MOUSEREC—Monitoring Online Users' Emotions by Recording and Evaluating Cursor Movements

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Abstract. Emotions have been shown to influence users' actions in a variety of situations. However, online retailers or website owners in general are typically unable to infer changes in users' emotions and to respond accordingly. Based on prior findings, which state that changes in mouse cursor movements can be indicative of users' emotions, we propose a system for real-time tracking and analysis of website users' mouse cursor movement parameters, and instantiate a prototype in the context of an online store. An initial qualitative evaluation of the system demonstrates that the system is indeed capable of detecting changes in users' mouse cursor movement characteristics during the interaction with a website, highlighting the potential of detecting users' emotional changes in real time.

Keywords: Emotions, Mouse Movements, Mouse Tracking

1 Introduction

The rise of e-commerce has provided retailers with unprecedented opportunities, such as extending their reach to a global scale, or the ability to provide individualized products or services to each individual customer [1]. However, as such systems are often complex [2] various emotional reactions (e.g., frustration) may arise, potentially resulting in terminated transactions, negative word of mouth, and so on [3,4].

Research in marketing has repeatedly demonstrated the benefits of keeping current customers satisfied [e.g., 5], and the ability to monitor customers' emotions (and reacting accordingly) can offer great potential. In offline settings, experienced sales personnel can relatively easily detect a customer's emotional changes and assist or support customers accordingly. In contrast, online service providers have fewer possibilities to monitor their customers' reactions, and are thus limited in their ability to quickly react to emotional changes and assist their customers in real time.

Recent research has shown that mouse cursor movement data can be indicative of users' emotions [e.g., 6], suggesting that it may indeed be possible to monitor online users' emotions. To this end, using a design science approach, we build a prototype of MOUSEREC (*M*onitoring *O*nline *US*ers' *E*motions by *R*ecording and *E*valuating

adfa, p. 1, 2011.

*C*ursor movements), an adaptive emotion recognition system designed to monitor a user's mouse cursor movements, so as to detect emotional changes and to trigger certain actions based on predefined parameters.

2 Emotions and Mouse Cursor Movements

Emotion, often associated with the appraisal of an external stimulus [7], can be defined as "a mental state of readiness that arises from cognitive appraisals of events or thoughts; has a phenomenological tone; is accompanied by physiological processes; is often expressed physically (e.g., in gestures, posture, facial features); and may result in specific actions to affirm or cope with the emotion" [8, p. 184]. Physical expressions of emotions are often associated with psychophysiological responses [9], such as changes in electrodermal activity or minuscule but distinct changes in facial expressions [10]. Yet, apparatuses to record such responses are only available in laboratory settings, making it literally impossible for online retailers to use such devices to monitor their customers' emotions in real time.

Recently, it has been suggested that in addition to psychophysiological responses, a person's bodily movements (such as hand movements), can indicate certain mental processes [11]. For example, Fitts' law [12] suggests that moving a cursor to a target typically requires a trade-off between speed and accuracy of movements; as mental processes interfere with the execution of these motor movements, changes in hand movements (or mouse cursor movements) can signal changes in emotions [11]. Maehr [6] and Zimmerman et al. [13] have demonstrated that different emotions influence hand movements and can thus result in markedly different mouse cursor movements; specifically, Maehr demonstrated that mouse cursor movement parameters such as speed, distance, or precision are associated with certain emotional states (e.g., arousal). Drawing on these findings, we develop a prototype of MOUSEREC, a system that observes users' mouse cursor movements, and triggers certain actions if deviations are detected. For example, if users experience negative emotions because they are unable to complete a task on a complex e-commerce website, the system could help in attempting to remedy this situation by presenting a different (e.g., less complex) user interface or it could suggest appropriate next steps in the shopping process.

