Driver Fatigue Reduction Using Touch Enabled Steering Wheel

Dr. P. Somasundaram, Dr. C. Jegadheesan, M. Srinithin, R. Saravanan, C. Madhu Krishnan

Abstract: An Automotive vehicle had changed drastically since they were made. One of the major concerns in automobile is safety and comfort. When travelling at 65 mph driver can be driving blind for 100 to 200 feet looking down at the small switches located slightly below steering wheel, so it can be achieved by fitting the control switches in the steering wheel based on the ergonomics law that makes the driver, comfort and convenient while driving and it also reduces the driver's distractions while operation. But the desired amount of comfort is not achieved with this existing system while often usage of horn especially during long rides because of its hardness during operation and also it produces the fatigue stress to the drivers. An effective way for elimination of fatigue stress could be achieved by replacing the conventional switches to touch enabled switches and also by changing its position of mounting it. For this, we use the Arduino Uno as a control unit and it can actuate the relay whenever signal from the touch sensor (via human). Thus, this method reduces the fatigue stress and increases the comfort and reduces the distraction to the driver.

Keywords: **Arduino**, ergonomics, Fatigue stress, Safety and comfort, Touch sensor.

1. INTRODUCTION

The number of automobiles is showing an increasing Figure nowadays and this sudden increase in the automobile population is due to the growing demand for a faster and safer means of transport. This increased number leads to a large number of accidents on road which caused the automotive manufacturers to improve the safety systems in automobiles. The major causes for road accidents are improper road conditions and improper design of vehicle components. The number of vehicles on our road is burgeoning day by day.so car manufacturers offers more infotainment systems as well as in comfort to both driver and passengers. That provided systems will be easily accessed and it shouldn't distract him/her. Vehicles running today like LCV's are using conventional switches for all purposes. While horning driver must remove their hand, thus it reduces the steering ability to the driver and over the period of usage (Especially long travel) drivers get fatigue so even in critical situations driver won't operate those switches, which may some time it leads to an accident. So With our research we investigate new interaction techniques that aim to make the operations easier to the driver. For that we are replace the Touch enabled switches instead of conventional switches. These switches are applied to more frequently used operations like Horn, Light adjustment and Indicators. To achieve this we use Arduino Nano, it act as the control module and it controls the relay actuation and flasher unit for light indicators. Touch enabled steering wheel is designed purely based on the law of automotive Ergonomics which gives comfort and extra safety to driver. Initially it was drawn two dimensional and then modelled in SOLIDWORKS 2016 software and its lifetime and fatigue properties are analyzed in ANSYS software. To make the circuit connection we initially use the FRITZING software and circuit stimulation is done by MATLAB. The use of Arduino Nano and Touch sensor will be economical and whole system will be designed foe feasibility, simplicity and best performance.

- *Dr. P. Somasundaram, Dr. C. Jegadheedsan, S. Vinoth, S.T. Arun Kumar, N. Kowsalya Dr. P. Somasundaram, Dr. C. Jegadheesan, M. Srinithin, R. Saravanan, C. Madhu Krishnan*
- *1 Professor and Head 2 Associate Professor, Department of Automobile Engineering, Kongu Engineering College, Perundurai, Erode, Tamilnadu, India.*
- *3, 4, 5 UG Scholars, Department of Automobile Engineering, Kongu Engineering College, Perundurai, Erode, Tamilnadu, India.*

2. LITERATURE REVIEW

2.1 Literature Introduction

Driving a automobile has become a challenge for several individuals despite the very fact that evermore technology is constructed into vehicles so as to support the driving force. Above all, the increasing variety of in-vehicle info systems (IVIS) could be a main supply of driver distraction. The fragmentation of IVIS components within the cockpit will increase the eye demand and psychological feature load of the driving force. During this paper, we have a tendency to gift Associate in nursing approach to integrate most in-car interaction prospects into a Steering wheel, by combining a multi-button row with one bit in Associate in nursing intelligent Steering wheel. we have a tendency to performed an internet study (N=301) to analyze the pre-prototype user acceptance of the 3 totally different Steering wheel modalities (single bit, multi button, combinative bit) further as a lab-based driving machine study (N=10) to assess the utility of the only touch interaction. The results of the net study showed that particularly the only bit was extremely accepted by the participants. The driving machine study discovered that touch-based interaction on a Steering wheel is possible for low demand tasks in terms of driver distraction. Especially, the only bit embedded into the Steering wheel could be a promising approach for close info within the automotive.

