**Research Methodology**

**(IN 6910)**

**Assignment**

D.N.H Senevirathna

139180A

Faculty of Information Technology

University of Moratuwa

**Analysis of the research paper “A real-time computer vision system for vehicle tracking and traffic surveillance (Coifman et al., 1998)” using scientific method.**

1. Observation

According to the study by Coifman and coworkers, they have observed that in recent years the increasing traffic congestion on freeways has become a significant problem for the existing vehicle detectors. Furthermore they have noticed that the early solutions such as to lay more pavement and add more lanes to avoid congestion had become less feasible with time. They have noted that existing commercial vehicle detection systems based on video image processing are working well in free-flowing traffic but having difficulties with situations like congestion, shadows and light transitions occur due to partial occlusion of vehicle and also due to the fact that vehicles appearing differently under various light conditions. Therefore they have stated the significance of introducing a feature based tracking system for detecting vehicles under these challenging conditions.

1. Preliminary study

Coifman and coworkers, in their work, have studied about the commercial video image processing systems (VIPS) available at present and stated that most of them are tripwire systems which mimic the operation of loop detectors rather than tracking vehicles. AUTOSCOPE, CCATS, TAS, IMPACTS and TraffiCam (Hockaday, 1991; Hoose, 1992; Chatziioanou et al., 1994; Klein and Kelley, 1996; MNDOT, 1997) are some of the commercial tripwire systems they have studied. They have identified that these available systems do not identify individual vehicles as unique targets and follow their movements in time distinct from other vehicles.

Furthermore, they have studied about third generation video image processing systems which track vehicles by using region based tracking in which vehicles are segmented based on movement. They have considered commercial system such as CMS Mobilizer, Eliop EVA, PEEK VideoTrak, Nestor TrafficVision, and Sumitomo IDET (Chat-ziioanou et al., 1994; Klein and Kelley, 1996; MNDOT, 1997; Nihan et al., 1995) as third generation VIPS. They have recognized that in situations like occlusion, two different moving targets may become merged by these systems.

They have also studied about recent evaluations of commercial VIPS, and the evaluations has revealed that the current systems had problems with congestion, high flow, occlusion, camera vibration due to wind, lighting transitions between night/day and day/night, and long shadows linking vehicles together (Hockaday, 1991; Chatziioanou et al., 1994; Nihan et al., 1995; Klein and Kelley, 1996; MNDOT, 1997).

In this research, they have also studied about the algorithm developed to differentiate vehicles from shadows by Chao and coworkers Chao et al. (1996).

Different vehicle tracking strategies from computer vision literature has been studied and discussed in this work and they have been classified as model based tracking, region based tracking, active contour based tracking and feature based tracking. For each of this modal, they have discussed the mechanism used inside and features available along with the limitations of each modal.

1. Problem definition

After the study of existing vehicle detection systems, they have identified the following stringent requirements of a system in order to be an effective traffic surveillance tool.

1. Automatic segmentation of each vehicle from the background and from other vehicles so that all vehicles are detected.
2. Correctly detect all types of road vehicles - motorcycles, passenger cars, buses, construction equipment, trucks, etc.
3. Function under a wide range of traffic conditions - light traffic, congestion, varying speeds in different lanes.
4. Function under a wide variety of lighting conditions - sunny, overcast, twilight, night, rainy, etc.
5. Operate in real-time.

They have stated that many of these criteria still cannot be met by the existing commercial VIPS for monitoring traffic available in the market, and therefore the requirement of traffic surveillance under all conditions.

1. Hypothesis development

In order to address the requirement they identified during the preliminary study, they have proposed a new vehicle tracking system which includes camera calibration, feature detection, feature tracking, and feature grouping modules. With the proposed system, they have focused on feature based tracking as a means to improve detector performance in congestion and difficult lighting conditions, and also to facilitate new and improved traffic parameters by using true wide-area detection to yield vehicle trajectories.

1. Experimental design
2. Data Collection
3. Data Analysis
4. Conclusion

Recent evaluations of commercial VIPS found the existing systems have problems with congestion, occlusion, lighting transitions between night/day and day/night, camera vibration due to wind, and long shadows linking vehicles together. We have presented a vehicle detection and tracking system that is designed to operate under these challenging conditions. Instead of tracking entire vehicles, vehicle features are tracked, which makes the system less sensitive to the problem of partial occlusion. The same algorithm is used for tracking in daylight, twilight and nighttime conditions, it is self-regulating by selecting the most salient features for the given conditions. Common motion over entire feature tracks is used to group features from individual vehicles and reduce the probability that long shadows will link vehicles together. Finally, camera motion during high wind is accounted for by tracking a small number of fiducial points.

The resulting vehicle trajectories can be used to provide traditional traffic parameters as well as new metrics such as lane changes. The trajectories can be used as input to more sophisticated, automated surveillance applications, e.g. incident detection based on acceleration/deceleration and lane change maneuvers. The vehicle tracker is well suited both for permanent surveillance installations and for short term traffic studies such as examining vehicle movements in weaving sections. The vehicle tracking system can also extract vehicle signatures to match observations between detector stations and quantify conditions over extended links. A real-time version of the system has been implemented using a network of DSP chips. The system has been tested on approximately 44 lane-hours of data and has demonstrated good performance under the challenging conditions that have limited earlier VIPS.

References:-

Coifman, B., Beymer, D., McLauchlan, P., Malik, J., 1998. A real-time computer vision system for vehicle tracking and traffic surveillance. Transp. Res. Part C Emerg. Technol. 6, 271–288.