



System for Analysis of Driver's Skills Based on Passengers Comfort

Sarang P. Suryawanshi¹, Sunil B. Somani², Virendra V. Shete³

ME Student, Dept. of E&TC, MITCOE, Pune, Maharashtra, India¹

Professor, Dept. of E&TC, MITCOE, Pune, Maharashtra, India²

Professor, Dept. of E&TC, MITCOE, Pune, Maharashtra, India³

ABSTRACT: The comfort of the passengers is affected by the factors of the dynamic motion. The extreme tilts of the vehicle and the vibrations affect the comfort. These tilts could be caused by the driver lack of driving skills. The vibrations of the vehicle are due to defects on pavement. These factors indirectly reflect the behaviour of the driver and driving skills. These eventually affect the comfort of the passengers inside the vehicle. This paper develops an in vehicle embedded data acquisition system. The data is collected on-board and stored into the external memory for further reference. The tilt of the vehicle is measured using the 3-axis accelerometer. The vibration is detected using the vibration sensor. The alcoholic state of the driver is known by using alcohol sensor. The global positioning system (GPS) allows detection of the exact location where the reckless driving is done, defects on the pavements. Thus the system is to capture the data coming from these sensors during the journey. Over the complete journey the captured data in the memory reports the location of reckless driving along the journey.

KEYWORDS: Driver's skills, passengers comfort, tilt, defects on pavement, 3-axis accelerometer, vibration sensor, global positioning system, alcoholic state of driver, external memory.

I. INTRODUCTION

The transportation system has a positive economic and social impact. Transportation is important for society as efficiency in transportation provides better accessibility to markets, employment, welfare of populations and additional investments. Transport systems deficiency for reliability or capacity, can have an economic cost impact. The quality of service can be influenced by several factors as speed, travel time, reliability, convenience, manoeuvrability, cost, accessibility, safety, comfort, etc. The relocation of people to places of work, education, recreation and for their other needs also require transportation. Thus, an important social and environmental load is carried by transport. This cannot be neglected.

India has experienced tremendous increase in the total number of registered vehicles from about 0.3 million on 31st March, 1951 to about 142 million as on 31st March, 2011. The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 9.9% between 2001 and 2011. During 2001 -11 growth rates of registered motor vehicles was almost three times the growth rate of road network. Amongst motor vehicles, except for jeeps, which recorded 75 per cent increase in registration, registration in other categories of vehicles, increased by about 100 per cent or more with cars and taxis recording an increase of about 200 per cent (192 & 182 % precisely). Overall growth in registration of motor vehicles, during the period was about 158 per cent [4][5].

As per World Health Organization (WHO) reports, traffic accidents are one of the most important causes of mortality. More than 1.3 million victims claim life annually. The injured victims are around 50 million over the world [2]. These figures are projected to increase by about 65% in the coming next 20 years. Global public health and development is seriously harmed by unsafe road traffic systems [3]. Therefore, the tools that evaluate the performance of the driver are to be developed. These vehicular measurement systems thus check for the state of the driver when he is driving. The aim of establishing these tools includes: a) the major causes that lead to an accident and b) driver's security while driving [2][6].



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Road traffic injuries are a major public health challenge. However it is neglected. Thus for effective and sustainable prevention it requires concerted efforts. Road traffic systems are the most complex and the most dangerous system [1]. The following are the major causes for traffic accidents: a) reckless driving, lack of driving skills, b) driving by consuming alcohol or psychoactive substances. It is important to promote responsible and prudent driving behaviour. This is a solution, in order to decrease the increasing rate of accidents. The number of fatalities will certainly decrease using this solution [6]. The driving manoeuvres are taken into consideration for reckless driving. The major manoeuvres by drivers which are dangerous can be following: sudden speeding, sudden acceleration or deceleration manoeuvres.

The vehicle technology is rapidly developing. Hence, as one kind of intelligent vehicle system, pre-driving analysis of the driver could decrease the traffic accident and improve the passenger comfort [7]. A lot of focus is being placed on safety issues with the rapid development of vehicle technology. This applies to long distance driving over highway. A formidable task now is to establish the factors to determine the driver's skills [8]. It is impossible to make direct measurements of the mental character factors of the driver. It is necessary to choose a suitable indicating factor those can be evaluated.