2.2 Reviews of Touch Enabled Steering Wheel

Multi-touch enabled steering wheel – exploring the design space:

They investigate new action techniques that aim to create it easier to interact with these systems whereas driving. In distinction to the quality approach of mixing all functions into hierarchic menus controlled by a multifunctional controller or barely screen we advise to utilize the area on the wheel as further interaction surface. During this paper we have a tendency to show the look challenges that arise for multi-touch interaction on a wheel. Specifically we have a tendency to investigate the way to trot out input and output whereas driving and thence rotating the wheel. We have a tendency to describe the main points of a practical example of a multi-touch wheel that's supported FTIR and a projector, that was engineered to explore by experimentation the user expertise created. In AN initial study with twelve participants we have a tendency to show that the approach contains a general utility

which individuals will use gestures for dominant applications intuitively however have difficulties to imagine gestures to pick out applications

Steering wheel and integrated touchpads for inputting commands:
A motor vehicle includes a steering wheel, a first touchpad integrated into the steering wheel adapted to input commands, a second touchpad integrated into the steering wheel and spatially separated from the first touchpad adapted to generate a command to operate a function of the motor vehicle as a function of a touch motion over the first touchpad and a simultaneously-occurring touch motion over the second Touchpad

A survey paper on automatic vehicle horn intensity control system:
The primary goal of the project is to prevent sound pollution happening thanks to the over honking of auto. Supernumerary honking produces a serious downside to the healthy society and animals and birds. This cannot be stop fully however are often reduces to an excellent extent. The honking of horn is detected or work only if the opposite vehicle is within the given vary of at given specific distance. Here the planned system is that the horn won't work unless a vehicle is shut enough instead merely the horn won't work. By this fashion it will avoid all the sound pollution and provides a noise free atmosphere, this project ensures that there'll be less noise generated by horn and that we will avoid the supernumerary honking wherever it's not in the least needed. The traveller enumeration technology provides additional service, to trace changes in travellers demand, and to trace on time performance problems

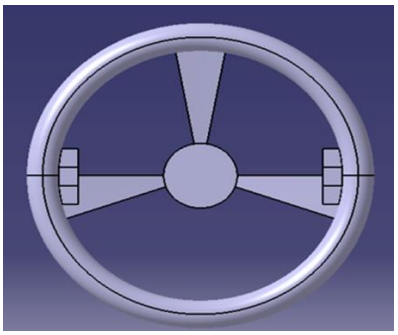
2.3 Literature Conclusion
The above study has a high impact on the selection and design of the touch enabled steering system and it could be inferred that the touchpad is much more practical and economical than their TFT or LCD touch panel equivalents. Hence the touch pad with Arduino Uno is being chosen for our project. Also the single point relay is chosen for simple circuit design and increased performance, though the circuit with multi point relay has an advantage of being multi controlling at single actuation.

3. Problem Statement and Market Needs
The main concern of the modern automotive industry is the Driver safety and make them comfortable while driving a vehicle. Also while it is difficult to operate the horn while driving and also in night, for continuous changing of low and high beam switches causes stress and irritable to drivers. Due to this stressful mechanism, most of the drivers, always drives in high beam only which leads to an accident. In order to minimize a driver's distraction while interacting with automotive systems, capacitive touch sensors are used to actuate the controls. As these systems are high cost, this project aims at designing a low cost system for automobiles.