3 Functional Design Considerations

A system capable of detecting changes in mouse cursor movement parameters should continuously monitor such parameters and react to deviations. The functional requirements for MOUSEREC are guided by two main considerations. First, as individuals differ greatly in the way they use the mouse, it is impossible to infer emotions from absolute movement parameters; emotional changes can only be inferred by detecting deviations from a person's "normal" movements, requiring to establish a baseline for each individual user. Second, given the complex interplay between emotions and physiological reactions, it stands to reason that a combination of multiple movement parameters is required to maximize precision in inferring a user's emotions.

In the following section we describe the functional design of MOUSEREC (see Figure 1 for the activity diagram). As the user enters the website, MOUSEREC is started and records the user's mouse cursor position using x/y positions and corresponding timestamps while the user is interacting with the website. During the user's session, MOUSEREC performs two main tasks: a) establish an individual baseline of mouse cursor movement parameters such as distance, speed, acceleration/velocity, or accuracy/precision, and b) continuously record the current values of these movement parameters and compare these with the established baseline.

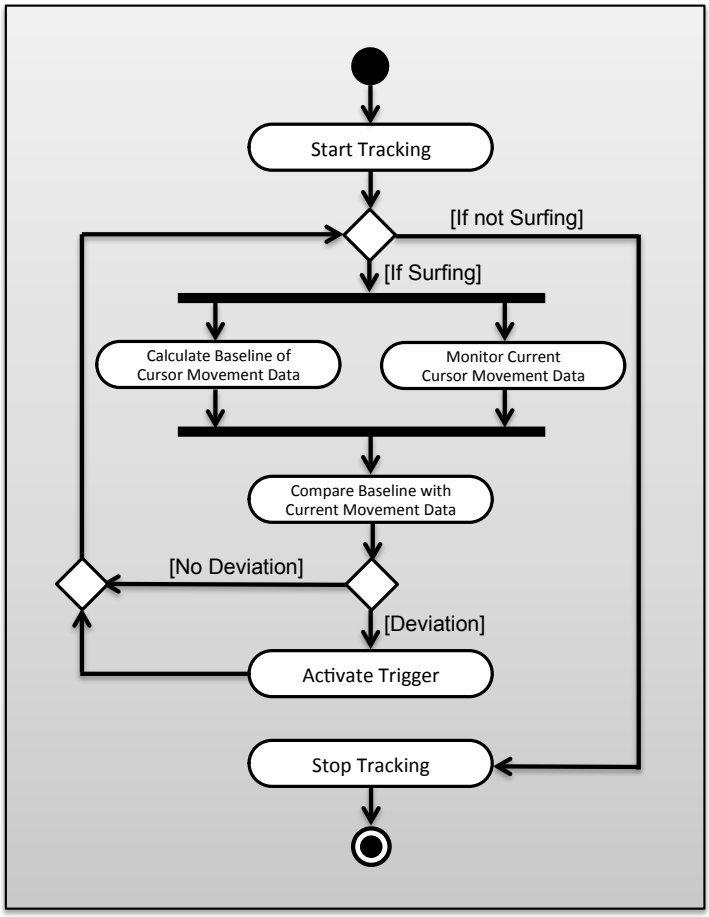

Fig. 1. – Activity Diagram of MOUSEREC

As long as the current values do not differ from the baseline values, MOUSEREC keeps calculating the baseline and current values. When a deviation of the current values from the baseline values is detected, MOUSEREC responds to the user's emotional change by triggering a pre-specified action. MOUSEREC continues tracking the user's mouse cursor movement parameters until the user's session ends.

As user interactions are likely to differ based on the complexity of tasks, the number of pages visited during a session, or the website's design in general, MOUSEREC allows for predefining parameters (such as the length of the tracking intervals or thresholds for triggering actions) for each individual website.

