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Vehicle Overloading: A Review

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Abstract: The growth of every nation's economy is estimated by the evolution of its transport substructure. With the moderate development of economy, the scale of transportation industry continues to inflate. Vehicle overloading is illicit exceeding of maximum allowed weight of vehicles, is a serious problem both in developing and developed countries around the world. This paper basically highlights the work done in determining the problems caused due to overloading in vehicles and the technologies used for monitoring, detecting and controlling overload in the vehicles. It also identifies and discusses the efforts undertaken by different researchers using different technologies like GSM, GPS, RFID, BOT (build Operate transfer) projects, WIM (Weigh-in-motion), FOS (Fiber Optic Sensor), IoT (Internet of Things) and geophone that proposes a solution for boosting public transportation management services.

Keywords: Overloaded vehicle, WIM (Weigh-in-Motion), RFID, FOS (Fiber Optic Sensor), GPS, GSM, IoT (Internet of Things).

I. INTRODUCTION

Overloading has been acknowledged both as cost and safety concern, and the National Department of Transport has integrated a movement in contrast to overloading in its strategy of Road to Safety. Economic development require a satisfactory transport substructure. Overloaded vehicles, particularly load vehicles, abolish the roads and hence strike undesirably on economic development. Hence the damage instigated propagates exponentially when the load starts to increase. Overloading harms the roads which in turn leads to high cost of repair and maintenance thereby reducing the life of road and adds burden on the nation along with righteous users of road who eventually carry the casual and inconsiderate overloading cost. Overloaded vehicles contributes in too many of the deadly accidents on roads and threatening road safety. Not only driver's life but also other road users and passenger's life is in danger due to overloading [1]. The effect of engine functioning will increase due to overloading on vehicles and this will cause fuel consumption to burgeon. That burgeoning would also affect the concentration of gas emission from vehicles [2]. Overloading on vehicle is a danger to safety that not only advances to unessential loss of life but also leads to the rapid worsening of roads which results in increased cost of perpetuation and transportation. Notably there have been studies regarding the detection of overloaded vehicles and what all has been done to stop it. There are systems developed based on number of passengers or the load sensors measuring the load of the vehicles and some measure load with help of earth vibrations. There are even some proposed system using RFID tags and Remote frequency transmitter. This review paper has all the studies related to all monitoring and handling overloading in vehicles.

Vehicle overloading will give rise to the following risks

1) The vehicles react unusually when they carry exceeded maximum weights for which they are outlined hence the vehicle become less firm, difficult to lead and takes longer to halt.
2) There will be chance of untimely, menacing and overpriced failure to escalate as overloading cause the tyres of vehicle to overheat and rapidly wear out which can get worse by time.
3) The chances of accident will increase if the driver's work space and control in the overloaded vehicle is decreased.
4) Overloaded vehicle's headlight will lean upwards at night, glaring the approaching drivers to possible detritus or hindrance on the road.
5) The brakes of vehicle as the vehicle is ponderous due to overloading, work hard because of 'the riding of brakes' and hence lose their efficacy to halt the vehicle due to overheating.
6) Overloading make the vehicle hard to outdo as vehicle cannot expedite normally.
7) When there is stress in the suspension system of vehicle, the infirm point can yield over time.
8) If the vehicle is overloaded it leads to high perpetuation cost such as higher fuel exhaustion, brakes, tyres and shock absorbers.
9) Since the purpose is to cram in as much people as possible into the vehicle, seat belts are often not used with overloading.
10) Overloaded vehicles insurance cover may be empty as overloading is illegitimate.

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Now we know that there are so many problems regarding the overloaded vehicles, we go through all the work done regarding overloaded vehicles and all the proposed methods that can help to avoid overloading in vehicles so that this can reduce the risk of road accidents and damages caused due to it.

