uLog:
Towards attention aware user-system interactions measurement

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In user interface development, it is essential to find the balance between grasping and, subsequently, holding attention and providing an optimal information density both in the center and periphery of focus, refraining from information overload [2,7]. This process is like balancing on a thin line: the exact amount and optimal manner of information presentation are crucial [6]. In this paper, we provide an outline on how user interface development can be facilitated, using the program uLog, developed by Noldus IT.

uLog was developed to record user system interaction and, subsequently, determine programs' usability. In addition, we aim to determine user's attention to parts of a user interface (e.g., a website). For example, the latter is of great importance for advertising. uLog records interactions such as keystrokes, mouse clicks, application activations, and mouse movements. We expect that such information can also reveal the pattern of user attention. To verify and validate the uLog recordings for user attention analysis, a research line is developed as will be described in the current paper.

The uLog recordings need to be accompanied by other measures that can reveal user's patterns of attention. The following, complementary data sources were collected in parallel to the uLog recordings:

- Questionnaires, including demographic information
- Eye tracking: fixation points and eye gazes during website usage
- Think aloud of the participants during the task
- ECG recording: determination of Heart Rate Variability of participants
- Skin Conductance (SC) determination during the experiment

The questionnaires, as conducted at both the begin and the end of the experiment, were used to gather demographic data and to determine user's self reported mood, emotions, and evaluation of the stimuli.

Using the think aloud technique, users were asked to verbalize their thoughts during the experiment. In the most commonly used approach, concurrent think aloud (CTA), users' verbalization takes place simultaneously with their task performance [1]. CTA is widely used in research on cognitive processes and for HCI processes. CTA data provides a good indication on users' attention while performing certain tasks.

The eye tracker is integrated in the computer screen and detects the gazes, which are called saccades, and fixation points of the users' eyes. When exploring an object or a website or when reading a text, users typically show a pattern of a saccade followed by a fixation [4]. These patterns of viewing behavior are recorded through the eye tracker and, subsequently, can be visualized, providing information on the attention patterns of the user.

Heart Rate Variability (HRV) is one of the physiological measures recorded in the experiment and refers to the variability of the heart period over time or between beats [8]. Research has resulted on contradicting results with respect to the correlation between user's HRV and user's mental state. Though, some evidence is present for a negative correlation between mental load and HRV [9]. Therefore, HRV is included as a measure, in particular to determine the amount of workload and attention experienced by users.

As a second psychophysiological measure, Skin Conductance (SC) [8,10] is included. Differences in SC also indicate possible changes in attention or workload [3]. As for HRV, various factors (e.g., stress and emotion) can heavily influence the results of this measure. Hence, these factors have to be controlled as much as possible.

The variety of measures that are recorded in parallel with the uLog recordings provide a multiperspective view on users' behavior, in particular their pattern of attention. These measures are incorporated in one set of analyses, as the principle of triangulation proposes. Triangulation refers to use of multiple sources and/or analyses to capture a construct. This approach reduces the amount of error in interpretation of users' behavior. Errors can be detected more easily and isolated from the construct itself [5]. Especially when taking in consideration the complexity of the phenomenon of attention, triangulation is needed to derive conclusions from the measures recorded. Possibly, not all measurements are needed since they are not completely complementary to each other. The current research outline will reveal this also. Most important it can provide us solid evidence on the patterns of attention of users and can show us how they relate to uLog recordings.

Although the current research outline can be considered as rather obtrusive and, therefore, unwanted in practice, it can provide us the way to unobtrusive recording of users' patterns of attention, using the uLog recordings. uLog can record user-system interaction even without awareness of the user and without any disturbance or delay in the interaction process. However, even when solely uLog data would not provide enough information, a selection of other measures can be made that, on the one hand, optimally complement uLog recordings and, on the other hand, limit the obtrusiveness of the recordings for the user.

Taking all in consideration, a unique research outline is introduced that can be an important step towards automated analysis of users' behavior and of their patterns of attention.

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