4 System Design

MOUSEREC consists of four main components, an administration component, and several artifacts (i.e., the tables of the databases) (see Figure 2 for the component diagram). The main components are the *MouseTracker* (responsible for collecting, calculating and evaluating mouse cursor movement parameters by using the artifacts *MT Monitoring* and *MT Calculation*) and a website, as well as the connected databases. The website provides an interface for the *MouseTracker* to allow for the recording of mouse cursor positions; further, the website is connected to the database *DB Website*, which contains a table *SessionID*. The *MouseTracker* connects to the *DB Website* to obtain the user's session ID. The *MouseTracker* further connects to a database called *DB MTracker* containing the three tables: *MT Times*, *MT Values*, and *MT Settings*. The table *MT Times* stores the session ID as well as the starting time of each user's session; the table *MT Values* stores the mouse cursor positions and associated timestamps needed to calculate the different baseline and current mouse cursor movement parameters; the table *MT Settings* stores predefined settings, such as the extent of deviations for triggering an action or frequency of calculating baseline and average values. These values can be changed using the component *Admin Interface*.

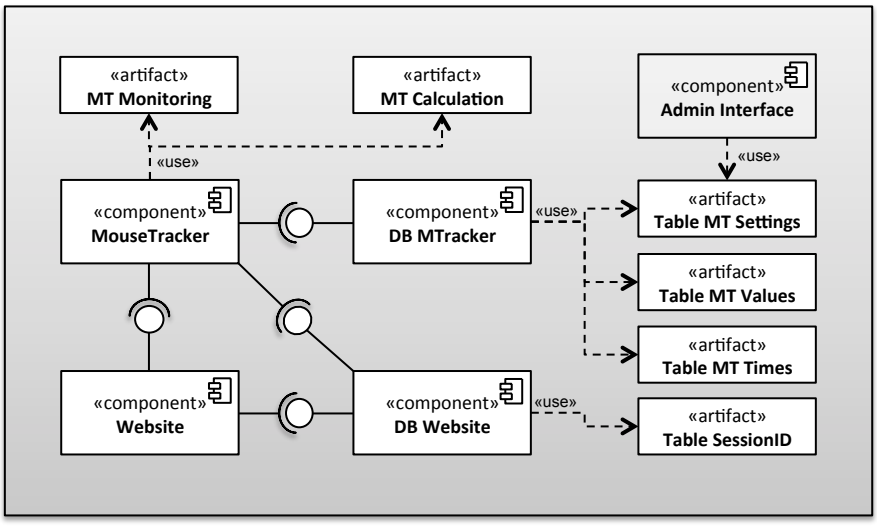

Fig. 2. – Component Diagram of MOUSEREC

The sequence diagram (Figure 3) presents how these components might interact within MOUSEREC. Upon the user entering the site, the website assigns a session ID

(stored in the Database *DB Website*), and a script automatically starts the *MouseTracker*. The *MouseTracker* requests this session ID from the *DB Website* and stores both session ID and the user's session starting time in the database *DB MTracker*. The *MouseTracker* then starts recording the user's mouse cursor positions to calculate a baseline of mouse cursor movement parameters over a predefined duration.[1] Further, the *MouseTracker* calculates and continuously updates the current mouse cursor movement parameters (based on predefined intervals preceding the calculation) and stores these in the database *DB MTracker*.[2] At predefined intervals, the *MouseTracker* requests current and baseline values from the database to calculate the deviations. If the deviation exceeds a predefined threshold, a pre-specified action is triggered, so as to attempt to respond to the user's emotional change. If no deviation is determined, the *MouseTracker* continues tracking the mouse cursor movement parameters. The *MouseTracker* stops when the user leaves the site.