4. TARGET SPECIFICATIONS
After the study of problem statement and the market needs for the system, the target specifications for the systems are being framed. In this case size of the system, position of touch pads, and the electronic circuit for the system are being defined. The main parameters based on which the system is to be designed are as follows

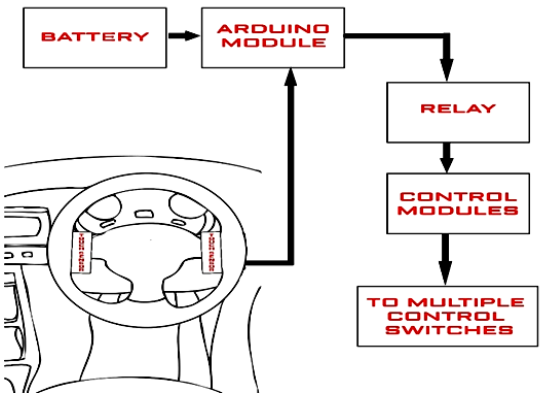
- Construction
- Comfort
- Sensor durability
- Cost
- Ease of service
- Performance
- Life time
- High efficient
- Stability

4.1 Modification in the Steering Wheel
The normal Steering wheel is replaced by the developed associate technology Steering wheel that permits the user's hands to be set during relaxed position for higher comfort. This advanced Steering wheel style was developed by operating surgeon conversant in injuries ensuing from improper hand position on the Steering wheel. A survey of a thousand drivers on highways in metropolis, American state unconcealed virtually 75% of the drivers place only 1 hand on the Steering wheel whereas driving. Throughout collisions wherever the airbag deploys that inflicts additional injury.



4.2 Research and development
The whole system is being controlled by a PLC (Programmable Logic Controllers). The main reason for choosing the PLCs are their advantage of having higher processing speeds and their ability to handle multiple inputs and outputs at the same time without compromising the accuracy and precision of the outputs. The PLC being used here is Arduino UNO which has enough capacity to process the input form touch sensor. The main purpose of the processor is to process the signal from all the sensors. By using these input signals Arduino Uno process these signal and actuate the respective relays and the processor accordingly generates output signals. This specific board can also be connected to a computer for easy implementation or modification of the code that basically is the brain for the processor to control the activities. Also the board's ability to connect with the computer via dedicated software can be use to view analogue or graphical representation of both inputs.

4.3 Design Considerations
There is no time lag for the output signal to reach the actuators. The average time taken to process the inputs and outputs by the Arduino is 30ms(approx.)
The relay takes around 10ms(approx.) to switch the circuits
Therefore, the total delay in execution of the program will be,
Delay = 10+10+30 = 50 ms (milliseconds)

