installation of the detectors themselves. In this guideline, the type of vehicle detectors is mainly categorized based on the function of vehicle detectors at signalized intersections based on the requirement of the research.

The selection of the type of detector in signalized intersections is determined primarily by suitability for the intended purpose. The decision whether a particular detector is appropriate for a certain purpose depends on its operating characteristics, its adaptability to the particular application, and the location specific details of the installation requirements.

2.1 Detector Modes of Operations

Before selecting one type of vehicle detector to be applied at signalized intersections, the engineer must consider the traffic variables to be measured. Generally, vehicle detectors at signalized intersections are designed to sense either the presence of a waiting vehicle or the passage of a through vehicle.

2.1.1 Pulse (passage) Mode

The passage or motion of a vehicle is sensed by detectors which operate in the pulse mode. Each vehicle crossing the detector transmits a single pulse to the controller, regardless of the time a vehicle spends in the detection area. Detectors operated in the pulse mode are often referred to as point detectors. With this mode, the memory feature on the traffic signal controller for the traffic phase associated with the detector should be placed in the memory on (locking) mode.

2.1.2 Presence Mode

In presence mode, a continuous call is provided to the controller as long as a vehicle is within the detection area. Presence mode is used for detectors arranged to cover an area rather than a point. These detectors are generally used in left turn lanes or on low speed (40 km/h or less) approaches to an intersection. With this mode, the memory feature on the traffic signal controller for the traffic phase associated with the detector should be placed in the memory off (non-locking) mode.

The operation mode is important to how to choose vehicle detectors at intersections. Some vehicle detectors can only operate in a pulse mode, such as a magnetic vehicle detector. That is,

this kind of detector produces a short output pulse when detection occurs. Accordingly, it can only be used to detect motion at intersection approach and as a counting device. Some vehicle detectors can be used to detect either presence or passage of vehicles.

2.2 Types of Vehicle Detection at Intersections

Based on the functions of vehicle detection at signalized intersections, the main types of vehicle detections at signalized intersections are listed as follows:

1. Advanced detection
2. Stop line detection
3. Right turn detection
4. Counting detection
5. Queue detection
6. Violation detection
7. Truck Detection

2.2.1 Advanced Detection

Advanced detectors are so named because they are located in advance of the stop line. They are only used to detect moving vehicles and are therefore operated in passage mode.

Advanced detectors should be used at sites where the approach speed limit is greater than 35 mph and particularly if there is a large proportion of heavy vehicles. Distance of the location advance detectors to the stop line depends on the limited approach speed. When the speed is high, the distance is long. Generally they should be located to suit the stopping distance required for the 85th percentile approach speed.

The common function of advance detection is to provide dilemma zone protection on high-speed approaches to signalized intersections. The dilemma zone is an area on the approach to a traffic signal whereby there are varied responses by drivers to the onset of the yellow signal. There is a different length dilemma zone for each approach speed. The midpoint of the dilemma zone is defined as the point where 50 percent of the drivers upon seeing a yellow would attempt to continue on through the intersection while the other 50 percent of the drivers would be likely to attempt to stop. The vehicle detectors are usually placed at the 10 to 15-percentile point for drivers who would attempt to continue through on the yellow. The signal controller will turn the signal yellow if the detector is unoccupied for the time specified in the controller. That means that any vehicles that approach after that time will be likely to stop on the yellow and all vehicles inside of the last vehicle that passed over the detector will be likely to pass through on the green.

Based on the functions of advanced detection, selected detectors used in advanced detection should meet the requirement of the detection. The detectors should be able to produce lock pulse signal to detect the passage of high approach speed vehicles and keep a high accuracy.

2.2.2 Stop Line Detection

Stop line detectors are the most common and are so named because they are located at the stop line. And they are always operated in locking mode.

Stop lines are normally located 4 ft. [1.2 m] in advance of, and parallel to the nearest crosswalk line. In the absence of a marked crosswalk, the stop line is placed at the desired stopping point, in no case more than 30 ft. [9 m], or less than 4 ft. [1.2 m], from the nearest edge of the intersecting roadway.

Stop line detectors require greater sensitivity as slow moving or stopped vehicles must be detected. The location of the loop in relation to the stop line must be such as to ensure that a vehicle's normal stopping position is in the detection zone. In addition the detector must have sufficient memory time to monitor waiting traffic even under conditions of extreme congestion.

