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Spielbasiertes Verfahren zur Fahrerzustandserkennung aus der Sidestick-Eingabe

Experiment design for collecting multiple sidestick-relevant data

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Kurzfassung

Um den Einbau der zusätzlichen Sensoren für Fahrerüberwachung zu vermeiden, versucht wird den Fahrerzustand nur aus der Fahrereingabe über Sidesticks zu bestimmen. Die Daten werden mit Hilfe vom einfachen Computerspiel und einem Auto-Cockpit-Simulator gesammelt und offline analysiert. Parallel dazu werden Hirnmessungen der Probanden mit dem Emotiv EPOC Elektroenzephalograph gesammelt. Bewertet wird die Änderung der Fahrfähigkeit über einen längeren Zeitraum, insbesondere unter dem Einfluss von Müdigkeit.

Abstract

In order to avoid the installation of additional sensors which monitor the driver, we try to determine the driver state indirectly from the sidestick input. The sidestick data is collected with a simple computer game and an automotive simulator. The analysis is done offline. In parallel, driver's EEG data is collected with the Emotiv EPOC Electroencephalograph. The change of driver fitness over a longer period of time is evaluated, in particular under the influence of tiredness.

1. Introduction

The Innotruck is an experimental serial hybrid vehicle built-up in the scope of the "Diesel Reloaded" project on the Technische Universität München. Its purpose is to serve as a test bed for various new concepts in the field of human-machine interfaces and driver assistance systems, system architecture and energy management.

This work is focused on the experiment design and data collection in the scope of driver assistance system experiments with sidesticks as main input devices.

The term "sidestick" is borrowed from the aviation domain and represents a joystick placed on the driver's side, as opposed to the position between the legs, which is usually called a "centre stick". In this experiment, the sidestick was placed on the right of the driver, above the gear stick.

2. Input device choice

The decisions leading to the choice of sidestick as an input method are out of the scope of this document, but the topic is briefly explained in the following paragraph.

As already investigated in The software car: Building ICT architectures for future electric vehicles[1], the advent of electric vehicles offers a possibility of a major architectural overhaul with low cost of transition. The shift to new engine and energy concepts, taking the IKT requirements of the same into account, can be used to redevelop the vehicle's IKT through a centralized, data-centric approach, integrating new functionality on the software level. One of the goals is to do away with the complex interconnections between the contemporary ECUs while reaping the benefits of a safe drive-by-wire architecture.

Assuming a similar trend of integration in the area of input devices, the sidestick is a good candidate for replacing the current "vertical" paradigm, in which various input devices separately control different aspects of vehicle dynamics. With appropriate real-time feedback to the driver, it would enable simple by-wire control of the vehicle. Such input device would be fully personalisable and the input concept transferrable between various vehicle types, although this is out of the scope of this document.

3. The EEG helm

Emotiv EPOC EEG Helm was used in the conjunction with the Research SDK. The device offers real-time compatibility with OpenViBE, BCI2000 and BioExplorer, direct API access to EEG data in real time and a collection of basic applications for Matlab and Labview.

The so-called affective suite of the accompanying Emotiv software package was not used to determine the operator's state, even though it has been designed for that very purpose. The main reason is the unknown underlying algorithm, basically a trade secret of the Emotiv's development team. The correctness of the algorithm which could be determined through field tests would therefore not be relevant, since the inner workings remain unknown.

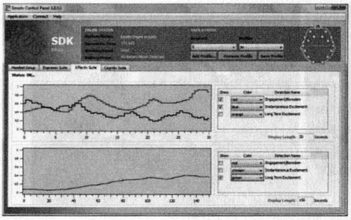

Fig. 1: Screenshot of the affective suite, red graph is the intensity of “engagement / boredom”

4. Research questions

What follows are the most important questions and topics dealt with in this experiment.