II. LITERATURE REVIEW

Tri Basuki et.al in his study of Safety and security in public transport explores the view regarding the problem of safety and security by those parties that are involved in the public transportation operation. Safety and security are the two valuable aspects in the enhancement of the performance of public transport and requires planning in complete way. In this study the improvement agenda was developed which consisted of basically 3 aspects: technology, management and institution [3]. To control overloading the different methodologies were proposed in different research work and among these one of the technique could be counting the number of passengers to control passenger overloading in the buses. Various techniques in controlling overloading of passengers in public transport were discussed by Kilvano Hassan, Anael Sam and Dina Machuve. One of the technique proposed was installing a single camera vision system at the entrance of the bus that count the number of passenger effectively even in a crowded place by using cluster based feature point algorithms. Another technique proposed was IR Motion Analyzer (IRMA) that count the no. of passengers moving in and out of vehicle using infrared sensor technology. This technology uses high quality sensors that have optic element integrated with it. They function on the basis that every individual emits thermal radiation that creates contrast in temperature to the individual's environment and hence can be measured using pyro-electric detectors. Stereo Vision was also proposed as one of the method to count the number of passengers with the objective to get a distance from the sensor from each point which is inversely proportional to disparity hence with the help of results from stereo matching the disparity maps were calculated[4]. In the Study by Shanzhen XU, Qian ZHAO a vehicle-mounted overloading control system was designed based on sensor circuit and interface circuit with AT89C51 microcontroller. It monitored real time passenger count and if increase in the number of passenger up to certain limit would stop the fuel injection to control overloading. This System responded fast and saved lot of manpower, and resources in comparison with the traditional control methods [5].

A different study to detect overloading in vehicle using geophone was proposed. Siquan Hu, Min Kong and Chundong She, in "Design of vehicle overload detection system based on geophone", proposed a system to detect overloading vehicle using geophone. This system detects the tiny vibration of the ground when any overloaded and ordinary vehicles go through the road. These collected vibration data is transmitted through the wireless transmission module to the background. For factoring the information they used the SVM algorithm, which helps in determining the overloading. It has small size and high sensitivity and it can adapt well to any sort of environment [6].

The detection of vehicle overloading along with monitoring the real time location of vehicle is also one of the way to control overloading. Therefore A hybrid RFID GPS RTLS system was built by Manon G. Guillemette, Isabelle Fontaine, and Claude Caron that provided the real-time location of human assets with the help of GPS, RFID and RTLS considering inside and outside both [7]. Later K.R. Prasanna, M. Hemalatha in their study addresses problems in load vehicles like misplacement of goods, vehicle overloading, late goods delivery and vehicle load identification. The RFID tag is used in the proposed system for identification of the goods to evade their misplacement and it also controls the overloading of goods in vehicles by using weight sensors. The tracking of the vehicle is done by use of GPS and GSM that periodically sends the details of goods to source [8]. The paper work by C. Matheswaran, V. Senthilkumaran describe the designing of low cost transportation system based on RFID and GSM module. This system provides the cost effective SMS service and saves lots of time in waiting at the bus station as it shows the exact location and arrival time of the bus to the user. With the execution of this system, un-utilization of buses and waiting time at the bus station gets reduced and it is very helpful for handling the emergency situations. It is beneficial for administration as well as for passengers [9].

Swapan Bagui et.al [10] in their paper, controlling overloading in BOT projects highlighted reasonable ways to control overloading through strict implementation. Build Operate and Transfer (BOT) projects are project delivery methods in which private sector receives allowance from the public sector, such projects can be used to control overloading as Swapan Bagui et.al conducted survey on axle load for real project and through that study they concluded that overloading can be controlled by placing heavy restrictions on heavier vehicles and a Weigh in Motion (WIM) system can be integrated along with toll revenue system that will be more effective as WIM can allow high efficiency and through put at toll operations. By study it was found that weigh bridges were economically efficient as 14 weigh bridges can be installed at each end of the road. Later Mohamed Rehan Karim et.al [11] in their study suggested that the weight in motion (WIM) system can function as a vehicle weight sorting tool which can be used in place of static vehicle weight system. Collection of data was done during the study from the developed system so as to explore how WIM

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system can be effective. The result suggested that WIM system are effective and efficient in the current vehicle weight implementation and hence will be beneficial in generating sufficient revenue. Reducing overloading can be optimal as the accidents reduces and budget for road maintenance also reduces benefitting the public. WIM have proved to be an effective technique to control vehicle overloading and so this technique is integrated with various techniques to make it more efficient and effective in various ways.

