



Intelligent Transportation System and Vehicle Detection Techniques

Dinesh Bhardwaj¹, Prof. Gulshan Goyal²Research Scholar¹, Associate Professor²

Department of Computer Science & Engineering, Chandigarh University, Punjab

Abstract: 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. Traffic congestion can lead to drivers becoming frustrated and engaging in rage. Traffic congestion in the larger cities of the world is a growing problem that has to be taken into account seriously. After a long time survey in the field of Vehicle and Highway System, different alternatives are analyzed to solve this problem and the concept of Intelligent Transportation System (ITS) is proposed as the best solution. This contains flexible system that can respond in an effective way to solve the problem of traffic congestion. Present paper provides a state-of-practice summary of ITS evaluation methods and impact measurement efforts, by drawing on a comprehensive survey of available literature.

Keywords: - Intelligent Transportation System, Microwave Radar, Passive infrared, Active infrared, Ultrasonic, Video image processor Detectors.

I. Introduction

The number of vehicles and the need for transportation is continuously growing. Nowadays, cities around the world face serious traffic congestion problems. Traffic jams do not only cause considerable costs due to unproductive time losses; they also augment the probability of accidents and have a negative impact on the environment (air pollution, lost fuel) and on the quality of life (health problems, noise, stress)[1]. Fig 1 shows Schematic representation of the dynamic traffic management control loop. Based on the measurements provided by the sensors the controller determines the control signals sent to the actuators. Since the control loop is closed, the deviations from

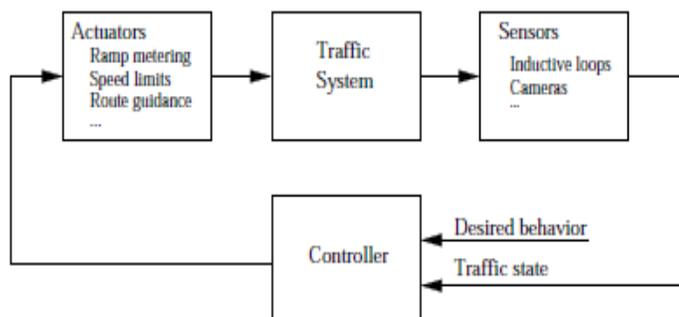


Fig: 1 Schematic representation of the dynamic traffic management control loop [1]

Vehicle detection technology has evolved quite a bit in the last couple decades. From air hoses to inductive loops embedded in roadways, most legacy detection methods were concentrated on getting vehicle presence information to a decision making set of control systems. Fig2 shows earth's magnetic field through Vehicle [2]



Fig2 - Earth's Magnetic Field through Vehicle [2].

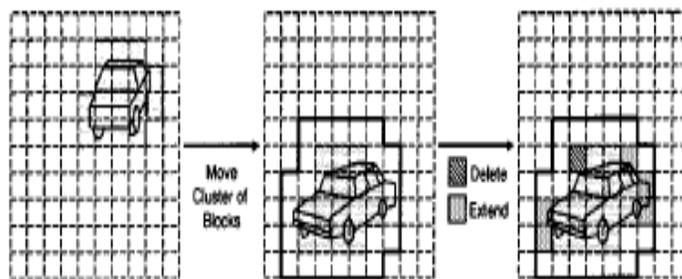


Fig 3. Object moving and remapping [3]

One of the most important research efforts in ITS is the development of systems that automatically monitor the flow of traffic at intersections [3]. Fig 3: shown Object moving and remapping. Many Video Image Processors ITS applications have been developed over the last decade to improve safety and reduce congestion, on the whole making surface transportation more efficient. [4]. Fig 4 shows CMEM's interface with transportation models. Traffic Congestion reduces efficiency of transportation infrastructure and increases travel time, air pollution, and fuel consumption. In the leading nations in the world, ITS brings significant improvement in transportation system performance, including reduced congestion and increased safety and traveler convenience [5].

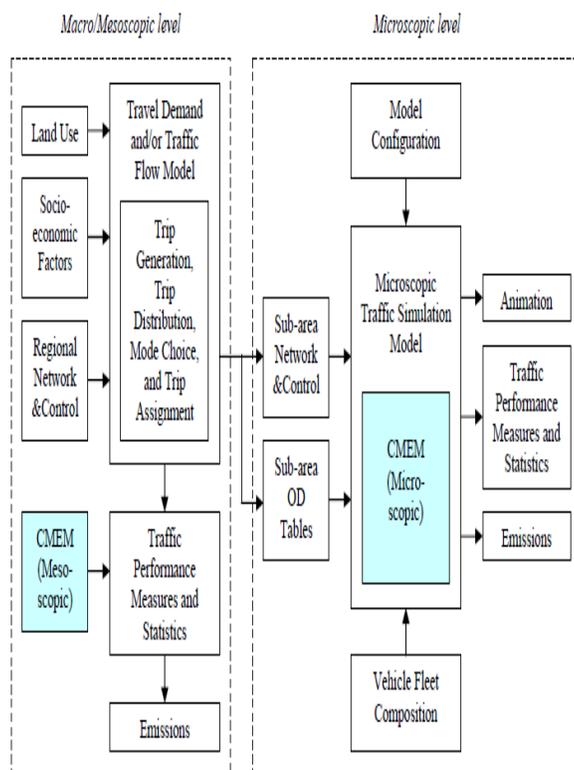


Fig 4. CMEM's interface with transportation models [4]



Fig5: Intelligent Transportation Systems | MIRA [18].