The quality of driving can be influenced by several factors as comfort, convenience, speed, travel time, reliability, manoeuvrability, cost, accessibility, safety, etc. Statistics from accidents, number of complaints, vehicles fails and some other specific surveys are mostly used to assess the quality of transportation service. However, comfort statistics evaluation is an expensive task in terms of time and human resources as it involves personal interviews and surveys. Hence, system to collect data with aim of safety and comfort is being proposed.

II. RELATED WORK

A system capable of identifying dangerous situations caused by human mistakes and hazardous spots in roads is proposed in [3]. Nokia N95 mobile phone is used as it has inbuilt GPS (Global Positioning System) and accelerometer. An application designed exclusively for Nokia N95 was required and developed. The necessary captured data by the application would be analysed afterwards off-line in a computer. Geographic Information System (GIS) would show the report of the result on the route and any other potential problems that may have arisen. Various compatible GIS can be used to visualize this standard-based report. Google Earth was used as it is public and freely accessible. The validity of results of the approach has been proven in different road trips by different drivers.

The vehicular state, inter-vehicle state and driver's lane change behaviour in lane change process is analysed in [7]. Real vehicle experiment data on highway is collected. The characteristic of drivers lane change on highway is based on real vehicle states such as relative velocity, longitudinal velocity, relative distance and time headway. The results reveal longitudinal velocity and longitudinal acceleration change little during lane changes. In the lane change period the longitudinal acceleration ranges from -1m/s^2 to 1m/s^2 mainly. The driver's behaviour is studied from the statistic of turn signal usage, lane change frequency and rear mirror usage. The system provides assistance in respect to lane change decision. It also provides collision avoidance.

The analysis of a vehicle for its dynamic behaviour while driving is described in [8]. Thus the behaviour of the driver is indirectly reflected. The analysis of lateral and longitudinal acceleration of the vehicle provides assessing the condition of the driver. The repeatability of the environmental factors in the driver-vehicle-environment system is ensured. The changes that occur when the driver changes (even slightly) his driving style, or if the driver is loaded with an additional activity (for example phoning) is studied. The interaction of the driver in the driver vehicle environment system is measured. The driver's behaviour can be indicated by the elements of the lateral and longitudinal acceleration.

The risk behaviours using a video monitoring system for commercial vehicles is developed by [9]. A video recording is studied to recognize dangerous behaviours and manoeuvres of the drivers. They implemented a visual recording low-cost system which allowed reducing the probability of a risk event. Also, the registration and control purpose is done using audio and video recordings during a route. They allowed sending real-time data at the end of the tour.

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A vehicular digital video recorder system is designed in [10]. Thus the behaviour of a running vehicle is recorded. A system is developed and put in-vehicle that acts as a fleet recorder. An online real-time navigator as well as an offline video data viewer is supported. The recorded video data is watermarked for data security to prevent tampering. The recorded video can be played with the viewer system and find the reasons of the accident.

A system which depends on the characteristics of the braking made by the driver in time critical situations for detecting jerks in safety critical events is developed in [11]. The proposed method is capable of distinguishing between critical and potentially critical situations in a small pilot test. It well detects traffic conflicts and also distinguishes between traffic conflicts estimated to be more serious and conflicts with lower severity. The study involves analysing different characteristics of acceleration profiles like the rate of change of the acceleration profiles which is jerk like negative jerk and a peak-to-peak value of the jerk.

The problem of characterizing the way people drive is applied to driver assistance systems without using direct driver signals is discussed in [12]. The proposed method is to identify potentially high risk areas on the road taking into account the average rate of diagnosis in each signal on the road. It presents the structure of a driver model based on neural networks. System performance was tested in a driving simulation system.

It is lately found that more and more accidents are caused by people who drive while intoxicated. [14] shows the response to the fact that drunk drivers are not able to manage the wheel. Drunk driver cannot make the most basic movements required when driving. This often puts their life and other traffic passenger's lives in danger. The proposed system in [14] uses alcohol sensors that can determine the alcoholic state.

