Interictal epileptic activity and its impact on driving ability

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Epilepsy is a common disease affecting ~ 3% of the population in the course of life. Due to seizures while driving, epilepsy patients have a higher risk of traffic accidents. Interictal epileptic activity (IEA) is not defined as an overt seizure and is not realized by patients but can be observed in the electroencephalogram (EEG). Typically IEA lasts only a few seconds and can lead to transient cognitive impairment, but its impact on driving is unclear [1, 2].

Andreas von Allmen

Introduction

IEA can be investigated by measuring reaction times (RT). To achieve this, 1) IEA has to be detected in real time, so that the stimulus can be delivered to the patient during the short period of IEA. This is normally done by visual analysis, but the need for real time requires development of automatic IEA detection.
2) The time when the stimulus is visible on the screen and can effectively be seen by the patient has to be known, but the digital device cascade between trigger and effective display on the screen has unknown and variable cumulative latencies, so that the effective appearance of the stimulus on the screen has to be actually measured. 3) The time of the braking response of the patient hast to be determined. This thesis aimed at solving these problems.

Materials and Methods

In the developed device named "iRT" (Fig. 1A), a single-board computer running Linux (Raspberry Pi), acquires EEG data in real time through a serial port from an amplifier (Trackit). Each channel is automatically processed by the own developed IEA detection software. Upon detection of IEA, a trigger is sent to the driving simulator, resulting in the display of a stop sign in front of the patient (Fig. 1B). The stop sign can also be manually triggered during normal EEG to obtain reference RTs without IEA. A RGB-color sensor (Fig. 1C) measures the reflected light from a selected area of the screen. The RGB signals are processed by software on a microcontroller to detect the on-screen stop sign. Together with the brake signal, this yields the effective RT (eRT).

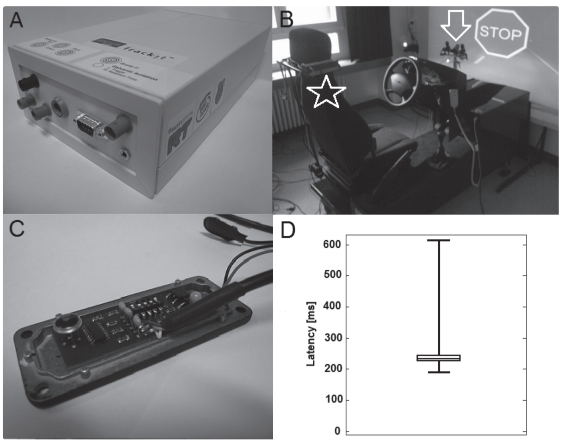

Fig. 1: Reaction time measurement units. A) iRT unit (Raspberry Pi & microcontroller). B) Foerst driving simulator with EEG registration (*, Trackit; arrow, sensor unit). C) Sensor unit. D) Latency between stop sign triggering and registration.

Results

Measurements were done to assess: a) the internal timing of the developed system, which used 5.4 ms for sampling and filtering the stop sign signal, and 520 us for registration of the braking signal; b) to assess the delays of several digital systems, including the driving simulator which showed a median latency between stop sign triggering and on-screen display of 234 ms (range: 189–611 ms; Fig. 1D); c) to assess the feasibility of IEA detection and determination of eRT in 6 healthy subjects and one patient with epilepsy: the average reaction times of controls were 871.4 ±20.2 ms. Reaction times of the patient were 846.7 ±123.9 ms (n = 38) during normal EEG and were prolonged by 113 ms (p = 0.004) to 960.4 ± 126.1 ms during IEA (n = 16).

Discussion and Conclusion

The developed iRT system allowed automatic IEA detection. The digital delays between triggering and on-screen display have been measured for various digital systems including the driving simulator. The driving simulator latencies and variability (189 – 611 ms) are large. For the first time, IEA detection and reliable measurements of effective RTs are possible.

References

[1] Krestel H et al. Epilepsia 2011;52:126-129.
[2] Yang L et al. Epilepsy Behav 2010;18:238–246.