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. [6]. Fig5 shows ITS provided different techniques to detect vehicle on highways. Present paper is a survey of different techniques of vehicles detection are explained and comparisons of each one, result and conclusion.

II. Literature Review:

In the literature several authors have proposed different approaches for Traffic control and Vehicle detection, most of them using ITS.

In [7], the idea of virtual technologies integration is a novel in transportation field and it plays a vital part to overcome the issues in global world..

In [8], Optimal Control Theory (OCT) is widely used to address various aspects of management issues in ITS within which a large portion of the studies aimed to reduce traffic congestion. In [9], this paper provides a state-of-practice summary of ITS evaluation methods and impact measurement efforts, by drawing on a comprehensive survey of available literature. The results of a survey of practitioners and stakeholders designed to address the main issues are also reported on. In [10], the purpose of this paper is to investigate whether or not the costs associated with the application of ITS technology for temporary Construction Zone. In [11] the goal of ITS is to improve the effectiveness, efficiency, and safety of the transportation system. Effective deployment of ITS technologies depends in part on the knowledge of which technologies will most effectively address the issues of congestion and safety. In [12], it is shown that the proposed monitoring and control approach of traffic results with reduced congestion-levels, lower-journey times and an overall enhancement of the transport-infrastructure capacity utilization. In [13], this report identifies existing, new and emerging technologies, and identifies factors that determine if and how these new technologies might be integrated or implemented in Australia. In [14], this paper intelligent transport system capability were used to create a flexible transportation system capable of coping with many uncertainties. High occupancy toll, bus rapid transit and truck only toll managed lanes were examined in a case study in Houston, Texas.

In [15], this paper examines the uses of traffic data gathered using smart work zone technology.

In [16], this report is a framework for a national ITS architecture in New Zealand. It compares international examples of ITS architecture and describes ITS components such as data capture and services currently in use or that may be in use in the future.

III. Vehicle Detection Techniques:

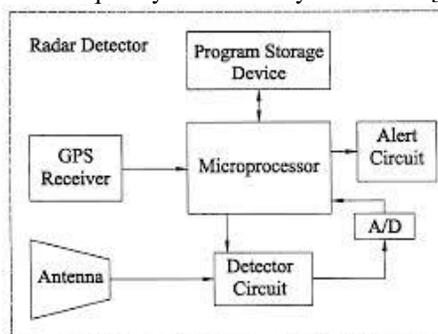
The detail explanation of the underlying operating principles for microwave, passive infrared, active infrared, ultrasonic, and video image processor detectors:

- Microwave Radar
- Passive infrared,
- Active infrared,
- Ultrasonic,
- Video image processor

1. Microwave Radar: Microwave detectors have been used extensively in Europe, but not in the United States. Some of the advantages of microwave detectors: they are a mature technology because of past military applications, detect velocity directly, and a single detector can cover multiple lanes. Two types of microwave radar detectors are used in traffic management applications:

- Microwave Radar transmits Electromagnetic energy at a constant frequency.
- Frequency-modulated continuous wave (FMCW).

The first transmits electromagnetic energy at a constant frequency. It measures the speed of vehicles within its field by using the Doppler principle. The second type of it is called a frequency-modulated continuous wave (FMCW) which transmits a saw tooth waveform that varies the transmitted frequency continuously with time. [17] Fig 6 shows microwave Radar



Detector.

Fig 6: MPC - Detector Technology Evaluations Microwave Radar [19].

2. 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. Fig7 shows Passive Infrared Detectors.

3. 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 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 profile Fig 8 shows Active Infrared Detectors (MPC - distance apart).

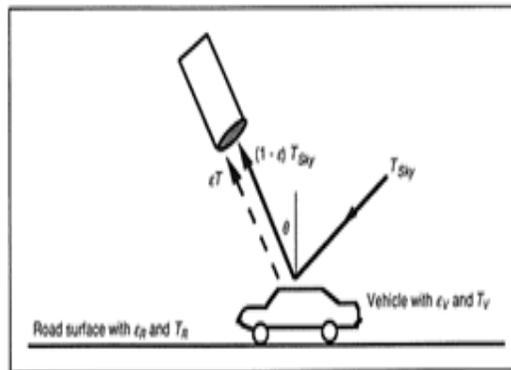


Fig7: Passive Infrared Detectors [20].