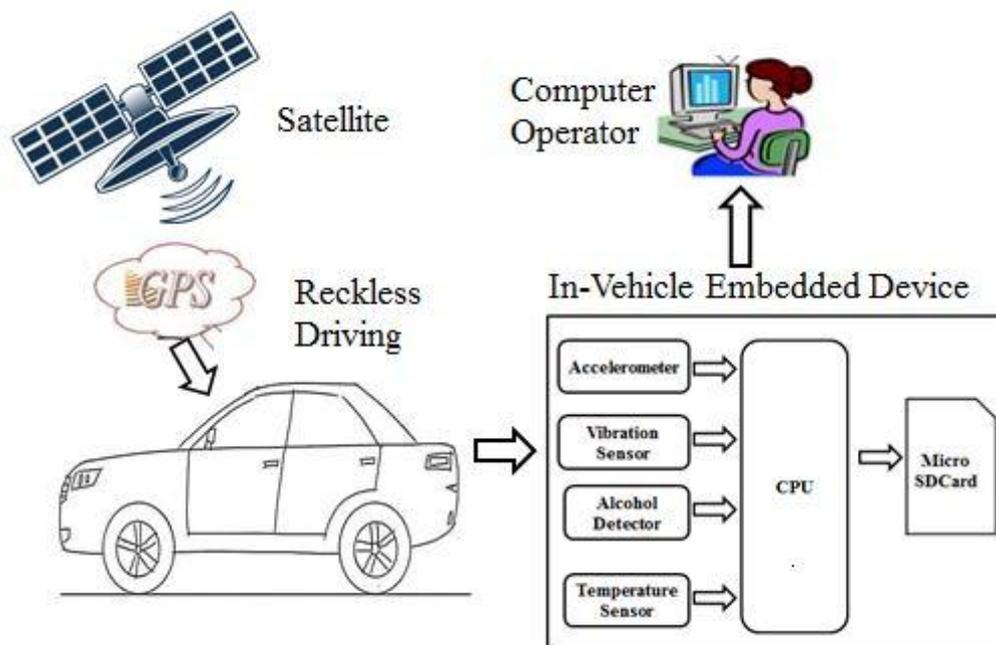


Fig- 1: System layout

III. PROPOSED ALGORITHM

The proposed in-vehicle system layout consists of the main parts as shown in figure 1. The complete system is installed inside the vehicle. The interaction of vehicle with road is reflected in terms of acceleration, jerks (the rate of acceleration change), vibrations and tilts. These depend on vehicle's maintenance, road's state and driver's skills and driving behaviours. The proposed system in this paper is designed for long travelling periods on highways.

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This paper also considers the alcoholic state of the driver into consideration. Thus it implements a complete system specially designed to assess the dynamic motion and driver's state during driving in public transportation. The proposed system receives the GPS signals which give the exact geographic location of reckless driving. This data recorded by the system can be highly important for transportation agencies, road state surveillance authorities and for efficiency of quality transport polices.

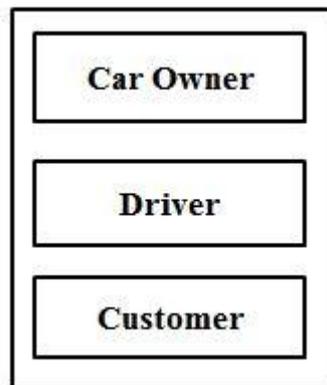


Fig- 2:Car renting system in India

In India the cars on rent industry works mostly as shown in figure 2. This shows a 3-layer approach. It clearly indicates that car owner, driver and customer are altogether different. Car owner rents his car. The driver is deployed by the owner. Customer takes the car on rent along with the driver employed by car owner. The customer is the end user in this approach of car renting. Thus it happens that the customer does not know the driving skills of the driver. The faith in the driver's skills is the only critical option available to the customer. The proposed system provides the history of the driver's driving skills. This guarantees the safe and comfortable journey to the passengers.