2.2.3 Counting Detection

For traffic counting, a passage detector is generally used. These detectors can be used to count traffic in individual lanes, lanes in a particular direction simultaneously, or all lanes in both directions continuously. As the number of lanes counted by a single detector increases, the accuracy of the count decreases as multiple vehicles can occupy the same detector at the same time. However these detectors have no effect on the controller operation but use the controller's detector inputs. They are usually operated in locking mode.

2.2.4 Queue Detection

Queue detectors are used in special circumstances to detect stationary vehicles for queue detection and strategic purpose and must therefore be operated in non-locking mode. Because the operation of theory of right turn detection is almost the same as that of queue detection, the guideline does not discuss the right turn detection in detail.

Queue detectors should generally be used for side street right turn movements and for all permitted left turn movements. Delay for permitted left turn detectors is especially important when the intersection layout is such that left turning vehicles from other approaches may impinge on a specific left turn lane by "corner cutting."

If the queue of vehicles waiting at the red indication extends upstream to the queue detectors, a vehicle will be over the detection zone longer than the selected delay time. When the delay timer times out, the detector logic issues a signal to discharge the queue. The green signal will remain on until all vehicles are moving with gaps longer than the loop itself.

The detection zone must be long enough so that it can span the distance between standing vehicles. Concomitantly, it must be shorter than the shortest gap in moving traffic so that the break between motion vehicles will cause the delay timer to reset. The latter consideration can be critical when the queue detector covers two or more lanes. A detection zone of 30 ft [9 m] will generally satisfy this criterion.

Currently the inductive loop proves to be the most prevailing detector in signalized intersections. The long loop (elongated inductance loop) is used to detect the presence of a vehicle. An approach where speeds are low (35 km/h or less) or where most of the traffic makes a right or left turn onto the cross street (regardless of approach speeds) should be considered for long loop installation. Long loops are particularly well suited for use in left turn lanes with separate traffic signal phases or in right turn lanes with a right green arrow displayed during a cross street left turn phase. Long loops are also useful in right turn lanes or through/right lanes when a large number of vehicles make right turns on red. When some non-intrusive vehicle detectors are used to replace the long loop, the corresponding detection zone should be long enough to meet the requirement.

2.2.5 Violation Detection

Violation detectors are installed in conjunction with a red signal violation camera and flash unit to enable red signal traffic violations to be detected. If a vehicle passes over one of the detectors while facing a red signal the camera and flash are activated.

The camera equipment can accept up to four red inputs. This normally comes from the full red; hence violation detectors should only be installed in lanes where all traffic is stopped by the full red. This includes exclusive through and right turn lanes and shared lanes where there is no left or right turn green arrow displayed in conjunction with the full red.

Based on the function of violation detection these detectors should meet the requirement of high accuracy to detect vehicles in high and low speed. Moreover, the detectors should be sensitive enough to detect red light running vehicles and activate the camera equipments.

2.2.6 Truck (Bus) Detection

The truck detection means that some detectors are installed in order to detect some particular vehicles, such as buses and trucks.

The truck detector would be an added detector and would be placed much farther from the intersection. Its purpose would be to grant a green extension that would carry the truck to the normal detector location where it would also get an additional green extension. Therefore, if the “last vehicle” arriving at an intersection during the green interval is a truck, it will get dilemma zone protection as well as a green extension. If the last vehicle over the normal detector is a car, but there is a truck following that has actuated the truck detector, the truck will have sufficient green time to also reach the intersection.

These detectors should have the ability to detect the specific vehicles such as trucks or buses with a high accuracy.

2.3 Summary

The operation mode of vehicle detectors in signalized intersections includes two kinds: passage and presence mode. Different types of vehicle detectors operate in different mode. Except the operation mode, different types of vehicle detectors should meet different requirements. The Figure 2-1 following illustrates this difference.