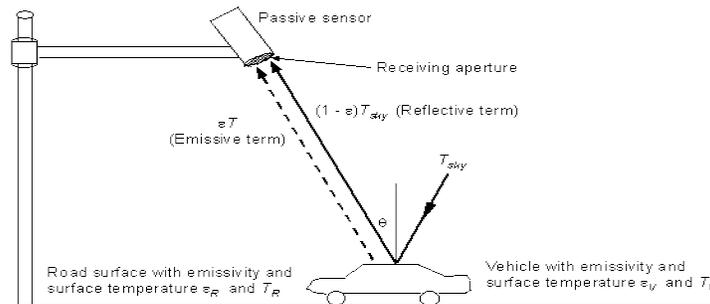


Fig 8: Active Infrared Detectors (MPC - distance apart).

3. Ultrasonic Detectors: Ultrasonic detectors have not become widely used in the United States, but they are very widely used in Japan. Japan uses ultrasonic detectors in traffic applications as much as the U. S. uses inductive loop detectors in traffic applications. Fig9 shows Ultrasonic Vehicle Detector. There are two types of ultrasonic sensors available: (a) Presence Only, (b) Speed measuring.

4. Passive Acoustic: Another type of vehicle detector is the passive acoustic array. Arrays of acoustic microphones are used to pickup these sounds from a focused area within a lane on a roadway. The signals from the microphones in the array are processed and correlated to obtain information about vehicle passage. Video-conferencing companies have been developing sophisticated microphone arrays for their systems, and it is possible that some of their techniques or designs could be adapted to traffic applications. Fig10 shows Passive Acoustic Detectors and transportation control systems product details.

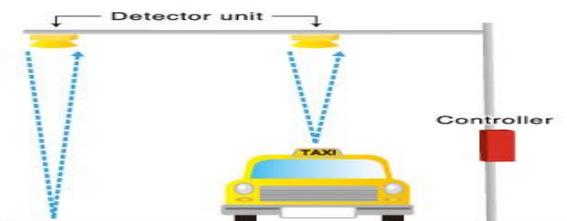


Fig 9: Sumitomo Electric's ITS | Ultrasonic Vehicle Detector [21].



Fig10: Passive Acoustic Detectors Transportation Control Systems' Products Details [22].

5. Video Image Processors:

A video image processor (VIP) is a combination of hardware and software which extracts desired information from data provided by an imaging sensor. This imaging sensor can be a conventional TV camera or an infrared camera. A VIP can detect speed, occupancy, count, and presence. Because the VIP produces an image of several lanes Advantages of VIPs are that they are mounted above the road instead of in the road, the placement of vehicle detection zones can be made by the operator, the shape of the detection zones can be programmed for specific applications Disadvantages are the need to overcome detection artifacts caused by shadows, weather, and reflections from the roadway surface. Fig11 shows Video

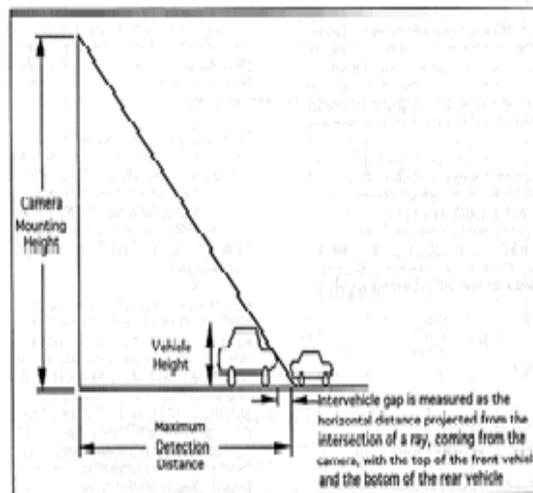


Image Processors.

Fig11: Video Image Processors [23]

IV. Results and discussion:

Present paper reviews different type of vehicle detection techniques like Microwave Radar, Passive Acoustic Detectors, Passive infrared, Active infrared, Ultrasonic and Video Image Processors. Microwave Radar helps to direct measurement of speed and performs some multiple lane operation available however CW Doppler sensors cannot detect stopped vehicles. Passive Infrared helps to measure Multimode passive sensors speed, Passive sensor may have reduced sensitivity to vehicles in heavy rain, snow and dense fog however some models not recommended for presence detection. Acoustic Detectors helps to Insensitive to precipitation and multiple lane operation available in some models however cold temperatures may affect vehicle count accuracy and Specific models are not recommended with slow moving vehicles in stop-and-go traffic. Video Image Processor has rich array of data available, Monitors multiple lanes, Easy to add and modify detection zones however Some models susceptible to camera motion caused by strong winds or vibration of camera mounting structure and It is cost-effective Active Infrared is easy to Mature, well understood technology, Large experience base and Accurate occupancy measurements however Installation requires pavement cut, Decreases pavement life and Installation and maintenance require lane closure.

