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# A Survey on Detecting Overloaded Vehicle in Video Surveillance Systems

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***Abstract* - Overloaded vehicle is a challenging issue in public transport systems and is one of the major causes of road accidents. Vehicle which carry heavy load pose threat to human life expectancy and also cause excessive wear and damage to road, bridges, pavements and make the vehicle less stable. According to Motor Vehicle's Act, overloading vehicle is an illegal offence which carries with fine and prison sentence. Even then, our community is least bothered about the same. Hence the need to address this problem is relevant in the present scenario. The large volume of vehicle on roads has been a challenge to authorities and manually monitoring them is practically not possible. There arises the need for an entirely automated surveillance system. In Intelligent transportation systems, automated vehicle detection plays an important role in detecting overloaded vehicle, identifying abnormal or suspicious behavior of vehicle, traffic congestion, and counting the number of vehicles for traffic analysis and security. Video surveillance technologies are being improved to provide information about vehicle velocity, traffic counting, presence detection, headway measurement, vehicle classification and weigh-in-motion data. Surveillance systems also help in extracting information about the vehicle such as vehicle body type, tire size and trajectory dynamically. Many researchers have contributed towards the automatic detection of overloaded vehicle. This paper reviews various techniques to detect overloaded vehicle in video surveillance systems.**

***Keywords: Weigh in Motion Sensor, Overloaded vehicle, Video surveillance***

## INTRODUCTION

With the advancements in digital imaging and technology, video surveillance has become a powerful means for monitoring vehicle on roads. It is a complicated task for authorities to monitor vehicle which carry heavy load, deviating signals, exceeding speed limit and other related issues. Public places such as railway station, airport, malls, shops make use of surveillance cameras in order to prevent the occurrence of harmful incidents. In traffic environment, as a result of enormous volume of vehicles on roads, detecting overloaded vehicle and tracking manually has been a critical task. The use of intelligent visual surveillance camera helps in detecting moving vehicle without any human operator. Video surveillance is a process of analyzing video sequences which can be manual, semi-automatic and fully automatic. Semi-automatic surveillance systems helps in extracting information with human intervention whereas fully automatic surveillance systems helps in automatically detecting moving object without human involvement. The working of visual surveillance system is depicted in Figure 1.

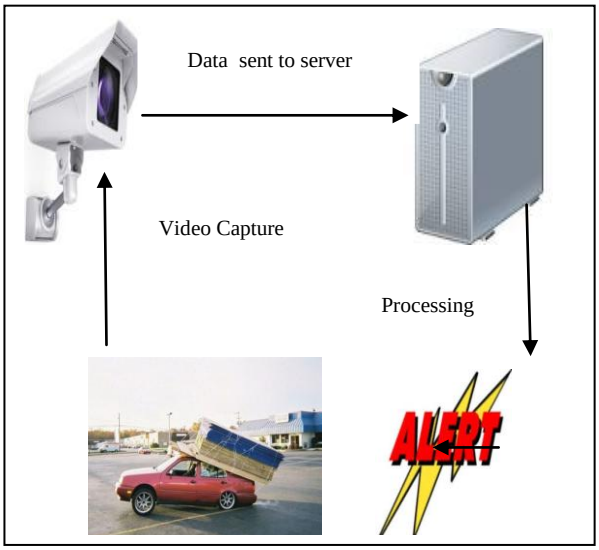


Figure 1: Working of Visual Surveillance System

The video surveillance system mounted at the signals capture the overloaded vehicle information automatically and send to server for processing. The system captures vehicle number, time, place automatically and immediate action would be taken against the owner of the vehicle. There are different methods to detect overloaded vehicle such as extracting information about axle load, counting the number of passengers and also by weighing vehicle using Weigh in Motion (WIM) sensors.

