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Vehicle Detect And Monitor Techniques For Intelligent Transportation - A Survey

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ABSTRACT : *Traffic congestion in the larger cities of the world is a growing problem that has to be taken into account seriously. After an extensive survey in the field of Vehicle and Highway System, different alternatives are analyzed to solve this problem and the concept of Intelligent Transportation System is proposed as the best solution. Intelligent Transportation System includes the latest trends in this area and compares the different options. This contains separate fully-functional units with their own characteristics interrelated to each other to conform a flexible system that can respond in an effective way to solve the problem of traffic congestion.*

Increasing the efficiency and capacity of the existing traffic monitoring network is today's requirement due to the continuous increase in traffic volume and the limited construction of new highway facilities in urban and rural areas. Smart street systems that contain real-time signal control systems, traffic monitoring detectors, motorist communications media and control to develop smart corridors that increase the effectiveness of the transportation network. The infrastructure improvements and new technologies are being integrated with communications and displays in smart cars and public access areas to form intelligent transportation systems.

Keywords- *Intelligent Transportation System, Detector Technologies.*

1. INTRODUCTION Vehicle detectors are an important part of modern traffic control systems. Therefore while choosing vehicle detector different parameters like types of traffic flow data, their reliability, consistency, accuracy and precision and the detector response time should be considered. These parameters become more important as the number and types of detectors increases and the real-time control aspects of Intelligent Transportation System becomes complicated because of number of different data collected by different detectors and data interpretation and integration into the existing traffic control system may produce complications.

Current vehicle detection is based on inductive loop detectors (ILDs) installed in the roadway subsurface. When properly installed and maintained, they can provide real-time data and a historical database against which to compare and evaluate more advanced detector systems. Alternative detector technologies being developed provide direct measurement of a wider variety of traffic parameters, such as density (vehicles per mile per lane), travel time, and vehicle turning movement. These advanced detectors supply more accurate data, parameters that are not directly measured with previous instruments, inputs to area-wide surveillance and control of signalized intersections and support of motorist information services. Furthermore, many of the advanced detector systems can be installed and maintained without disrupting traffic flow.

1.1 THEORY OF DETECTOR OPERATION

The detail explanation of the underlying operating principles for microwave, passive infrared, active infrared, ultrasonic, and video image processor detectors. [2]

Microwave Radar

Microwave radars used in the U.S. for vehicle detection transmit energy at 10.525 GHz. Their output power is regulated by the FCC and certified by the manufacturer to meet FCC requirements.

Two types of microwave radar detectors are used in traffic management applications. The first transmits electromagnetic energy at a constant frequency. It measures the speed of vehicles within its field by using the Doppler principle, where the difference in frequency between the transmitted and received signals is proportional to the vehicle speed. Thus, the detection of a frequency shift denotes the passage of a vehicle. This type of detector cannot detect stopped vehicles and is, therefore, not suitable for applications that require vehicle presence such as at a signal light or stop bar.[1]

The second type of microwave radar detector is called a frequency-modulated continuous wave (FMCW) which transmits a sawtooth waveform, that varies the transmitted frequency continuously with time. It permits stationary vehicles to be detected by measuring the range from the detector to the vehicle and also calculates vehicle speed by measuring the time it takes for the vehicle to travel between two internal markers. Vehicle speed is then simply calculated as the distance between the two markers divided by the time it takes the vehicle to travel that distance. Since this detector can sense stopped vehicles, it is sometimes referred to as a true-presence microwave radar.

Passive Infrared Detectors

Passive infrared detectors can supply vehicle passage and presence data, but not speed. They use an energy sensitive photon detector located at the optical focal plane to measure the infrared energy emitted by objects in the detector's field of view. Passive detectors do not transmit energy of their own. When a vehicle enters the detection zone, it produces a change in the energy normally measured from the road surface in the absence of a vehicle. The change in energy is proportional to the absolute temperature of the vehicle and the emissivity of the vehicle's metal surface. The difference in energy that reaches the detector is reduced when there is water vapor, rain, snow or fog in the atmosphere. For the approximately 20ft (6.1 m) distances typical of traffic monitoring applications with this type of detector.

