

# **NOVEL APPROACH FOR CARGO VEHICLE MANAGEMENT**

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## **ABSTRACT**

*Advanced world of internet of things has brought a vast change in all walks of life. The concept of goods handling is drastically changed. All the tasks are time bound and needs to be accomplished to maximize the potential benefits. The increasing number of fast moving cargo vehicles imposes challenges to the road safety, vehicle safety and the cargo management team. Current paper presents various modern trends being incorporated in cargo vehicles to ensure location and status of vehicle and road safety.*

*Authors have extended the scope of study with due consideration to the native cargo handling scenario and its effects on the transport system. To overcome these challenges the author suggests an experimental model to incorporate safety and efficient management of cargo vehicle.*

**Keywords:** *ARM9, cargo, safety, stability, tracking*

## **I. INTRODUCTION**

Traffic density is increasing day by day. New types of vehicles with advanced technology are the challenges for the existing road infrastructure as well as for the vehicle driver. All the vehicle movement are very crucial and time bound which results in more accidents that in turn leads to the traffic jams and public inconvenience. Impacts of various road accidents are severe as regards the loss of life and the damage to goods and infrastructure. Especially in case of cargo vehicles ensuring a safety of vehicle itself, the goods inside and the external environment is a challenging task. Efforts have been taken to overcome such unforeseen hazards. Tele-monitoring and management system for inter-cities transportation vehicles such as taxis and buses has been experimented. The system utilizes the readily available GSM mobile public networks; therefore the worry about upgrading or maintaining such network is ruled out [1]. The parameters such as exchange of information, identification, positioning, instant communication means and preventive mechanisms to avoid accident are stressed upon and experimented. The activities identified specific to road transport fall under the sub-domains of road network management, road safety management, road traffic management, cargo transport management, cross-border transport management, etc [2].

## **II. LITERATURE SURVEY**

India is a developing country which mostly uses land transport mode for goods. India has an extensive network of inland waterways in the form of rivers, canals, creeks, etc. covering approx. 5200 km. She has dense rail

network which traverses through the length and breadth of the country, covering more than 7,000 stations over a total route length of more than 65,000 km (40,000 mi) and track length of about 115,000 km (71,000 mi)[3], the limitations of rail transport such as time, requirement of road services assistance to reach the last mile; has forced the community to avail the road transport for long distance. Even today with improved air services also the road transport is highly economical and is utilized for long distance cargo transportation. In summary of recommendations Automotive Mission Plan 2006-2016 have mentioned of few points as –National Road safety board to act as coordinating body to promote road safety, Fleet modernization to be encouraged, Integration of IT in manufacturing and automotive infotronics to be promoted, Continuous investment in transport media such as road, rail, port and power to be encouraged[4]. With focus on recent developments which can enrich the scope of the work in the area of designing the tactical transportation plan for intermodal carriers has been discussed which includes prediction of services required over the next activity season, their schedules and the associated transportation itineraries for the forecast demand [5].

Automatic vehicle location (AVL) is the preliminary requirement of modern fleet management systems. Logistic support should essentially have accuracy, celerity, efficient and personalization. Accuracy and celerity play a vital role in ensuring the survival and growth of the enterprises [6]. It further emphasizes improvement in the efficiency of the logistics delivery and enhancement in core competence. Energy optimization can also be achieved if the geographical data of the intended route is available. Same data can be utilized by IC engine/ hybrid electric/ fuel cell. The experimental results have shown improvements in energy consumption which is vital factor for any transport system [7]. Apart from the location details, instant communication and fuel economy, the safety of the cargo is of prime importance. Monitoring of cargo either by a carrier vehicle itself or a monitoring center or at times by transport authority by means of special infrastructure are the recent trends in cargo transportation. Load/ goods distribution varies from vehicle to vehicle. In native scenario after departing the cargo monitoring center, the driver can augment the load in cargo vehicle, since it is easily accessible. The acoustical properties of an intermodal container change with respect to load distribution and doors being open and closed. Thus the ability to monitor the condition of an intermodal container for security purposes has been demonstrated [8]. Research work for entire monitoring and tracking solution for vehicle fleets has been carried out. This aids to check at the same time the position and the mechanical status of the vehicle, as well as the conditions in the cargo bay. The system exploits battery-powered environmental sensors such as temperature, humidity, pressure, gas concentration, ionizing radiation levels, etc. These sensors communicate through ZigBee-based Wireless Sensor network [9]. Different methods have been experimented to detect hazardous material in the cargo truck. Suitable safety measures to mitigate the disaster are also mentioned [10, 11, 12].

