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Analysis of Driver's Skills from Passenger's Comfort

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Abstract: This paper presents the factors of the dynamic motion which affect the comfort of the passengers. The extreme tilts by the driver and vibrations of the vehicle due to defects on pavement shows the way driver drives. These factors indirectly reflect the behaviour of the driver and driving skills. These eventually affect the comfort of the passengers inside the vehicle. The system develops a 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 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, external memory.

I. INTRODUCTION

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

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 [1]. 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 [1][6].

The following are the major causes for traffic accidents include: a) driving by consuming alcohol or psychoactive substances, b) reckless driving, lack of driving skills. It is important to promote responsible and prudent behaviour while driving as a solution, in order to decrease the increasing rate of accidents. The number of fatalities will certainly decrease using the solution [6]. The major manoeuvres by drivers which are dangerous can be following: sudden speeding, sudden acceleration or deceleration manoeuvres.

A lot of focus is being placed on safety issues with the rapid development of vehicle technology. As one kind of intelligent vehicle system, pre-driving analysis of the driver could decrease the traffic accident and improve the passenger comfort [7]. 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. 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 [2].

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.

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

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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].

II. RELATED WORKS

The characteristic of drivers lane change on highway in [7] 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 -1 m/s^2 to $1m/s^2$ mainly. The drivers 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 for assessing the condition the driver. 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.

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 risk behaviours using a video monitoring system for commercial vehicles is developed by [9]. A video recording is studied to recognize dangerous behaviours and maneuvers 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.

The behaviour of a running vehicle is recorded in [10]. 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 can be played with the viewer system and find for the facts of the vehicle when a traffic accident occurred.

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]. It analyses 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.

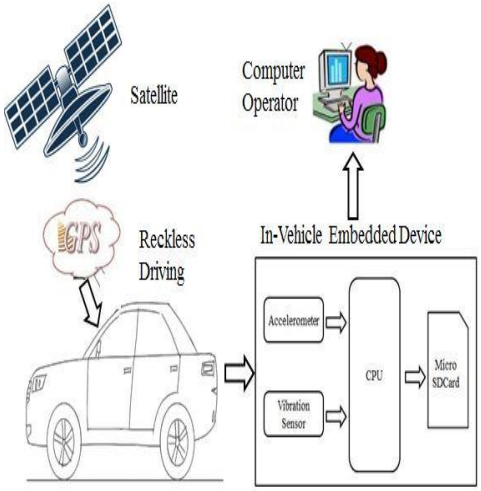

Fig- 1: System layout

III. PROPOSED APPROACH

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

This paper implements a complete system specially designed to assess the dynamic motion in public transportation. The data reported by the system can be highly important for transportation agencies, road state surveillance authorities and for efficiency of quality transport polices.

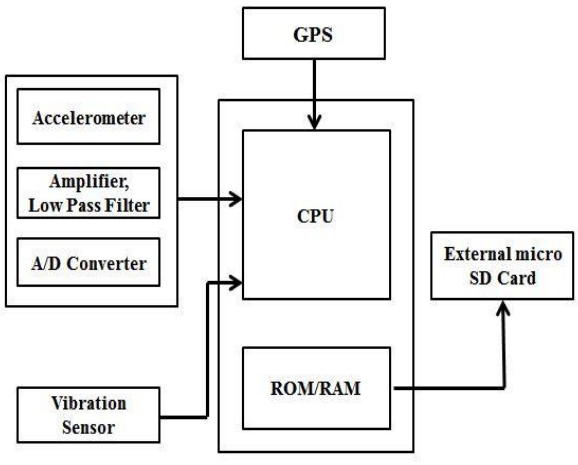

Fig- 2: Hardware Configuration Block Diagram

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In India the cars on rent industry works mostly as shown in figure 4. This shows 3-layer approach. It clearly indicates that car owner, driver and customer are 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. 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 guarantee's the safe and comfortable journey to the passengers.

A. Hardware

The hardware in figure 2 is based on 3-axis accelerometers, vibration sensor, a Global Positioning System (GPS) module, micro SD card. The 3-axis accelerometer detects the tilt of the vehicle 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 3 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.

