# Literature Review & Thesis Writing

**(IN 5910)**

## Assignment

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## Literature Review

In their study, Benjamin Coifman, David Beymer, and coworkers have proposed a real time computer vision system for vehicle tracking and traffic surveillance under challenging conditions (Coifman et al., 1998). Their work is based on an algorithm to differentiate vehicles from shadows by Chao and coworkers (Chao et al., 1996). According to the study by Benjamin Coifman, David Beymer, and coworkers, the existing systems for vehicle tracking and traffic surveillance have problems with accurately tracking vehicles under conditions like congestion, occlusion, lighting transitions between night/day and day/night, camera vibration due to wind, and long shadows linking vehicles together. Therefore, in this system, they have proposed to track vehicle features instead of tracking entire vehicles, making the system robust and the system less sensitive to the problem raised in these challenging conditions. In their work, they have developed an algorithm and by tracking in daylight and nighttime conditions, the system itself allowed to choose the most appropriate features for the given conditions. The resulting vehicle trajectories from this system has been used to provide traditional traffic parameters as well as new metrics such as lane changes. This vehicle tracking system is suited both for permanent surveillance installations and for short term traffic studies. However this system has not been tested under all challenging conditions mentioned here due to space constrains. Furthermore they have detected some errors in flow and density primarily due to missed or over segmented vehicles by the system (Coifman et al., 1998).

A similar study has done by Dailey and his coworkers to extract vehicular speed information from a given sequence of real-time traffic images (Dailey et al., 2000). This work is based on two preliminary researches done on pixel speed estimation in images. First research they have based their work on is analysis of road image sequences for vehicle counting by Soh and coworkers (Soh et al., 1995). The other work they have refereed as the basis of their method is a study on tracking and segmentation of moving objects in a scene by Picton (Picton, 1989). In the work by Dailey and coworkers, a new approach is presented for extracting vehicular speed information from a given sequence of real-time traffic images. They have developed an algorithm to extract moving edges and process the resulting edge information to obtain quantitative geometric measurements of vehicles. Their approach differs from existing approaches because a simple geometric relations obtained directly from the image is used instead of using reference objects to perform camera calibrations. Furthermore this proposed method does not require an explicit camera calibration. The results presented in this report demonstrates the validity of their approach and shows that neither direct camera control nor placement of a calibration object in the environment is required. Even though this proposed approach is straightforward to extend to other related traffic applications, still there are some problems remain to be solved. In this system they have not addressed the effect of shadows and occlusion of vehicles which is a very common scenario in traffic surveillance applications (Dailey et al., 2000).

Vasu and Chandler have proposed a method for vehicle tracking using a human vision based model of visual similarity (Vasu and Chandler, 2010). Their work is based on a visual quality estimator, called MAD (Most Apparent Distortion) developed by Larson and Chandler in their study - most apparent distortion: a dual strategy for full-reference image quality assessment (Larson and Chandler, 2009). In their study, Vasu and Chandler have proposed an automatic vehicle tracking method for monitoring traffic intersections. For this purpose they have developed an algorithm by using a weighted combination of low-level human-visual-system (HVS) modeling and low-level features of vehicles to track vehicles. They have demonstrated that combining low-level features with an HVS-based model can be an effective strategy for vehicle tracking. However their approach has not addressed the problem of occlusion between the vehicles, and in order for the system to operate the cameras to capture video had to be places in higher position than usual. Therefore it would be difficult to implement this system without a modification of existing infrastructure (Vasu and Chandler, 2010).