The sidestick is analyzed as an input device with “additional value”, that is, as an input device which provides both data relevant to steering and data about the driver state (superimposed on the main input data). The question is, can the sidestick provide more data about the driver state due to its sensitivity? In particular, could the (for steering) irrelevant movements of the sidestick be “mined” for additional data?

The EEG helm is currently utilized as a passive listening device and not as in input device. The question is, could already proven methods with this particular EEG helm, like the P300 detection, be confident enough for determining the driver state over longer periods of time?

Decomposing the “sidestick driving” task into simpler and with the EEG helm measurable cognitive activities would be a considerable advantage when collecting experimental data. If simple target following task could be used as a simplification of sidestick steering, it would alleviate the need for complex sidestick simulators. Determining this cross-correlation based on the sidestick and EEG activity is another task.

What remains after excluding the EEG and cross-correlation between tasks is the following question: Could driver state be inferred by analyzing the difference between driver’s sidestick input and optimal sidestick input from the virtual co-driver through longer periods of time?

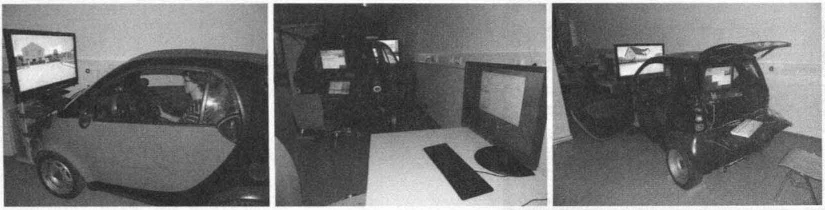

Fig. 2: VTD Driving simulator from VIRES

5. Experiment design

The experiment is divided into two phases with different data collection methods. Baseline (default) EEG activity is recorded before the first phase and at the end of the second phase. Questionnaires are filled out before and after every phase, in order to evaluate the subjective driver state.

In the first phase, a simple target following game with horizontal sidestick movements is played. The player should try to keep a sidestick-controlled object (a dot) inside a moving frame. There is a time limit and it is necessary to collect as few collisions (points) as possible.
EEG data, sidestick movements and frame position are saved.

In the second phase, a test track is driven with the sidestick inside the VIRES Virtual Test Drive (VTD) simulator.
EEG data, sidestick movements and simulation data are saved.

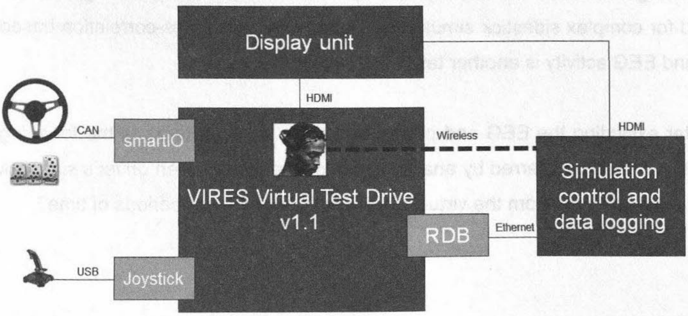

Fig. 3: Basic diagram of the VTD simulator setup

A proprietary Interface called Runtime Data Bus (RDB) is used to extract data from the Virtual Test Drive (VTD) simulator via ethernet.

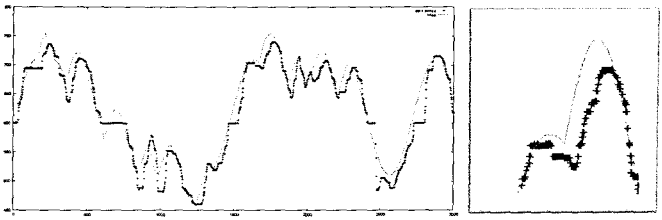

Fig. 4: *Sidestick movements (red) and the optimal movements (green) in the first phase*

Data analysis is out of the scope of this document, which primarily concerns experiment design and main research questions.

Literature:

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