Augmenting Selection by Intention for In-Vehicle Control and Command

Catalin Diaconescu
Ovidius University from Constanța
124 Mamaia Blvd., 900527
Constanta, Romania
diaconescucatalin97@gmail.com

Dragos-Florin Sburlan
Ovidius University from Constanța
124 Mamaia Blvd., 900527
Constanta, Romania
dsburlan@univ-ovidius.ro

Dorin-Mircea Popovici
Ovidius University from Constanța
124 Mamaia Blvd., 900527
Constanta, Romania
dmpopovici@univ-ovidius.ro

ABSTRACT
Our paper proposes an in-vehicle interactive environment that facilitates driver to interact with a computer-based (multimedia) system through intentional gestures. To this end we used two complementary gesture detection technologies, Leap motion responsible for user gesture detection, and Myo as a second interaction device that gives the driver the possibility to switch between launched applications and supplementary controls. Based on preliminary results of the usability test we conducted for our solution, we discuss the advantages and disadvantages of using two different gesture recognition technologies for in-vehicle interactive environments. We conclude by the main issues we identify until now and some future directions of our efforts.

Author Keywords
Natural gesture-based interaction, augmented reality, multimodal rendering, haptic feedback

ACM Classification Keywords
H.5.m. Miscellaneous. H.5.1. Multimedia Information Systems. D.4.7; H.1.2.; I.5.5.

General Terms
Human Factors; Design; Measurement.

INTRODUCTION
The main objective of this paper is the augmentation of natural gesture-based interaction between a car driver and multimedia system in-vehicle implemented or integrated, metaphor that has no language barriers and can rapidly turn into reflex due to its naturalness.

The augmentation we propose implies having the possibility of the user to select some of the existing applications by intention; i.e. by indicating the corresponding icon displayed on a (touch) screen and confirm its option by a gesture, without struggling to touch the screen.

Our contribution starts with some similar efforts in integration of new interaction devices in in-vehicle setups. Next, we present our first proposed system that is intended to use a driver to interact with a multimedia system inside a vehicle. Then we discuss some preliminary results and conclude future work.

BACKGROUND
In our approach we focused on low-cost and accessible Leap Motion [3] device. This technology enables the user to control computer generated content using various hand gestures and motions and rely on IR cameras and infrared LEDs that observes a roughly hemispherical working area in which the user hands are detected.

For example, Aslan et.al. [2] faced challenges related to how closely positioned (expanding) targets can be addressed. Prototypes were used as probes to foster the discussions on the results of the driving simulator study. They concluded that by combining mid-air gestures (provided by Leap Motion controller) with touch, it is possible to improve in-car touch-based interaction in situations that rely on visual attention, and therefore to increase the user safety while driving.

Moser also explores touch versus mid-air gesture input in physics-based gaming [5]. The study showed that, although the developers adapted the game to suit mid-air gestures, several playability problems occurred that should be considered for future game developments. The observations revealed difficulties with accuracy for small and precise gestures and sometimes partial recognition of very fast swipe mid-air gestures. Another problem was that while using the game, the player lost the orientation and moved towards the monitor when performing mid-air gestures (i.e., the signal was lost). Therefore, the mid-air gestures were rated to be more complex and difficult than touch gestures (i.e., rather easy to use).

Other efforts like Abdullah et.al. [1] focused on how wearable tactors can improve the suitability of a multimodal system in an in-vehicle interaction-based situation.

However, confirmation of a selection action may need a specific totally different gesture than frequently used gestures, and, perhaps, another gesture detection technology. We find a suitable solution in Myo technology [6].

To this end, Rajavenkatanarayanan et.al. [7] have evaluated a real time gesture recognition system in an automobile environment to control mobile applications, like music, phone and navigation, while driving.

In our approach we will consider Leap Motion device as main input device responsible mainly with user intention detection and secondly with user selection detection. As a backup solution for user selection detection we also considered Myo device as a candidate.