Chadil and his coworkers, have proposed an open source GPS tracking system named as Goo-Tracking system using hardware and open source software (Chadil et al., 2008). The system is based on Global Positioning System (GPS) (Kaplan, 1996), General Packet Radio System (GPRS) (Bates, 2001), and Google Earth software (Google Inc, n.d.). The proposed system by Chadil and coworkers includes a module based on Global Positioning System to locate vehicle, and a module based on General Packet Radio Service for message transmission. Further in their system, a Multi Media Card has been used to temporary store location information along with a microcontroller. The message transmission module transmit location data to a server, and then the location is displayed by the module developed using Google Earth software. Their system is claimed to have shown great stability when it was tested. They have argued that by using the robust message transfer protocol most of locations were accurately acquired and transmitted to the server in real-time. They have proposed the Goo-tracking system to be used in fleet management. Furthermore this system is suggested to be used in Intelligent Transportation Systems (ITS) such as to use in probe cars to measure real-time traffic data to identify the congesting areas. In case of an accident this system could be used to quickly and automatically report a vehicle position to a rescue agent. In the future, as a further enhancement, they have proposed it to be used for lost vehicle tracking by integrating with a car anti-theft system. This proposed system is showing the feasibility to be used in general applications as mentioned above due to the fact it is of minimal cost to be implemented. They have used commodity hardware and open source software for this system to keep the cost of implementation at a minimum, however since all the location updated are to be sent to a server, the hosting architecture will be costly to handle large amount of location updated received simultaneously. In addition, this system requires a hardware unit to be installed inside vehicles to detect the location and traffic congestion (Chadil et al., 2008).

In a similar study, Lee and his coworkers have presented a design and implementation of a vehicle tracking system using GPS, GSM, GPRS technology and a smartphone application (Lee et al., 2014). Their work is based on the smart on-board transportation management system proposed to reduce traffic violation in developing countries by Tarapiah and coworkers. This referred system uses GPS, GS, and GPRS technologies (Tarapiah et al., 2013). In their study, Lee and coworkers have designed and implemented a vehicle tracking system for tracking the movement of any equipped vehicle from any location at any time. The proposed system combines a smartphone application with a microcontroller. The designed in-vehicle device works using Global Positioning System (GPS) and Global system for mobile communication / General Packet Radio Service (GSM/GPRS). In addition to the in-vehicle device, a server and a smartphone application are used for the proposed vehicle tracking system. In the server, a web interface written in PHP is implemented to directly connect to a database. A vehicle's geographic coordinates and a vehicle’s unique identification obtained from the in-vehicle device are recorded in a database table. And a Smartphone application has been created to display a vehicle location on Google maps. Although this system claims to be of low cost of implementation it requires the installation of an in-vehicle device to locate vehicles and requires another smart mobile device to view the location. In addition to that, the requirement of a backend server to store location device accounts for some more cost of implementation to serve intense parallel requests to backend (Lee et al., 2014).

ElShafee and coworkers have taken a slightly different approach to the above mentioned systems for tracking vehicles by integrating social network services with vehicle tracking technologies (El Shafee et al., 2013). Their work is mainly based on the real time web based vehicle tracking using GPS by Muruganandham and Mukesh (Murugananham and Mukesh, 2010) and study by Boyd and Ellison on social network sites: definition, history, and scholarship (Boyd and Ellison, 2010). In their work by ElShafee and coworkers, a new vehicle tracking and security system has been proposed along with use of social network as a value added service for traditional tracking systems. For vehicle tracking in real time, the system has used an in-vehicle unit and a tracking server. The system has provided information like vehicle location (on Google maps), and vehicle status (door, and ignition) to authorized users of the system via the web interface over the internet. It also has facilitated the users to send different commands to in-vehicle unit (restart, shut down) to remotely control the vehicle. Therefore this system can be used as a vehicle security and tracking system. The system's tracking server is implemented to post vehicle location placed on a Google maps to vehicle's twitter account. This feature makes it easy for the vehicle followers to find targeted vehicle and this it could be easily applied to public transportation tracking. Compared to the other vehicle tracking systems discussed above, this proposed system accounts for a broad range of applications such as traffic management, vehicle tracking and an anti-theft system, and also traffic routing and navigation. Having mentioned that, the cost of implementation of this system would be considerable in a practical scenario since it requires a complex in-vehicle device to be installed for vehicle tracking purposes. Along with that, to use the system completely, a mobile device and a web server is required (El Shafee et al., 2013).