## LITERATURE REVIEW

Standoff Surveillance System proposed by Satyam Srivastava and Edward J. Delp[11], provides information about the vehicle which possess abnormal behavior. Anomalous behavior is detected by tracking the vehicle which constantly ignores the lane markings which could be a sign of driver's negligence. A vehicle with visibly flat tires and moving below the speed limit could be overloaded and pose a threat to human life expectancy. Using two video


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cameras installed near signals relevant information about the vehicle is extracted using video analysis methods. Traditional Background subtraction method [2] is commonly used to identify moving vehicle. However this method is not effective in cases when background suddenly changes due to weather or other environmental changes. Satyam Srivastava et.al proposes a Motion Assisted Background Subtraction method used for identifying vehicles against an uncontrolled outdoor background. The front view camera helps in identifying the vehicle type, make as the vehicle enters the point of interest. The side view camera estimates the size of the tire by identifying the gap between the vehicle body and tires. It can be an indication of an overloaded vehicle, if the gap above the rear tire is smaller. One thousands of vehicles were experimented during fifteen minutes of analysis and detection failures were negligible. The system failed to detect vehicle where the foreground and background were similar and also when two vehicles move together were counted as a single object. A comparison of Gaussian Mixture Model (GMM) against proposed Motion Assisted Subtraction Method were made and found that MABS is much faster than GMM and hence experimented. To determine the type of vehicle and size of methods namely shape matching and circular edge search method were discussed. By observing gap above front and rear tires and the visible flat tires of three different types of vehicles were experimented. Using this information, an overloaded vehicle could be easily identified.

Another method to detect heavy load on vehicle is counting the number of passengers inside the vehicle. Vehicles are allowed to carry passengers within a limit, which would be mentioned in vehicle manual. Overloading passengers beyond the limit is not advisable as it may cause accidents and becomes a menace to lives of innocent people. Kilavo Hassan et.al [8] discusses various techniques used for counting passengers in vehicle. Passengers coming in/out of vehicle could be captured by camera installed in vehicle and using video processing technique [6] , number of passengers get in/out of vehicle could be determined. Kilavo Hassan et.al also proposes a single camera vision system installed at the entrance of vehicle and using feature-point and cluster based algorithms, number of passengers were counted in an effective manner[7]. Infrared Motion Analyzer, another technique which uses infrared sensors to count the number of passengers passing through vehicle's entrance door. This thermal sensor analyses the temperature variation as and when each individual passing through the door by releasing thermal radiation which is measured by pyro-electric detectors.

Most countries namely UK, Canada and Australia have implemented video surveillance cameras in public transport buses to monitor abnormal and suspicious behavior of passengers. Several factors need to be considered in monitoring passengers inside a bus. Such factors include switching seats among passengers, seating to standing and vice versa. In this scenario, it is not easy to count the number of passengers as it wouldn't yield better results. The paper published by Boon Chong Chee[3] et.al proposes an elliptical head detection method count number of passengers in a bus using video surveillance systems. A human head is very suitable for elliptical matching as it is in the shape of an ellipse. Many researchers have contributed towards head detection method and it is explained in [ 9,12]. Boon Chong Chee et.al obtain the object boundaries used for head detection by applying edge detection method on an input image. This method did not give expected results in cases when boundaries of head in an edge image are shorter and are not continuous. Hence a template matching is carried out to locate head using a template of size of passenger's head. Applying least square ellipse fitting algorithm to fabricated ellipse obtained for each matched region, the fitted ellipse residing in the original portion of fabricate is retained and using this head detection can be performed using the formula

$$H=1/N \sum_{K=1}^{N} |xk . \hat{}yk|$$

where the matching head movements H is calculated from the average of N absolute dot products of the unnormalized gradient orientation at pixel k , xk , and its corresponding unit normal vector of the matching ellipse, ^ yk . N is the total number of edge pixels along the perimeter of a matching ellipse.