Active Infrared Detectors

Active infrared detectors function similarly to microwave radar detectors. The most prevalent types use a laser diode to transmit energy in the near infrared spectrum (approximately 0.9 micrometer wavelength), a portion of which is reflected back into the receiver of the detector from a vehicle in its field of view. Laser radars can supply vehicle passage, presence, and speed information. Speed is measured by noting the time it takes a vehicle to cross two infrared beams that are scanned across the road surface a known distance apart. Some laser radar models also have the ability to classify vehicles by measuring and identifying their profiles.

Ultrasonic Detectors

Ultrasonic vehicle detectors can be designed to receive range and Doppler speed data. Ultrasonic detectors transmit sound at 25 KHz to 50 KHz. These frequencies lie above the audible region. A portion of the transmitted energy is reflected from the road or vehicle surface into the receiver portion of the instrument and is processed to give vehicle passage and presence. A typical ultrasonic presence detector transmits ultrasonic energy in the form of pulses. The measurement of the round-trip time it takes for the pulse to leave the detector, bounce off a surface, and return to the detector is proportional to the range from the detector to the surface. When a vehicle enters the field of view, the range from the detector to the top of the vehicle is sensed, and being less than the range from the detector to the road, causes the detector to produce a vehicle detection signal.

Passive Acoustic Detectors

Vehicular traffic produces acoustic energy or audible sound from a variety of sources within the vehicle and from the interaction of the vehicle's tires with the road surface. Arrays of acoustic microphones are used to pickup these sounds from a focused area within a lane on a roadway. When a vehicle passes through the detection zone, the signal-processing algorithm detects an increase in sound energy and a vehicle presence signal is generated. When the vehicle leaves the detection zone, the sound energy decreases below the detection threshold and the vehicle presence signal is terminated.

Video Image Processors

Video image processors (VIPs) identify vehicles and their associated traffic flow parameters by analyzing imagery supplied by video cameras. Using personal computer-type architectures, the images are digitized and then passed through a series of algorithms that identify changes in the image background, that is changes in the quiescent contrast level between the pixels (picture elements) that make up the image. Information about vehicle passage, presence, speed, length, and lane change movement can be supplied, depending upon the type of image processing technique used. VIP processes an image that can encompass several lanes or images from multiple cameras, it is often a cost-effective approach for monitoring traffic flow in multiple lanes and in multiple zones within a lane.

1.2 Advantages and disadvantages of the detector technologies -

A summary of the advantages and disadvantages of the detector technologies given below. Some of them are application specific, implying that a particular technology may be suitable for some but not all applications.

Technology	***Advantages***	***Disadvantages***
Ultrasonic	Compact size, easy installation	May be sensitive to temperature and air turbulence
Microwave Doppler	Good in all weather Directly measures vehicle speed	Cannot detect stopped vehicles or vehicles moving less than approximately 5 mph

Microwave true presence	Good in all weather & Detects stopped vehicles Operates in side-looking mode	Requires narrow beam antenna to confine footprint to single lane in forward-looking mode
Passive infrared (only receive data)	Greater viewing distance in fog than with visible wavelength sensors	Potential reduction by heavy rain and snow
Active (transmit and receive) infrared	Greater viewing distance in fog than with visible wavelength sensors Directly measures vehicle speed	Potential degradation by deem atmosphere

CONCLUSION

Detectors representative of all technologies were found to satisfy current traffic management requirements. However, improved accuracies and new types of information, such as queue length and vehicle turning or erratic movements, may be required from detectors for future traffic management applications. The choice of a detector for a specific application is, of course, dependent on many factors, including data required, accuracy, number of lanes monitored, number of detection zones per lane, detector purchase and maintenance costs, vendor support, and compatibility with the current and future traffic management infrastructure.

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