A. Hardware

The hardware is shown in figure 3. It is based on 3-axis accelerometers, vibration sensor, alcohol sensor, temperature sensor, Global Positioning System (GPS) module, micro SD card module. The 3-axis accelerometer detects the tilt of the vehicle caused by reckless driving behavior above the threshold value. The vibration sensor detects the vibration of the vehicle above the predefined threshold value when it goes through the holes on the pavement. The threshold value can be set in the system using passengers experience feedback.

The acceleration threshold detection allows the system to detect disturbances out of the comfort caused by excessive acceleration or jerk. Figure 4 explains the flow of signal inside the system. If this value is higher than the threshold, the firmware gets the position from the GPS module and an event structure is generated. The generated event is then saved in the SD memory for future reference.

The alcohol sensor checks if the driver is intoxicated. Thus on the detection of the alcohol the GPS locations are time stamped and stored in the micro SD card. The temperature inside the vehicle is sensed by the temperature sensor. If in-vehicle temperature goes above the comfortable temperature value then an alarm is raised and the GPS location is stored.

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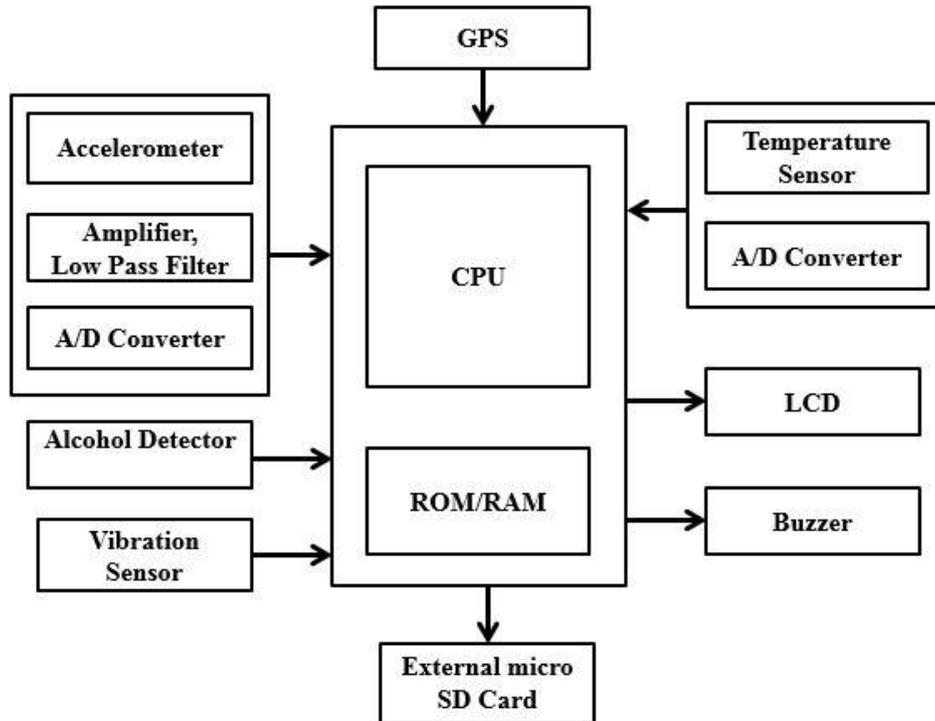