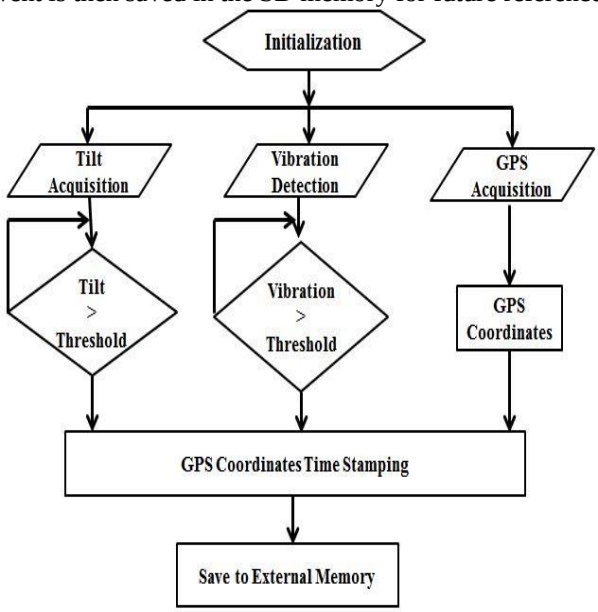

Fig- 3: Software Flow Chart

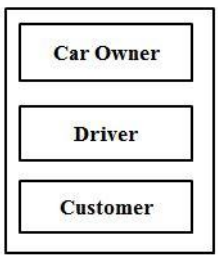

Fig- 4: Car renting system in India

B. Software

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

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. At these moments the GPS coordinates are time stamped and are stored into the micro SD Card. This event saves the GPS coordinate to the micro SD card.

IV. RESULTS

The experimental test drive is conducted by putting the system inside the car infront of the driver's seat. The weather conditions are good and normal. This means the condition of the road is normal for the daily commuters on the highway. The test path chosen is a two-way highway from Chandni Chowk, Pune to Wakad Bride, Pune. 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 15 min. Driver is asked to drive with his normal driving skills and styles.

The driver is 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 micro SD card. These above events if frequently performed by the driver may risk life. This means the potential risk of accident.

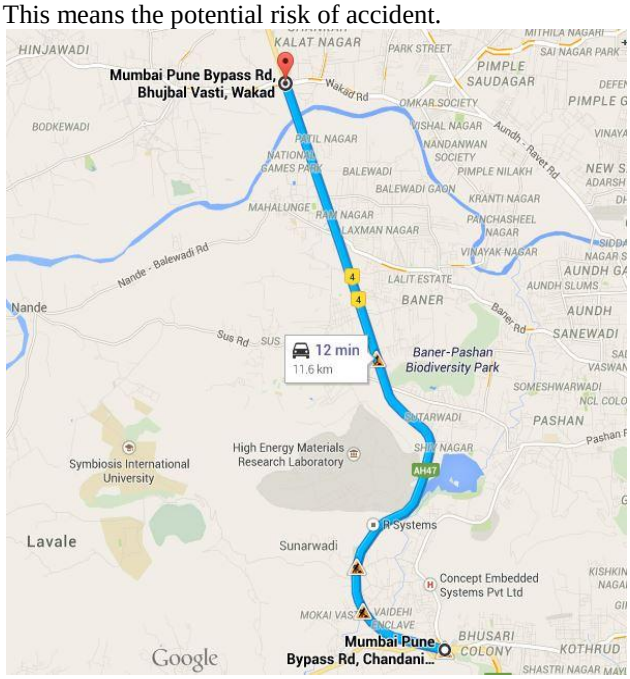

Fig- 5: Experiment Path

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Figure 6 shows the result table of the real time test performed by installing the system inside the car. Figure 5 refers to the path used to test the system. 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 for the occurrence of the corresponding event.

	A	B	C
1	Time	Latitude	Longitude
2	11:20:32	1850.7457	7378.276
3	11:21:41	1850.8953	7377.5897
4	11:21:54	1851.3388	7376.9974
5	11:22:25	1852.1018	7376.9416
6	11:23:22	1852.6817	7377.5213
7	11:24:04	1853.3511	7378.0102
8	11:26:13	1854.3072	7377.6412
9	11:28:21	1856.5591	7376.7099
10	11:32:28	1857.3504	7376.4181
11	11:33:58	1858.5829	7375.9589
12	11:34:43	1858.8839	7375.8409
13	11:35:21	1859.2378	7375.7101

Fig- 6: Event log created in memory during journey

V. CONCLUSION

This paper presented an embedded vehicular data acquisition system that is able to detect the comfort disturbances. 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.

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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BIOGRAPHIES

Sarang P. Suryawanshi received the B.E. degree in Electronics and Telecommunication Engineering from PVG's COET, Pune, India in 2012 and is currently pursuing the M.E. degree in VLSI and Embedded systems from MIT College of Engineering, Pune, completing project based on PSoC. His research interests include embedded system design.

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