Design of dynamic cargo transportation model comprising of the activities and procedures that present the cargo carriage from the sender to the receiving point is discussed [13]. It is brought out [14] that the futuristic Intelligent Vehicle Highway System (IVHS) represents the application of information technology in improving the effectiveness of the existing road transportation system which results in increased safety and better traffic management. Further the vehicle parameters, design of vehicle, loading parameters are also of concern for deciding the safety of the vehicle. Take an example of vehicle rollover which can be caused by many factors, such as the turning speed is very high, the turning radius available is too small, the lateral impact of other

vehicles, the impact of curbs and so on. In a cargo constrained vehicle these parameters are of prime importance [15]. Over weight and over size cargos put challenges for the transport industries as regards the road infrastructure [16]. Similar work of online monitoring of vehicle load can reduce the destruction of the vehicle and can also avoid a series of accidents which the overloading and lopsided load of truck can give birth to [17].

### III. SCOPE & SYSTEM DESIGN

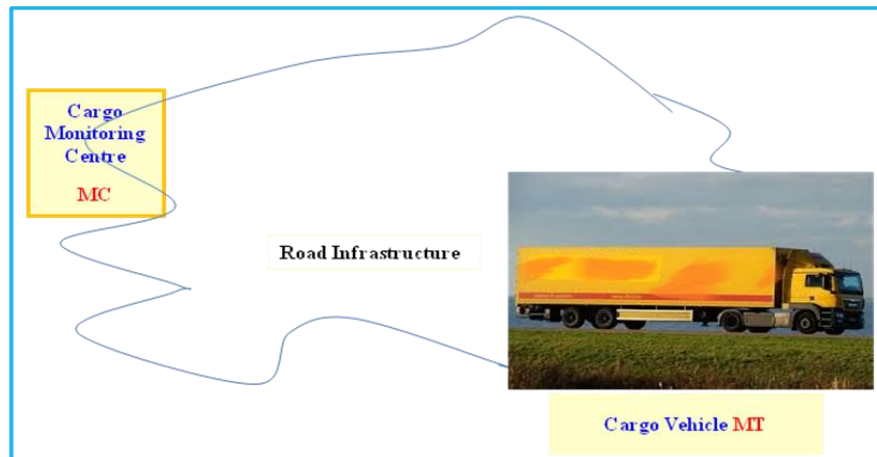
Intense literature survey has unfolded the techniques and methods used for fleet management. The present work focuses on the fleet management and also finds safety of vehicle as an integral part of management. Presented work is a dissertation work. The authors have carried out feasibility study which has been evaluated on a concept model. At present no vehicle manufacturing/ testing agency is involved. Authors are willing to enhance the scope and progress ahead the work with the vehicle manufacturers.

In Indian scenario, the loading of cargo vehicle by an illiterate driver is mostly to fill the vehicle loading space. Here no thought is given to the material density of load. This causes over loading and the advent of safety issues. The concept model carries out online monitoring of distributed load in cargo truck along with other vehicle parameters and the road gradients. The information is available to the driver as well as to the cargo monitoring center. Thus implementation of this system will restrict overloading/unauthorized loads in cargo carrier vehicle. Study is further enhanced to facilitate the driver with early warning signals in case the vehicle stability is in danger.

Overall architecture of the system mainly consists of mobile terminal (MT) i.e. a cargo vehicle and monitoring center (MC). The monitoring center is the core module of the system at the cargo monitoring center. It is part of fleet management system. It can be designed to communicate either periodic data or the extremities encountered during the travel. For simplicity the remote monitoring is carried out through GSM, the same can be implemented using vehicle ad-hoc network or a web based application on internet. Web information system developed possess all functionalities needed for vehicle tracking, fleet control and management [18].

Various parameters monitored are load conditions of the cargo vehicle along with the vehicle speed, vehicle acceleration, deceleration, gradient /slope being negotiated(i.e. road angle)vehicle tilt, steering angle, vehicle location, etc. The system will give on line on-board feedback to the driver about these parameters in a mobile terminal. The system generates warning signal to the driver in case of emergency when threshold limits are exceeded. Modularity in design is a major aspect considered which will assist the specialized configurations of existing and emerging modules and interfaces in subject system as well as the vehicle ECUs.