GENERAL ARCHITECTURE

We based our solution on three main components: a hand-oriented interaction module responsible with user gesture detection, based on Leap Motion [3] and Myo [6] devices (see Fig.1.a), a visualization module responsible with real-time rendering of icons that candidates for user selection/interactions, based on a mini-projector [4] (see Fig.1.b) and a module that interpret user gestures and concretize user selection/interactions (see Fig.1.c).

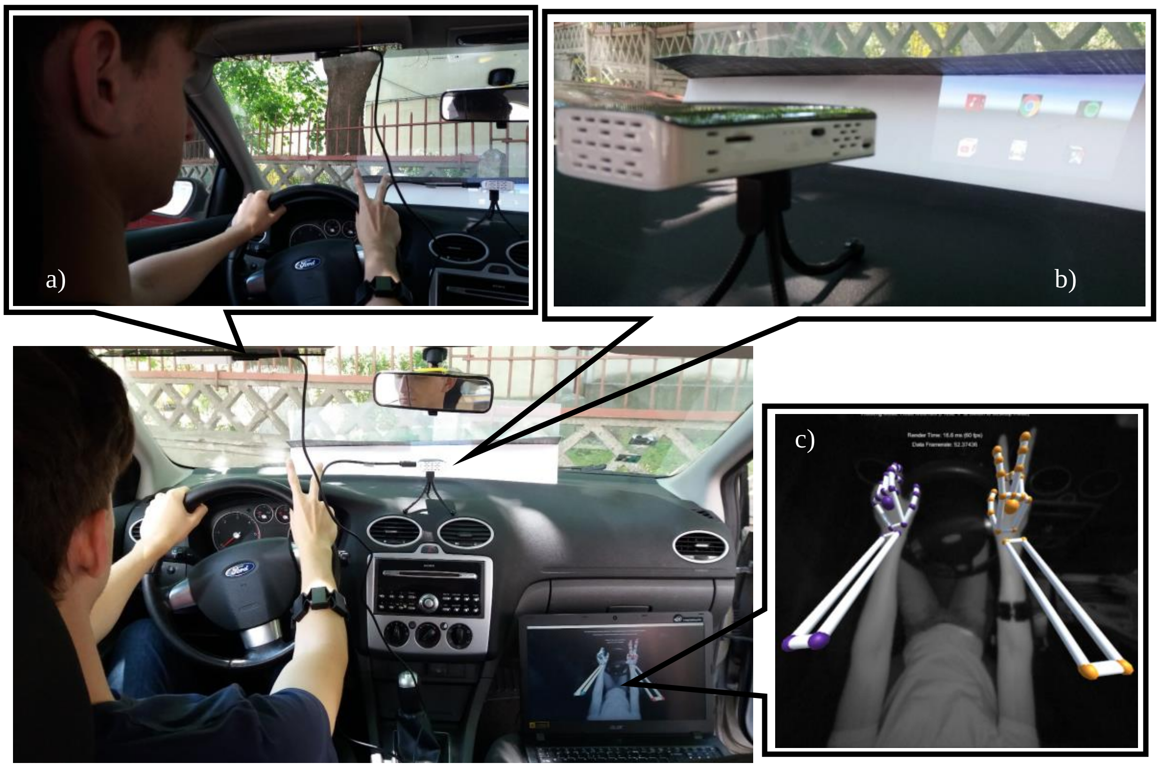

Figure 1. In-vehicle interaction by intention proposed setup.

In order to select an application, the user intention is expressed with one finger oriented towards (without releasing the wheel) and swinging it at the left or right in order to navigate in the available applications. Two fingers mean that user confirm selection of the currently highlighted application and launch it.

Technical aspects

The user of our application uses the Myo armband and the Leap Motion at the same time.

The Myo device is used for warnings through vibration signals if an event like opening or closing an app takes place and also for changing the focus back to our application.

Leap Motion takes care of the navigation through our application by recognizing the user's hands and fingers.