Overloading could also be determined by checking the vehicle axle load dynamically. Several factors such as uneven road profile, speed, heavy axle load would cause intense stress to pavement and becomes a barrier to adjacent buildings. The findings by M. Agostinacchio et.al [10] discloses that overloading of vehicle causes heavy vibrations to road pavement thus damage roads . The ISO 8608 describes various methods for the generation of road profiles by calculating power spectral density(PSD) for various classes labeled from A to H. M. Agostinacchio et.al generates an artificial road profile after identifying the class and compare with road profile specified in ISO 8608. By comparing the PSD of various classes, it is found that roads which belongs to class A produce small degree of roughness than class H. After determining road surface profile, dynamic force applies to road pavement is measured. The behavior of dynamic overload of different vehicles is obtained by the MATLAB code based on the generated road surface profile. The load that a vehicle transfers to the road pavement varies with respect to time and space and it is proved that dynamic force applied to the road pavement is accountable for the generation of vibrations. M. Agostinacchioe et.al proposes Quarter Car Model(QCM) which is used to model any type of vehicle . This model is used as a reference to understand the interaction between the vehicle and road roughness profile and hence responsible for generation of vibrations in traffic environment, After obtaining equations of motion using Quarter Car Model, dynamic overload is calculated by the equation


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$$A.e^{i\Omega t} = k_t(d-z) = p.(D-Y).\ e^{i\Omega t}$$

where A is the amplitude of dynamic overload; Ω is the system pulse; $k_t$ is the tire stiffness; d = d(t) is the displacement imposed by the road roughness profile;z = z(t) is the displacement of the mass $m_u$; H is the amplitude of harmonic forcing d(t) = D·cos(Ωt); Y is the amplitude of the displacement y(t) = Y·cos(Ωt).

Weigh in Motion sensors are used to weigh vehicles dynamically with respect to parameters such as axle load, distance between axles, total weight and velocity of vehicle. A common WIM system which would be generally mounted on road surface use static methods to determine the axle load. Though it gives reasonably accurate results for lower velocity vehicles, this system is rarely used in our country because of maintenance cost. It also interrupts the traffic due to service actions. For WIM systems mounted underneath the bridge, require multiple sensors which is not cost effective in terms of installation and maintenance. It has been observed that multiple sensors consumes more energy during operation. The research work published by B.Lechner et.al [4] provides a remarkable approach with a system that requires only single sensor and wavelet based signal processing to determine relevant vehicle parameters.

Different type of sensors namely piezometric or quartz sensors could be used for weighing vehicle in motion. But these sensors are expensive and when the road surface gets damaged, eventually these sensors also get destroyed. A.Grakovski et.al [1] proposes Fibre optic sensors for weighing vehicles in motion which would overcome the limitations of above mentioned sensors. Unlike sensors which are installed on road surface, optic sensors could be installed in places with compact metal constructions. The findings in this research includes that optical sensors have more life span and are cheaper as compared to other sensors .These sensors does not require electricity to transfer signals as it is transferred from light source. As and when vehicle moves over the sensors, mass of vehicle is checked against the allowed capacity and if exceeds information about the vehicle is sent for further processing.

## CONCLUSION

Overloading vehicles is one of the foremost reason of road accidents. Although certain measures are taken to detect overloaded vehicle dynamically, authorities are giving least importance to this issue due to various reasons. The safety of school children going to their respective schools in vans and buses is a major concern to parents. With regard to overloaded vehicle, there must be stringent law enforcement to monitor the authorities who are violating traffic rules. Many researchers have contributed towards detection of overloaded vehicle and different techniques are reviewed in this paper. A comparison of different Weigh in motion sensors are assessed in this survey and reached to a conclusion that WIM sensors are effective in detecting overloaded vehicle in motion. The findings made by different researchers in this area are remarkable. A vehicle that poses abnormal behavior could be a reason for overloaded vehicle and the detailed description of the same is reviewed in the survey. The technique such as counting the number of passengers inside the vehicle using camera installed at the door entrance and elliptical head detection method proposed by Boon Chong Chee overcome the difficulty of manual checking in case of excessive passengers. Overloaded heavy vehicle damages road pavements and shorten the life of road and to avoid this, the transport authorities and government agencies should work hand in hand as innocent lives have to pay for this criminal offence.

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