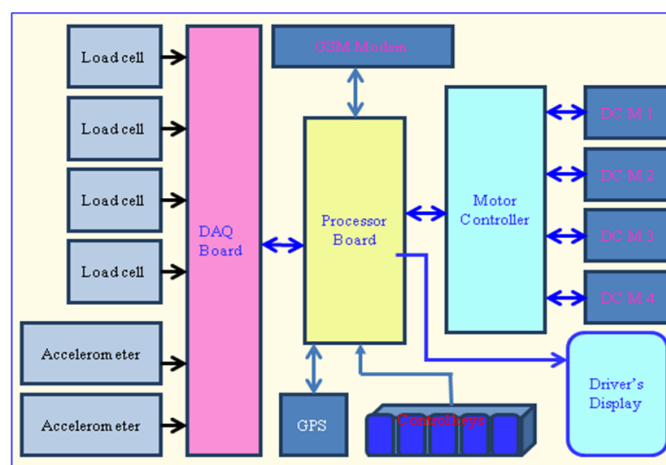
System architecture is depicted in Fig 1. MT and MC communicate through wireless link. In present study GSM is used.



**Figure 1: System Architecture**

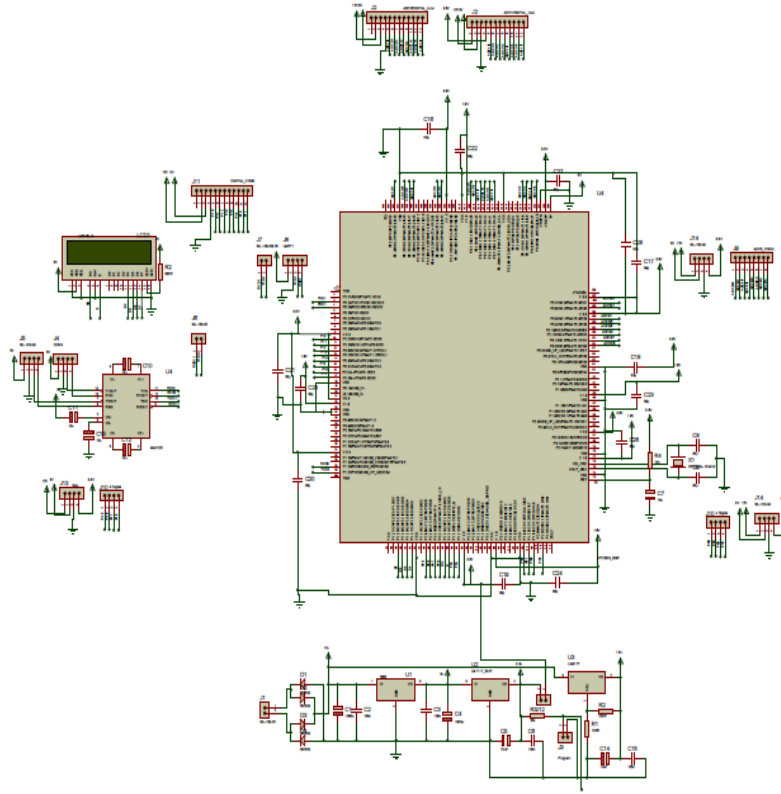
In the present study, the vehicle chassis is a robotic vehicle with four wheels which are coupled to four motors. For simplicity of the project the system processor will only monitor and control the operation of the robotic chassis. The block schematic of the Mobile Terminal Monitoring System is shown in Fig 2. The system consists of sensors, signal conditioning & data acquisition, GSM modem, GPS, display unit, processor, motors, motion controller, etc.

- Various sensors used are load cells mounted beneath the chassis near the four wheels, accelerometer mounted at the center of chassis for gradient and side slope angles, vehicle speed sensor, GPS, etc.
- Suitable signal conditioning is used for all above sensors.
- High performance ARM 9 is selected for processing unit considering the actual need of vehicle control and ease of integration with various ECUs.
- GSM module, GPS and driver's display are connected through USB
- Control keys give command to controller for forward, reverse motion of chassis, speed control of motors
- DC motors are controlled through PWM motor controller.
- Chassis so designed can carry max weight say @10 kg