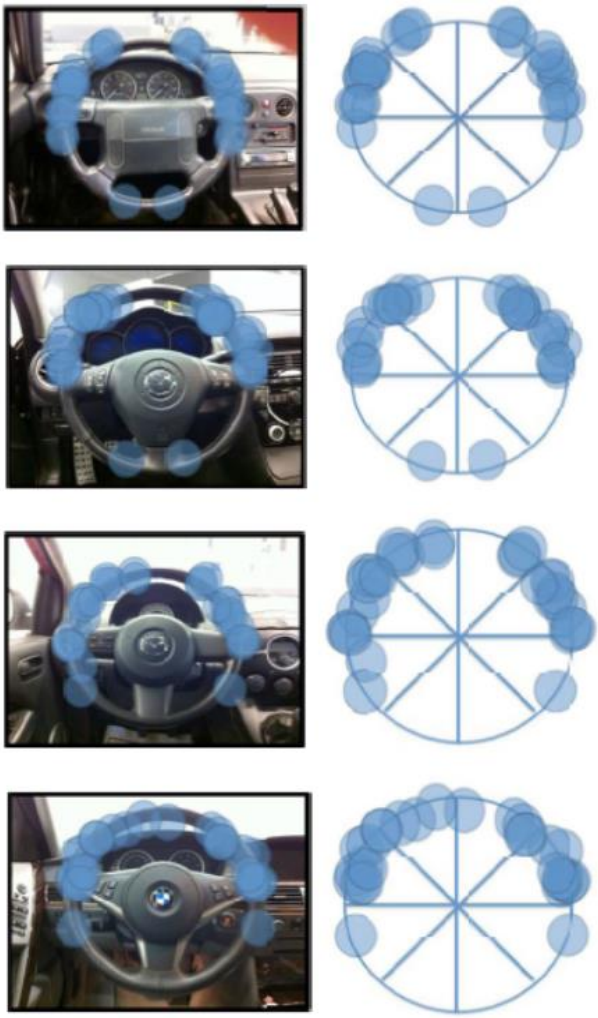


4.3.1 Findings

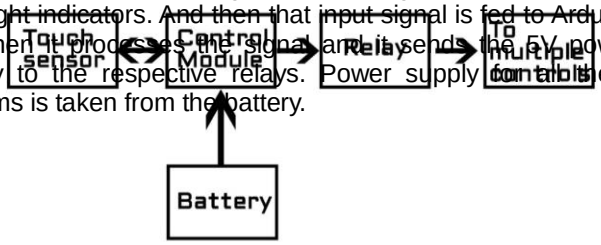
Time taken for current flow is negligible. Processing time could be reduced by optimizing the code and improving the processor could be used instead of Relays.

5. COMPONENTS OF THE SYSTEM

- Arduino UNO
- Touch sensor
- Relays
- Battery
- Controller
- Jumper wire
- Vehicle electrical



This above fig. shows the component and the signal flow of the touch enabled steering wheel. First the signal is received from the touch sensor when the driver want to actuate these systems like Horn, Headlight low and high beam and for left and right indicators. And then that input signal is fed to Arduino and then it processes the signal and it sends the 5V power supply to the respective relays. Power supply for all these systems is taken from the battery.



6. ERGONOMICS STUDY ON STEERING

6.1 Introduction

Historically, the Steering wheel has been viewed as a rhetorical or utility element of the vehicle; but, as in-vehicle technology will increase, the Steering wheel might offer how to integrate technologies into the vehicle. This study engineered upon a usability study that examined a broad vary of steering wheels within the current study, participants designed their ideal Steering wheel for an idea vehicle by employing a paper prototyping methodology. cardinal participants (20 young adults eighteen to thirty years ancient, twenty older adults forty seven to sixty five years ancient, and fifteen male automotive technology graduate students eighteen to thirty years of age) got a top level view of a Steering wheel and asked to decide on their ideal Steering wheel functions moreover because the styles of controls for those functions and rhetorical options. Results showed that whereas there was no single common style. These 3 teams hand-picked for the most part similar controls however attended find them otherwise, produce distinctive Steering wheel structures and categorical their desires and desires otherwise once asked concerning their styles supported trends in participant styles, 2 prototypes were created for every cluster and 2 for a mixture of all teams.

6.2 Ergonomics on Steering Wheel

Naturalistic grip positions show that participants grip the Steering wheel otherwise in every automobile which may been seen on the neutral, geometric Steering wheel and once grip positions are shown on a picture of the vehicle's Steering wheel; grip position looks to be influenced by the cross bars of the vehicle and maybe alternative characteristics of the steering wheel or vehicle style (i.e., arm rests). At the tip of the study, participants were asked what functions they might prefer to embrace on their ideal twenty two Steering wheel several of the options listed by participants are enclosed presently on some vehicles (i.e., radio and volume controls); but, many participants listed options not presently set on the Steering wheel for instance, 2 participants needed sunshine-roof controls and eight needed climate controls. Participants known phone controls and controller as options they might prefer to wear a Steering wheel, and whereas some vehicles place these controls on the wheel, several don't. Finally, participants were asked what form of management they might like for volume adjustment and cruise control increase and decrease speed functions as shown

6.3 Result

This study sought to understand what characteristics of a user-

designed steering wheel might be common among three different participant groups, Generation-Y aged males and females, male engineers, and male and female baby boomers. The method in this study was largely exploratory but reflects a much modified version of a study by Green and Goldstein in 1989. Because no theory specifically applies to user design of steering wheels, users were given considerable freedom in their designs and asked a series of questions about their backgrounds and their designs in order to find variables common among the groups.

7. Conclusion and Results

7.1 Future Scope

This system proves to be highly effective in minimizing the driver's distractions and also it reduces the fatigue stress produced. Hence further research and optimizations of the Touch enabled steering system will allow us to implement the same in all range of cars for improved safety and driver's comfort.

7.2 Findings

The steering system with touch sensor are much more practical and economical compared to the TFT display panels. The Arduino Uno is chosen for simple programming and increased performance, though the processor with Arduino is lighter and less power consuming.