Fig- 3:Hardware Configuration Block Diagram

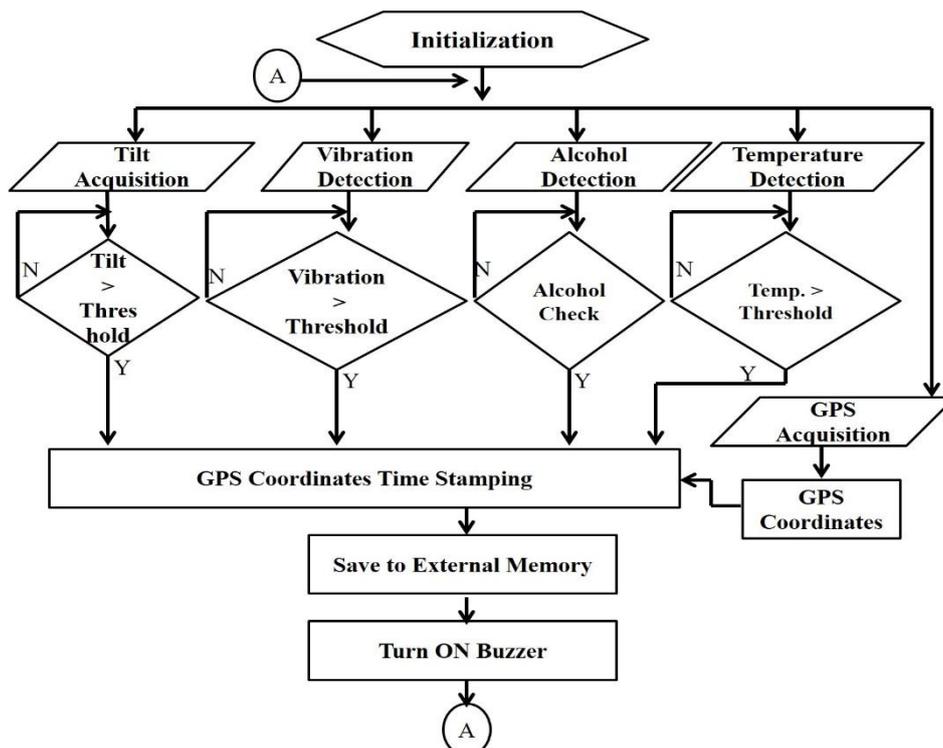


Fig- 4:Software Flow Chart

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B. Software

The software initializes the components used in the development of the system. The 3-axis accelerometer, vibration sensor, alcohol sensor, temperature sensor starts collecting the information of the physical world. The software used in this system consists of part that is responsible for communicating with the accelerometer, vibration sensor, alcohol sensor, temperature sensor and GPS receiver. The sensor data causes the GPS receiver to give the locations where accelerometer or vibration sensor or alcohol sensor or temperature sensor value crosses the threshold. These coordinates are stored into the external memory.

Whenever the accelerometer crosses the threshold value as a result of the reckless driving, it is detected by the system. The tilting or vibration events of the vehicle can lead to the decrease in the comfort level of the passenger. These above events can even risk the life of driver and the passenger. The alcoholic state of the driver is detected by alcohol sensor. This risks the life as well as reduces the comfort of passengers. At this uncomfortable location the GPS coordinates are time stamped. This event saves the GPS coordinates to the micro SD card.

IV. RESULTS

The path chosen for the experimental test drive is shown in figure 5. The test path chosen is a two-way highway from Chandni Chowk, Pune to Wakad Bride, Pune. The system is put inside the car in front of the driver's seat. The mental and physical state of the driver chosen is normal. The weather conditions are good and normal. This means the condition of the road is normal for the daily commuters on the highway. The system is turned on at Chandni Chowk. The total distance covered between the above two locations is around 12 km. The total time required is around 16 min. Driver is asked to drive with his normal driving skills and styles.

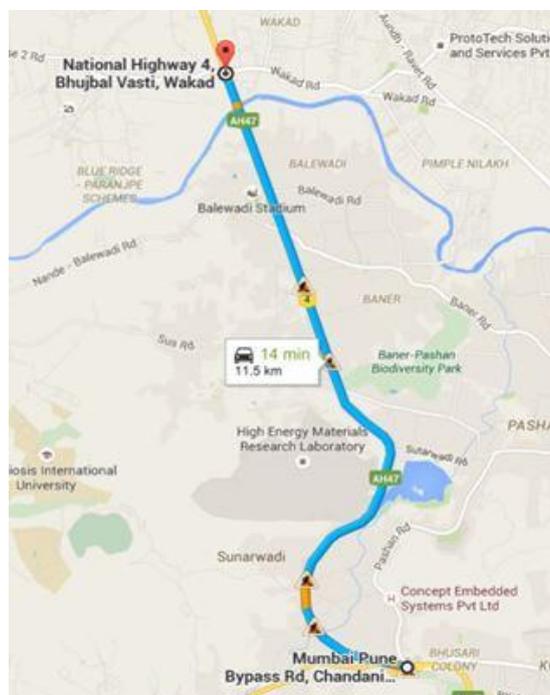


Fig- 5: Experiment Path

The driver was asked to apply sudden breaks to get the jerk as of sudden deceleration. This event is captured by 3-axis accelerometer. Again, the driver is asked to suddenly accelerate the vehicle to get jerk. The GPS coordinates at the locations where the vehicle experienced the jerky moments is stored in the microSD card. These above events if frequently performed by the driver may risk life. This means the potential risk of accident.