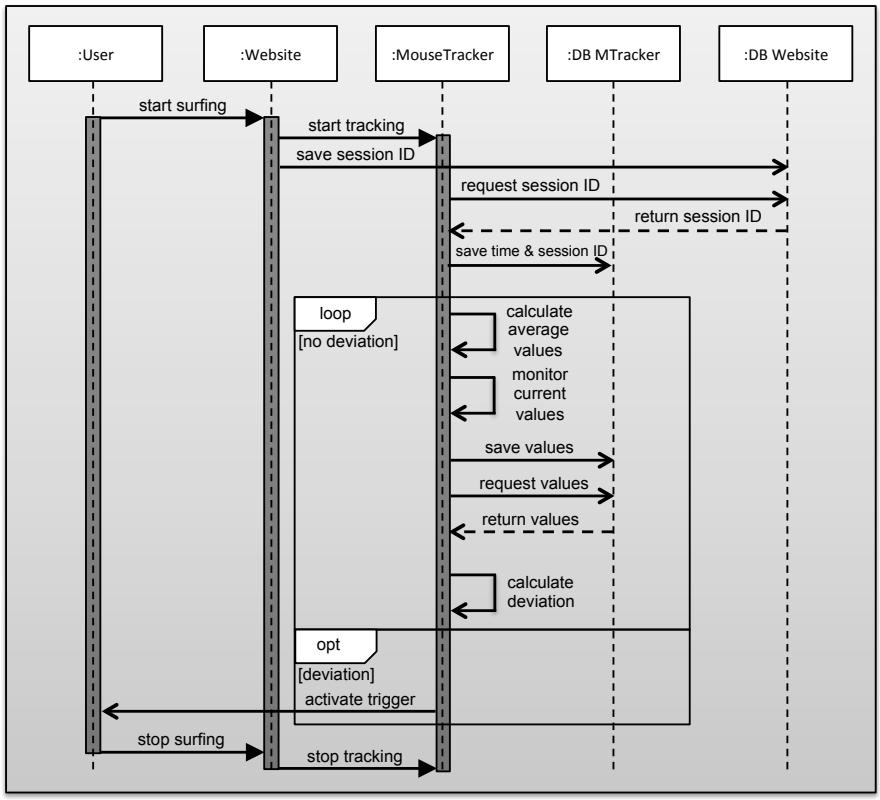

Fig. 3. – Sequence Diagram of MOUSEREC

[1] The baseline can be established in various ways, for example, statically (by averaging the values over a certain time period) or dynamically (by using only the latest X seconds, etc.). Further research is needed to determine the optimal parameters.

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5 Implementation and Evaluation of Prototype System

To evaluate the artifact and assess the system's efficacy in detecting emotional changes, we created an online grocery store (the Website component) using the open source e-commerce platform Magento (www.magentocommerce.com). We implemented the *MouseTracker* component in JavaScript, which we integrated in the HTML/PHP environment of the Magento platform; the *MouseTracker* recorded each user's mouse cursor x/y position and corresponding timestamps using the artifact *MT Monitoring*. Further, we developed a calculation script (*MT Calculation*) to calculate baseline and current mouse cursor movement parameters, as well as the deviations of the current values from the baseline. We used Ajax to transfer data to the databases.

For our prototype system, we decided to use mouse cursor speed as an exemplary movement parameter, as speed is an important part of Fitts' law [12], and may serve as indicator of emotional changes [6]. The baseline is established by first calculating the average session speed as $v = D/T$, where cursor distance D is calculated as the sum of the Euclidean distances between all recorded mouse cursor x/y positions during movement time T during the session. Second, using the same formula, the system calculates the current speed during the 10-second interval preceding the calculation.[3] The MouseTracker then compares those values to the deviation. If the deviation is below the predetermined threshold, the MouseTracker continues tracking mouse cursor movements and updating the user's current mouse cursor movement speed. If the deviation exceeds the threshold–in our case predefined as a 10% deviation from the baseline–the MouseTracker triggers an action. For purposes of testing the functionality of the system and fine-tuning the different parameters, the triggered action consisted of the display of the arousal scale of the Self Assessment Manikin (SAM; [14]–see Figure 4), a pictorial self-report emotion measurement instrument, enabling us to assess the user's current emotional state. In a production environment, various alternative actions could be triggered, based on the user's emotions as well as the designer's intentions. For example, the system could trigger the display of a chat window to aid the user, or could redirect the user to a simpler version of the website. MOUSEREC allows to predefine various parameters, such as the minimum extent of deviation to trigger an action, or length and number of calculation intervals. Given inherent differences in the design of websites, these parameters may have to be tested for each individual website.