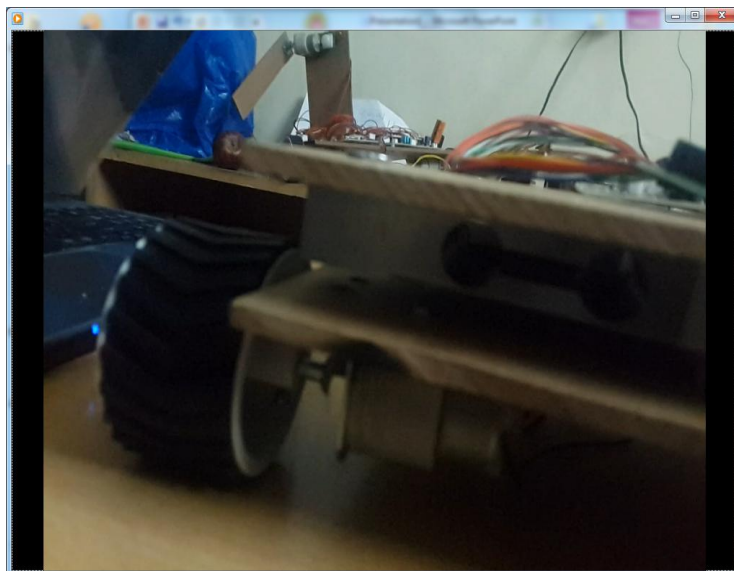


**Figure 2: Block schematic of Mobile Terminal Monitoring System**

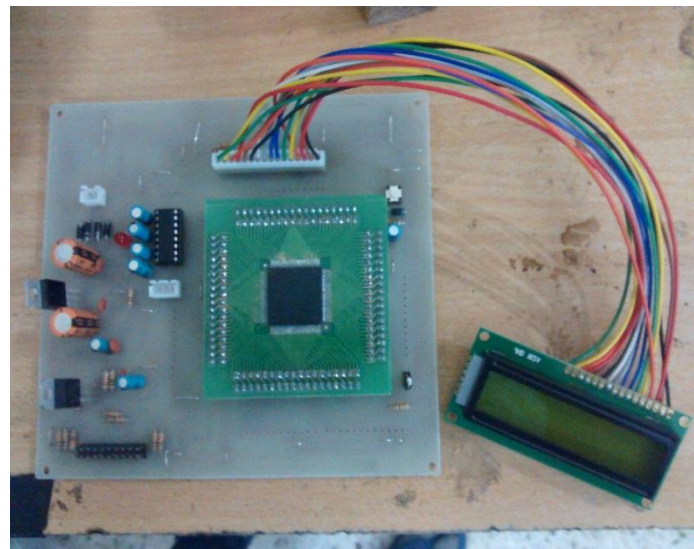
Development work carried out in the study is put forward as Fig3 shows the design of processor ARM9 board along with DAQ and the motor control circuits. Fig4 & 5 are the photographs of chassis and the system circuit board.



**Figure 3: Design of Processor Board ARM9**



**Figure 4: Photograph of Vehicle Chassis**



**Figure 5: Photograph of Circuit Board**

The work progressed so far has shown results as depicted in section 4. The results have encouraged the authors to use the available data to further enhance the scope of study for stability evaluation. The following TABLE-1 shows data utilization of the available data base to estimate vehicle stability. The authors are in touch with the automobile manufacturers and they have shown interest in the concept. Further process of trying on actual vehicle is an involved process which is highly time consuming and beyond the scope of this research work.

**Table 1- Data Utilization**

Sr No.	Parameters	Remark
1.	b - wheel base	Vehicle parameters.
2.	t - track width	
3.	W - Gross vehicle weight	
4.	w - Total load on vehicle	
5.	L1- Load on front left	Measured values
6.	L2- Load on rear left	
7.	R1- Load on front right	
8.	R2- Load on rear right	
9.	$\Theta$ - Longitudenal tilt	
10.	$\emptyset$ - Lateral tilt	

11.	Speed	
12.	Direction- F/R	
13.	Vehicle location – GPS data	
14.	alg : Distance of CG from front axel hlg : Height of CG from front ground alt: Distance of CG from left side hlt : Distance of CG from ground	CG Location – from calculations
15.	$\theta_{th} = \tan^{-1} ( alg /hlg )$ - safety angle	Threshold gradient (longitudinal direction)
16.	$\theta_{th} = \tan^{-1} ( alt /hlt )$ - safety angle	Threshold side curve( Lateral direction)
17.	$\theta_{th} \gg \theta$	Vehicle stability prediction for given load “w”
18.	$\theta_{th} \gg \emptyset$	

**IV. RESULT**

The chassis is put to varying loading conditions. System monitors and displays the load on individual load cells i.e. on all four wheels. Threshold limits are set for overload and suitable message is communicated to the driver and the cargo MC. Periodic communication of vehicle location, loads, speed is communicated to both MT and MC. Fig 6 – depicts various test results on two line LED display.