Pointing the index finger at a certain icon makes it enlarge and be in focus. At this point the user can raise the middle finger for opening the focused app the icon indicates or the thumb for closing that app, all of this while the index finger still points at that certain icon.

After the app is started or closed the user gets a vibration signal through the Myo for confirmation. If the user had opened an app, he has to use the double tap gesture, recognized by the Myo, to switch back from the current app to the main screen of our application.

Implementation issues

We have a few implementation issues that we're trying to fix with Leap Motion and Microsoft Windows.

One of the issues with Leap Motion is low movement detection accuracy due to different unexpected actions the driver might take and light that is being reflected towards the device's sensors, both factors making it harder to recognize the user's hands.

The other issue with Leap Motion is not correctly detecting the user's fingers, sometimes recognizing commands by mistake.

The issue with Microsoft Windows, on which we developed this application, is that we don't have access to certain deeper level controls in order to have more control of the operating system like switching more freely through apps and controlling those apps better.

EXPERIMENTAL SETUP

In order to evaluate the usability of our solution, we start conducting an experiment to verify the following hypothesis on natural gesture-based interaction for in-vehicle environments.

We target about 75 volunteers to take part in the study, selected from the body of university students and visitors. Until now, only 25 of them, with the ages between 18 and 24, tried our setup.

Preliminary results showed that natural gesture can provide good guidance for driver selection/interaction, if and only if the system coherently respond to the user gesture.

Although it took a few minutes for the subjects to adjust to the more delicate controls of the system, they learned them quickly because the movements and gestures came naturally.

In the questionnaire we focused on the following topics: ease of usage, quality/clarity of the image, responsiveness of the app, enjoyment of using the setup and final comments.

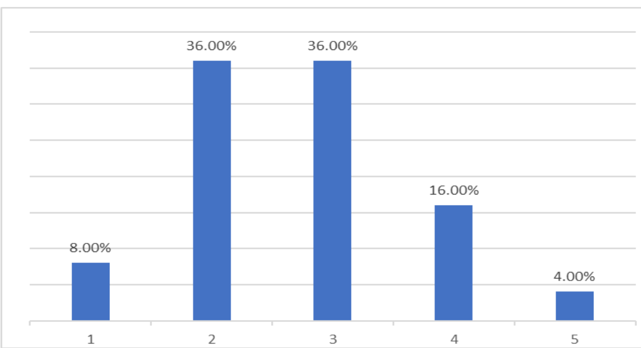

Figure 2. The frequency our users use of gesture-based technology. (Legend: 1-never 2-rarely 3-sometimes 4-often 5-all the time)

For example, with respect to the usage of gesture-based technology, the results are presented in the histogram from Fig. 2, regarding of the visibility of the displayed information, the results are presented in Fig.3, while comfort in using the application is highlighted in Fig. 4.

We had a few complaints with temporary lack of system responsiveness, but this was caused by the long time the application was running and heating of our laptop.

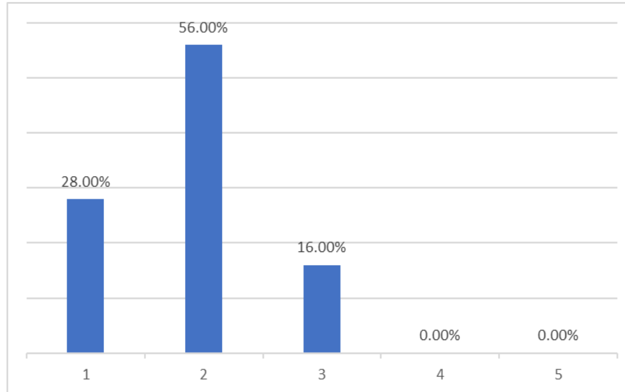

Figure 3. The information on the screen is hard to see. (Legend 1-Strongly disagree 2-disagree 3-no opinion 4-agree 5-strongly agree)