Leszek Rafalski, Michał Karkowski, Cezary Dołęga in "ANPR-MMR & WIM for detection of overloaded vehicles", suggested that Overloaded vehicles cause considerable damage to the roads therefore it reduces the length of their usability that's why they bring Standard WIM solutions that are designed to capture axle weight and gross vehicle weight. These parameters are used to detect the vehicles with exceed allowed axle or gross vehicle weight. This allows detection of overloaded trucks but not overloaded vans, which are also responsible for the road damage and road accidents. Their solution uses two detection subsystems, Weigh in motion and Video identification which allows number plates, make and model recognition. This implemented solution uses the following components: Weigh in motion software and electronic equipment from Traffic Data Systems GmbH, LINEAS quartz sensors, Instrumented AG, video cameras, ANPR-MMR engine (automatic number plates, make and model recognition) and additional hardware and software, Supervising software. The main idea of the solution based on comparing two sources of data that is real weight of the vehicle and legally allowed maximum vehicle weight. The system compares legally allowed maximum vehicle weight determined on a model with a real total vehicle weight delivered by the WIM system. If the real weight exceeds the allowed weight, the system generates alerts by SMS, SNMP, and e-mail or direct via the warning screen in the user interface application [12].

Raj Reddy proposed a system for controlling the overloading in trucks with the help of weight in motion. It ensure the safe and efficient traveling of trucks. This system controls the overloading automatically. In this system when any vehicle on road approaches any police station then the vehicle is sensed with the help of radio remote frequency receiver circuit. This control circuit trigger the siren on, that draw the attention of police and authority to stop the vehicle, examine and unload the extra weight from the vehicle. This system prevents the damaging of road and accidents as well [13].

The sensors used in WIM System like quartz sensor or piezoelectric sensors are quite expensive and may not have large lifetime. So Fiber Optic sensors are used which are cost effective. A. Grakovski, I. Kabashkin[14], suggested that Fiber optic sensors can be used to weigh vehicles in motion as Optical sensors are not sensitive to Electromagnetic Field and do not have limited life span unlike piezoelectric and quartz sensors, even installing the optical fiber sensor is cheap and transferring signals does not require any sort of electricity. Later in 2017 Myra Lyndon et.al [15] proposed B-WIM (Bridge Weigh in Motion) system combining WIM Systems with bridge to determine the vehicle weight that pass over it as considering the bridge as weighing scale. B-WIM uses FEA (Finite Element Analysis) Model and uses Fiber Optic Sensors (FOS). The results shows that FOS was suitable the B-WIM axle detection.

Vaishnavi D. Hajare, Dnyanada N. Meshram, Sachin V. Changlani and Prof. Rupali A. Meshram designed a vehicle tracking and overload detection system for public transport using IoT. Every vehicle has some number of seating capacity but most of the time they violate the law and allows more passengers which causes accident some time, that's why they provided the auto overload detection system. To detect the overloaded vehicle, weight sensors are employed on the vehicles suspension. The device automatically detect the in and out count of passenger/goods. Weight Sensors collect data from the vehicles, pass this data to an on-board data analyzer (normally to be placed at authority stations). Authority station marks the time and location of that vehicle at that moment. Later that whole data use to completely analyzer the vehicle. In inspection of vehicle the authority stations analyze the overloaded point and generate the fine according to that. So in their proposed system the counter is gets counted by using the IR sensors and manipulation done by server which helps to keep the eye on transportation system by RTO and owner of the transport system. Their tracking system has disadvantage that it can be invasion to privacy if any of their technology goes wrong or this system can cause lot of stress to the staff [16].

III. CONCLUSION

The overloading in vehicle has become an issue affecting different regions. In build operate transfer (BOT) project the broker controls overloading vehicle by mounting weigh bridge and strictly enforce overloading rule that maximize his return and may lessens the maintenance cost of the project. WIM (Weight-in-Motion) system helps to increase the weight limit enforcement that is beneficial for road authorities and also helps to reserve infrastructure of road from early weakening and improves safety of other road users. Fiber optic sensors can also be used to implement WIM as they are cost effective in comparison to Quartz and piezoelectric sensor and they are not effected by Electromagnetic Field, even do not have limited lifespan.

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Technology/ Parameters	Real time tracking	Cost	Accuracy for location Detection
RFID, GSM, GPS	yes	low	Accurate
IoT	yes	low	Accurate
IR Sensors	yes	low	Less accurate
Geophone	yes	low	-
WIM Using quartz sensor	yes	high	accurate
WIM Using Fiber optic sensor	yes	low	-

Table 1

The technology such as RTLS (Real Time Location System), RFID, GPS, GSM not only solved issues like overload of vehicles but also misplacements of merchandise, tracking of freight vehicles and periodic information of arrival of goods. Bus monitoring system uses RFID technology along with communication through GSM in which SMS is used to transfer the data between modules that is very cost effective and also provides location of the desired bus so that user can schedule accordingly and hence by using SMS for communication, the service cost has been reduced. Design of vehicle based on geophone is another technology highlighted in this paper. The overload system in which a geophone sensor and Sum algorithm is used is a novel kind of detection system that have small size and high sensitivity, can adjust in different trial atmosphere. We have also discussed vehicle tracking and overload detection system using IoT in which tracking system can be invasion of privacy or if any piece of technology go wrong could cause stress to the staff that comes to rely on the tracking system.