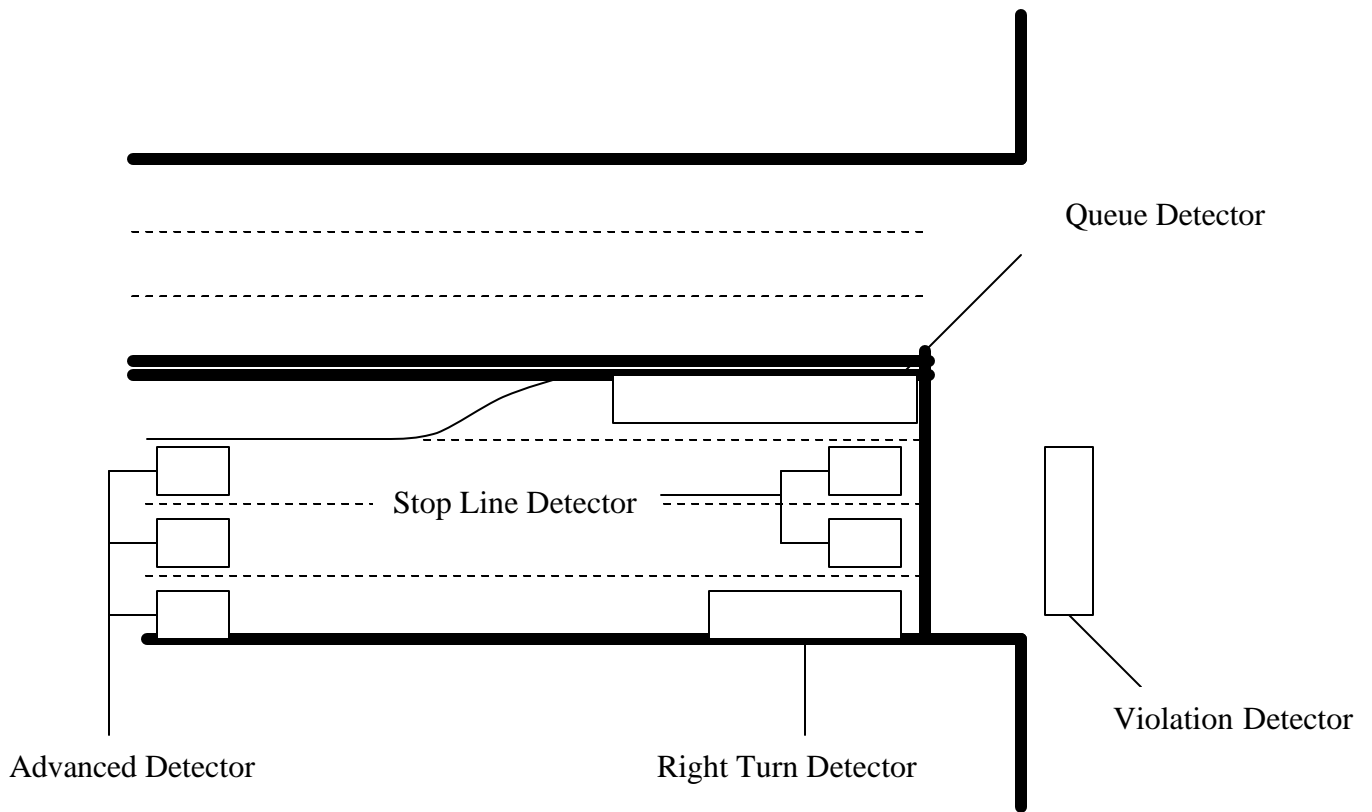


Figure 2-1: General Layout of Vehicle Detectors at Signalized Intersections

Table 2-1. Requirements of Different Types of Detection

Type of detection	Operation mode	Requirements
Advance	Passage	High accuracy in detecting high speed vehicles
Stop line	Passage	Great sensitivity in detecting slow moving or stopped vehicles
Right turn	Presence	The detection zone should be long enough.
Counting	Passage	High accuracy in detecting high speed vehicles
Queue	Presence	The detection zone should be long enough.
Violation	Passage	High accuracy and sensitivity in detecting moving vehicles
Truck (Bus)	Passage	High accuracy in detecting moving trucks and vehicle classifications

2.4 References for Chapter 2

- [1] University of Florida Transportation Research Center faculty and staff, “*Florida Intersection Design Guide, For New Construction and Major Reconstruction of At-Grade Intersections on the State Highway System,*” Florida Department of Transportation, March 2002.
- [2] Bill Semple, “*Road Planning and Design Manual,*” Department of Main Roads, Queensland, Australia, August 2001.
- [3] “*Highway Design Manual,*” New York State Department of Transportation, June, 2003.
- [4] Srf Consulting Group, INC. “*Truck Priority at Traffic Signals*”, Minnesota Department of Transportation, February, 2001.
- [5] “*Project Development Manual,*” Missouri Department of Transportation, June 2003.
- [6] James H. Ken, Iris J. Rllerton., “*Traffic Detector Handbook*”, Report No. A-IP-90-002, July 1990