V. Conclusion:

Present paper emphasizes the different techniques of vehicle detection and survey of ITS. The great potential offered by technologically and economically viable ITS was quickly recognized as an efficient way to resolve many simple and complex transportation problems In order to achieve the full potential of ITS, a careful systematic approach is required in the design and planning, development and implementation, which addresses the problems of user needs. 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.

References:

- [1] Hegyi.A, Bellemans.T, and Schutter.B.De (2009), 'Freeway traffic management and Control' ISBN978-0-387-30440-3, pp.3943 -3964.
- [2] (2005)'Application Note – AN218Vehicle Detection Using AMR Sensors Aerospace' Aerospace Electronics Systems, Defense and Space Electronics Systems and Honeywell International Inc.
- [3] Kamijo.S, Matsushita.Y, Ikeuchi.K, and Sakauchi.M (JUNE 2000)'Traffic Monitoring and Accident Detection at Intersections' IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, VOL. 1, NO. 2.
- [4] Barth.M, Norbeck.J, and Ross.M (2012), 'ECO-ITS: Intelligent Transportation System Applications to Improve Environmental Performance' Transportation Research Record, No. 1587, pp. 52-62. FHWA-JPO-12-042.
- [5] Parulekar.G, D, Desai.D.B.,Gupta.A.K (2013) 'an Overview of "Intelligent Transportation System": Transportation Management through Modern Technology- A Survey' IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 33-34.
- [6] Parulekar(2011). G.D, Desai D.B, Gupta A.K 'Vehicle Detect and Monitor Techniques For Intelligent Transportation - A Survey' IOSR Journal of Mechanical & Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 57-59.
- [7] Qureshi.K.N and Abdullah.A.H (2013) 'A Survey on Intelligent Transportation Systems 'Middle-East Journal of Scientific Research 15 (5): 629-64.
- [8] Jimmy. S.J, WANG.W and LIAO.S.S, (2013) 'Optimal Control Theory in Intelligent Transportation Systems Research - A Review' Department of Information Systems'.
- [9] Askins.R.N and Ferreira.L and Bunker.J (2003) 'INTELLIGENT TRANSPORT SYSTEMS EVALUATION: FROM THEORY TO PRACTICE'.
- [10] Brand, D(1998). 'Applying Benefit/Cost Analysis to Identify and Measure the Benefits of Intelligent Transportation Systems' Transportation Research Record. No. 1651, pp. 23-29.
- [11] Robert L. Bertini, Christopher M. Monsere(2004) 'Benefits of Intelligent Transportation Systems Technologies in Urban Areas: A Literature Review 'Center for Transportation Studies .
- [12] Tayan.O and Al-Binali.A (2013) 'Evaluation of a Proposed Intelligent Transportation Framework using Computer Network Concepts: A Case Study for Hajj-Pilgrim Traffic Monitoring and Control'IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 2, No 2.
- [13] McBride, C, Chadwick, D(2010) 'Compliance and enforcement: intelligent freight compliance technologies' Austroads research report AP-R348/10, Number 24.
- [14] McConnell.S, Sussman.J.M(2008), 'Design and management of flexible transportation networks through the use of intelligent transportation systems ' World Congress on Intelligent Transport Systems, , New York 8 pages.
- [15] Jackson, J (2012) 'Dynamic work zone traffic management 'ITE Journal, 2010 Volume 80, Number 5, pages 26-33.
- [16] James, RJ, Date, J, McBride.C (2010)'Framework for a national intelligent transport systems architecture 'New Zealand Transport Agency.2010 Research report 397. pp 33-37.
- [17] Al-sarawi.S.F, Abbott.D, and Franzon.P. D(1998) 'A Review of 3-D Packaging Technology' IEEE TRANSACTIONS ON COMPONENTS, PACKAGING, AND MANUFACTURING TECHNOLOGY—PART B, VOL. 21, NO. 1.
- [18] 'Intelligent Transportation Systems | MIRA' www.mira.co.uk.
- [19] 'MPC - Detector Technology Evaluation Microwave Radar', www.mountain-plains.org.
- [20] 'Passive Infrared Detectors' www.ntl.bts.gov.
- [21] 'Sumitomo Electric's ITS | Ultrasonic Vehicle Detector' www.global-sei.com.
- [22] 'Passive Acoustic Detectors. Transportation Control Systems Products Details' www.tcstraffic.com.
- [23] 'Video Image Processors' www.ntl.bts.gov.