**Figure 6: Test Results**

The result communicated to MC can be assessed on cell phone mobile SMS. Fig 7 depicts SMS on cell phone and Fig 8 shows the photograph of system output on mobile PC It is an integrated display consisting of load distribution, vehicle tilt, threshold warnings, location and Google map.

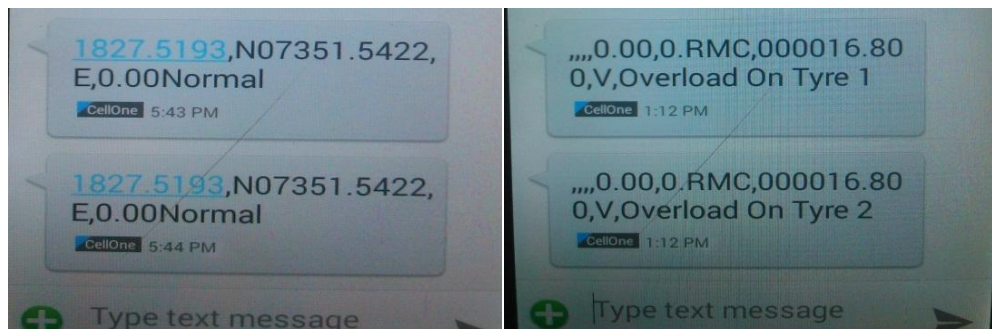


Figure 7: SMS on Cell Phone

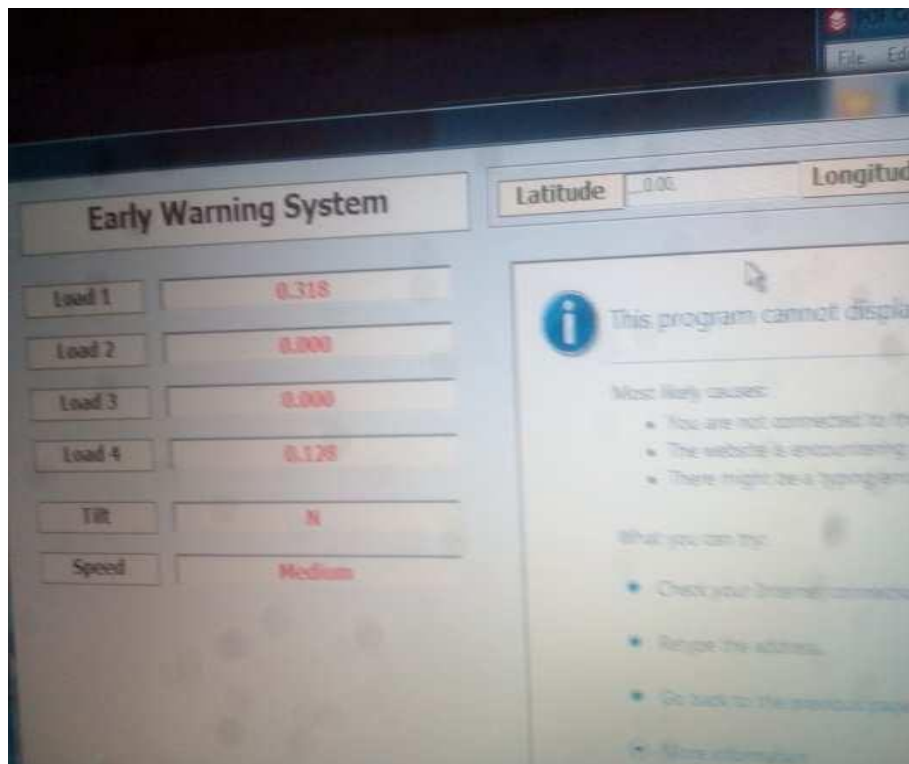


Figure 8: System Output on Mobile PC

## V. CONCLUSION

In this paper we have demonstrated a complete system for tracking and monitoring a cargo vehicle from a cargo monitoring centre. The use of various wireless technologies aids to develop a reliable system. Timely information to driver assists the driver during negotiating a road. Warning signal about overloading, vehicle speed, tilt and side slope alerts the driver in advance which in turn will avoid the accidents. Fresh values of threshold angles for gradient and side slope are generated when the system/ vehicle restarts. Thus any misbehaviour by a driver in overloading is monitored locally and at Cargo monitoring centre through SMS. SMS received at MC which is an updated information from time to time also updates the information at the MC fleet management system which ensures the safety and improves reliability of transportation services.

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