So by this we conclude that use of RFID, RTLS, GSM and WIM technologies could be quite effective and beneficial in monitoring vehicle overloading. Subsequently, this could be the subject of additional study and in this direction we motivate scholastic community to work.

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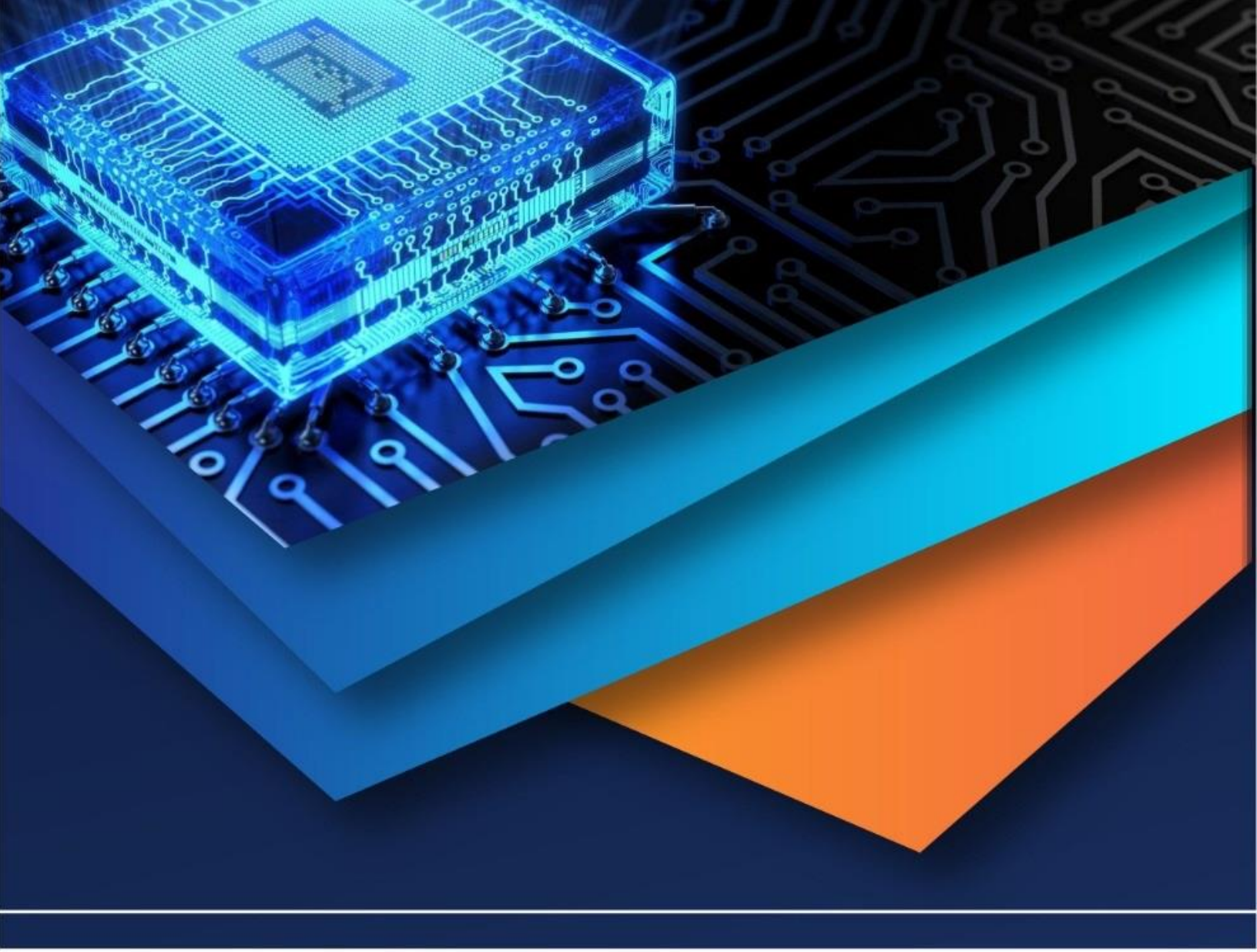
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