We conducted an initial qualitative evaluation of the prototype (using the think-aloud method) by observing nine participants who interacted with the system. Specifically, we directed the participants to our mock online grocery store, and instructed them to select different ingredients for a given recipe. During the process, we ob-

[3] Given the amount of data that needs to be transferred to the server, we expected a certain time lag; thus, we selected 10 seconds for our exemplary implementation to give the system sufficient time to complete the transmission and perform the calculations. Based on site-specific differences in movements on the site (e.g., having to move the mouse across the screen to reach the checkout button), different intervals may be more or less precise for inferring emotional changes.

served when the system triggered our pre-specified action (the emotion measurement scale). As expected, the action was triggered for different users at different times during the interaction, indicating that the action was indeed triggered by deviations from the individual users' mouse cursor movement baselines, rather than by site-specific (i.e., user-independent) mouse cursor movements (such as moving the pointer to the shopping cart button). Further, using the think-aloud method [15], we found that the system indeed triggered when the participants' experienced different levels of arousal.

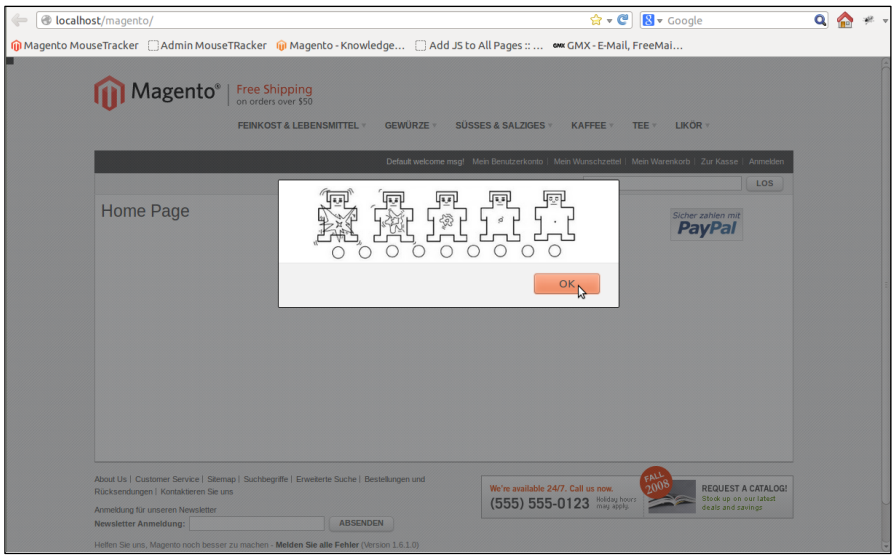

Fig. 4. – Prototype with Triggered Action

6 Discussion and Conclusion

In this work, we have presented the functional requirements and design of MOUSEREC, a system used for inferring a user's emotional changes based on deviations from the user's baseline of mouse cursor movement parameters. A prototype implementation, using mouse cursor speed as an exemplary parameter, highlighted the potential of reliably detecting deviations from such baselines, and thus, the potential of detecting changes in emotions. Further testing is needed to link specific mouse cursor movement parameters to specific emotions, and to find the right combination of parameters needed for detecting specific emotions. In addition, future work should fine tune the different algorithms used, such as determining the best time frame for establishing the baseline and current movements, or determining the deviation thresholds used for triggering actions. Notwithstanding the limitations of the current prototype implementation, this research demonstrates that the monitoring and evaluation of online users' mouse cursor movements can serve as an appropriate, low cost instrument to infer users' emotions; as such, MOUSEREC can be a valuable tool to assist

and support users, so as to enhance their online shopping experience or online interactions in general.

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