Dileepa Jayakody, Mananu Gunawardana and coworkers have proposed an intelligent train tracking and management system to be implemented in Sri Lanka for the purpose of improving the existing railway transportation system. According to their study, the proposed system is a combination of technologies like Global System for Mobile Communication (GSM), Geographical Information System (GIS), Global Positioning System (GPS) and a custom software. The train location is to be identified using the Global Positioning System (GPS) technology, and for this purpose a GPS module is proposed to be installed inside the train. Furthermore, the obtained train location using the installed GPS module inside the train is proposed to be transferred to a central system using the Global System for Mobile Communication (GSM) technology. Once the data of train's current location is received, the data is proposed to be processed using the custom software, and provide a visual positioning of train on maps using Geographical Information System (GIS) technology. In their study, they have mentioned that with the availability of this information, the administrative staff of Railway Department, like train controllers would be able to obtain more accurate details about train location and hence take more accurate decisions. At the same time, due to the availability of accurate, real time information including speeds of trains, the administrative staff is to be able to identify and address safety issues more effectively which occur in railway transportation system in a considerable frequency in Sri Lanka. Their study also shows that the collected data using the proposed system could be used for accurate scheduling considering the train arrival time and departure time at each station (Jayakody et al., 2013). This system can be considered as a comprehensive solution for the current issues observed in the train transportation system. It is proposed to facilitate the real time train tracking, and to provide collected data to the railway administration to enhance the efficiency and safety of their service. But it mainly focuses on train administrative staff rather than the passengers, and also the cost of implementation and infrastructure cost will be considerably large. Furthermore, this system should be implemented within the railway department itself.

| Research | Limitation |
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| A real-time computer vision system for vehicle tracking and traffic surveillance (Coifman et al., 1998). | This proposed system has not been tested under all challenging conditions it has been mentioned due to space constrains. Furthermore they have detected some errors in flow and density primarily due to missed or over segmented vehicles by the system. |
| Video Image Processing to Create a speed sensor (Dailey et al., 2000). | In this system they have not addressed the effect of shadows and occlusion of vehicles which is a very common scenario in traffic surveillance applications. |
| Vehicle Tracking Using a Human-Vision-Based Model of Visual Similarity (Vasu and Chandler, 2010) | This approach has not addressed the problem of occlusion between the vehicles, and in order for the system to operate the cameras to capture video had to be placed in a higher position than usual. Therefore it would be difficult to implement this system without a modification of existing infrastructure |

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| Real-Time Tracking Management System Using GPS, GPRS and Google Earth (Chadil et al., 2008) | Since all the location updated are to be sent to a server, the hosting architecture will be costly to handle large amount of location updated received simultaneously. Additionally, this system requires a hardware unit to be installed inside vehicles to detect the location and traffic congestion. |
| Design and implementation of vehicle tracking system using GPS/GSM/GPRS technology and smartphone application (Lee et al., 2014) | The proposed system requires the installation of an in-vehicle device to locate vehicles and requires another smart mobile device to view the location. In addition to that, the requirement of a backend server to store location device accounts for some more cost of implementation to serve intense parallel requests to backend. |
| Integrating Social Network Services with Vehicle Tracking Technologies (El Shafee et al., 2013) | The cost of implementation of this system would be considerable in a practical scenario since it requires a complex in-vehicle device to be installed for vehicle tracking purposes. Along with that, to use the system completely, a mobile device and a web server is required |
| GPS/GSM based train tracking system – utilizing mobile networks to support public transportation (Jayakody et al., 2013) | This system mainly focuses on train administrative staff rather than the passengers, and also the cost of implementation and infrastructure cost will be considerably large since it requires an onboard GPS tracking unit. Furthermore, this system should be implemented within the railway department itself |

By comparing two major approaches on vehicle tracking, video image processing based tracking and GPS/GPRS based tracking, the second approach appears to be simpler and feasible to implement with minimum effort and cost. When referring to the systems which used GPS/GPRS based tracking, the requirement of installing an in-vehicle unit is commonly observable in every system discussed here. It accounts for more cost of implementation with each vehicle tracked using the system. In order to display the vehicle location these systems require a web interface or a mobile interface, therefore the usage of both a smartphone and in-vehicle device to use the tracking system is costly. When referring to tracking public transport systems, especially train tracking, the above mentioned approaches are hard to be implemented without an involvement from railway authorities. It is due to the fact of requirement to install an in-vehicle device for tracking.

Instead of using an in-vehicle GPS unit to track the location, if smart mobile devices of passengers could be used to track vehicle, the related cost could be greatly reduced and system implementation would be much simpler. This approach is feasible since most people do own a smart mobile device with GPS facility nowadays.

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