7.3 Conclusion

This study shows the role of Touch enabled steering wheel improves the vehicle handling and its contributions in driver comfort. It is found that the use of Touch enabled steering wheel contributes a lot in minimizing the fatigue stress that occurs to a driver especially during long rides. Though the Touch enabled steering wheel minimize the fatigue stress effectively, they couldn't help much in terms of improving the ride comfort, keeping both the passenger safety until the driver adopt to this system. Hence it is concluded form the above study that the use of Touch enabled steering wheel in the vehicles minimizes the fatigue stress produced to the drivers and increases the driver's comfort to a great extent and of about 75% which when compared to the vehicle without Touch enabled steering wheel.

REFERENCES

[1] Bach, K. M., Jæger, M. G., Skov, M. B.,Thomassen, N. G. You can touch, but you can't look:interacting with in-vehicle systems. Proc. of CHI '08, Florence, Italy, 2008, pp. 1139-1148.

[2] Geiser, G. Man Machine Interaction in Vehicles. ATZ 87, 1985. pp. 74-77.

[3] González, I. E., Wobbrock, J. O., Chau, D. H.,Faulring, A., and Myers, B. A. Eyes on the road, hands on the wheel: thumb-based interaction techniques for input on steering wheels. Proc. of GI'07, pp. 95–102.

[4] Green, P. Driver Distraction, Telematics Design, and Workload Managers: Safety Issues and Solutions. Convergence 2004, Detroit, MI, USA.

[5] Harrison, C., Hudson, S. E. Providing dynamicallychangeable physical buttons on a visual display. In Proc. of CHI '09, Boston, USA, 2009, pp. 299-308.

[6] Kaltenbrunner, M. "reacTIVision and TUIO: A Tangible Tabletop Toolkit", Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces (ITS2009). Banff, Canada.

[7] Kern, D., Schmidt, A., Arnsmann, J., Appelmann, T., Pararasasegaran, N., and Piepiera, B. 2009. Writing to your car: handwritten text input while driving. In Proc. CHI '09 Extended Abstracts. ACM, New York, NY, 4705-4710.

[8] Kern, D., Schmidt, A. Design space for driver-based automotive user interfaces. In Proc. of the AutomotiveUI '09, Essen, Germany, 2009, p3-10.

[9] Sandnes, F. E., Huang, Y.P., Huang, Y. M.: An Eyes-Free In-car User Interface Interaction Style Based on Visual and Textual Mnemonics, Chording and

[10] Speech. In Proc. of MUE '08, 24-26 April 2008, Korea

[11] Schöning, J., Hook, J., Motamedi, N., Olivier, P., Echtler, F., Brandl, P., Muller, L., Daiber, F., Hilliges, O., Löchtefeld, M., Roth, T., Schmidt, D., von Zadow,

[12] U. Building Interactive Multi-touch Surfaces. JGT 2009: Journal of Graphics Tools, (2009)

[13] Wang, F. and Ren, X. 2009. Empirical evaluation for finger input properties in multi-touch interaction. In Proceedings of CHI '09. ACM, New York, NY, 1063-1072.

[14] Wobbrock, J., Morris M.R., Wilson, D.A.: User- Defined Gestures for Surface Computing. Proc. CHI '09, ACM Press, New York, NY, USA (2009)

[15] "False alarm", http://www.alarm.org/false/tips/dealer tip/dealer tip.html

[16] British Security Industry Association (BISA), "Journal on security system section strategy for intruder alarm system"

[17] British Security Industry Association (BISA), "Journal on security system section strategy for intruder alarm system", April 2005. Page 1-3

[18] Thomas Petruzzelis, "The alarm, sensor and security circuit book", TAB Books. Imprint of McGrawhill San Francisco, U.S.A. Reprinted 1994, Page 5-7 International Journal of Network Security & Its Applications (IJNSA), Vol.4, No.5, September 2012 165

[19] "History of Security Alarms", http://www.icee.org/organization/historycenter/firealarm.html

[20] Rana Sampson, "Burglar Alarm", U.S. Dept. of Justice, Pages 2-6, 13-14