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The alcohol sensor is tested by putting few drops of alcohol over cotton ball. This cotton ball is taken close to the sensor. Thus alcohol is detected by the sensor.

Figure 6 shows the result table of the real time test performed by installing the system inside the car. The events are logged into the excel sheet. Column 1 shows the time at which the event has occurred. Latitude and longitude are stored into corresponding column with their corresponding headings. The kind of event that is generated is stored in the event column. Reading number 1 and 5 shows the heading of the column repeatedly. These indicate that the driver removed device. This implies if the log table has only one column heading at reading number 1 then the driver was prompt and did not try to remove the device over the complete journey.

	A	B	C	D	E	F
1	Time	Latitude	LatDir	Longitude	LongDir	Event
2	10:31:11	1851.5451	N	7376.9794	E	X axis
3	10:32:08	1852.4368	N	7377.1572	E	X axis
4	10:32:39	1852.5273	N	7377.2034	E	Y axis
5	Time	Latitude	LatDir	Longitude	LongDir	Event
6	10:33:12	1853.0969	N	7377.8986	E	Alcohol
7	10:33:58	1853.7642	N	7378.0874	E	Alcohol
8	10:34:49	1854.1467	N	7377.8385	E	X axis
9	10:36:05	1856.2766	N	7376.8153	E	Y axis
10	10:36:51	1856.5736	N	7376.7034	E	Temp
11	10:38:17	1856.8502	N	7376.5789	E	X axis
12	10:39:03	1856.9844	N	7376.5275	E	Vibration
13	10:41:16	1857.4441	N	7376.3687	E	X axis
14	10:43:02	1858.0258	N	7376.1455	E	Temp
15	10:45:43	1858.4489	N	7375.9867	E	Y axis
16	10:46:23	1858.8353	N	7375.8623	E	Vibration
17	10:46:58	1859.1282	N	7375.7614	E	Vibration
18	10:47:23	1859.1465	N	7375.7442	E	Y axis

Fig- 6: Event log created in memory during journey

V. CONCLUSION

The system that is able to detect the comfort disturbances is presented in this paper. This paper thus develops an embedded vehicular data acquisition system. This information allows the detection of dangerous reckless driving behaviours. These driving behaviour styles include excessive accelerations and decelerations. The driving skills also include avoiding the holes on the pavements. The vibrations to the vehicle caused by driving through holes on the pavement are also detected. These jerks caused to the vehicle could be longitudinal jerks or lateral jerks. The intoxication of the driver by alcohol can risk the life of driver and passengers. This state of the driver is detected and GPS location is stored into the external memory. The type of event generated is shown in the event column.

This system is successfully tested in real road conditions. The weather conditions are good and normal. The event log table gives the GPS location of the event for sudden acceleration, vibration caused by the reckless driving behaviours. This is stored in the micro SD card that can later be utilized for the analysis of the skills of the driver during the complete journey.



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BIOGRAPHY

Sarang P. Suryawanshi is a Master of Engineering (ME) student in the Electronics & Telecommunication Department, Maharashtra Institute of Technology College of Engineering, Savitribai Phule Pune University. He received the B.E. degree in Electronics and Telecommunication Engineering from PVG's COET, Pune, India in 2012. His research interests include embedded system design.

Sunil B. Somani received the M.E. degree in Electronics and Telecommunication Engineering. He has been in the teaching field since last 22 years and specialized in areas such as Advance communication, Microwave engineering and Mobile communication. He is currently working as PG coordinator at MIT College of Engineering, Pune, India.

Virendra V. Shete, is Head of Department of E&TC, MITCOE Pune, affiliated to Savitribai Phule Pune University. He has published numerous scientific papers in various domains. His area of interest are soft computing, Signal Processing, Communication.