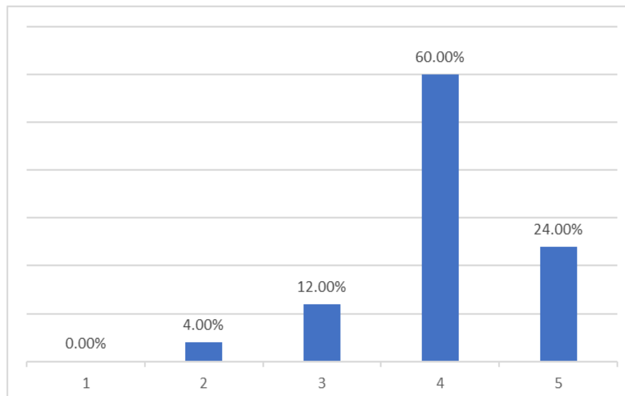

Figure 4. I felt comfortable using the app. (Legend 1-Strongly disagree 2-disagree 3-no opinion 4-agree 5-strongly agree)

While the user gesture detection and interpretation work well, the major withdraw of the actual solution is its strong dependence of illuminating condition; in sunny days the displayed information is however difficult to see in front of the driver.

CONCLUSION AND FUTURE WORK

In this paper, we start to explore and evaluate driver natural, gesture-based interaction by intention within an in-vehicle environment.

For the moment, the interface setup is quite simple and affordable, consisting of a simple laptop, a gesture detection device (Leap motion and/or Myo) and a mini-projector, with a modest contribution of some cheap materials used for fixing elements and projecting surface.

Despite the fact that we just started to conduct a formal study on a broader user experience in order to determine the best approach with our resources, we believe we came close to an easy to learn and use user interface and configuration.

The major issue that we faced is the strong dependence on lighting condition, so this is one item to be solved with high priority.

It would be interesting to further explore the effectiveness of extending driver tracking at other gestures by the mean of other interaction devices, together with facial/eye tracking would considerably augment the usability rates of our system.

Another aspect we can improve on is allowing dynamically assigning gestures to controls and also adding more personal settings in order to improve the naturalness of the user experience.

ACKNOWLEDGMENTS

This work was supported by grant of the Romanian Ministry of Research and Innovation, CCCDI – UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0917 / contract no. 21PCCDI/2018, within PNCDI III.

Thanks also goes to CeRVA research team from Ovidius University of Constanta for their useful discussion and constant support.

REFERENCES

[1] Che Abdullah, Glyn Lawson, and Tessa Roper. 2017. A virtual environment with haptic feedback for better distance estimation. In Proceedings of the ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '17). ACM, New York, NY, USA, 87-92. DOI: https://doi.org/10.1145/3102113.3102137

[2] Aslan, I., Krischkowsky, A., Meschtscherjakov, A., Wuchse, M., and Tscheligi, M.: A leap for touch: proximity sensitive touch targets in cars. In Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '15). ACM, New York, NY, USA, 39-46. ISBN: 978-1-4503-3736-6, DOI:http://dx.doi.org/10.1145/2799250.2799273 (2015).

[3] Leap Motion, https://www.leapmotion.com/, last accessed 2018/04/29.

[4] Merlin miniprojector, https://merlin-digital.com/, last accessed 2018/05/30.

[5] Moser, C., and Tscheligi, M.: Physics-based gaming: exploring touch vs. mid-air gesture input. In Proceedings of the 14th International Conference on Interaction Design and Children (IDC '15). ACM, New York, NY, USA, 291-294. ISBN: 978-1-4503-3590-4, DOI=http://dx.doi.org/10.1145/2771839.2771899 (2015).

[6] Myo Gesture Control Armband, Wearable Technology by Thalmic Labs, https://www.myo.com/, last accessed 2018/05/23.

[7] Akilesh Rajavenkatanarayanan, Yoga Vignesh Surathi, Ashwin Ramesh Babu, and Michalis Papakostas. 2016. MyoDrive: A new way of interacting with mobile devices. In Proceedings of the 9th ACM International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '16). ACM, New York, NY, USA, Article 18, 3 pages. DOI: https://doi.org/10.1145/2910674.2935863