Physical Data as an Implicit Input Modality in a Two Way Affect Loop

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Abstract
This papers describes our approach towards a system that aims at augmenting human perception by utilizing cognitive states as input for altering modalities of media. We are attempting to measure levels of attention through their related physical expression on the human face. For a system prototype we are employing off-the-shelf smart eyewear to sense eye movement, eye blink, and changes in facial temperature. These information are then utilized for the modulation of technical parameters of media, e.g. film.

Author Keywords
Eyewear; Attention; Cognition; Psychophysics; Interaction; Sensing

ACM Classification Keywords
H.5.2 [User Interfaces]: Interaction styles (e.g., commands, menus, forms, direct manipulation)

Introduction and Motivation
Being able to fully grasp the bodily foundation of mental processes and sensations is a major milestone on the way to computer-supported amplified human senses. Understanding which mental process or reaction causes a certain type of physical expressions would in return mean, that we can look into the human brain by simply looking at the person's outside. Within the rather short period of time, where

researchers have been able to depict brain activity and cognitive processes with extremely expensive medical equipment, investigations have been limited to laboratories. However, today's off-the-shelf wearable computing and sensing devices enable us to noninvasively investigate and observe human cognitive processes by measuring and interpreting physical signals.

One of the vitally crucial cognitive states is attention. The Merriam Webster dictionary describes attention as: "the act or state of applying the mind to something" and as "a condition of readiness for such attention involving especially a selective narrowing or focusing of consciousness and receptivity." [5]. Today, attention is still not measurable and therefore difficult to be quantified. It is a volatile phenomenon that all (human) individuals recognize in themselves.

We are aiming at the development of an unobtrusive attention tracking solution using J!NS MEME off-the shelf smart glasses [3]. In a next step we are proposing to integrate J!NS MEME smart-wear into a Two-Way Affect Loop (2WAL), a responsive system that reacts in real time to input modalities and alters predefined parameters of contents [7]. Therefore, by identifying fluctuations in patterns of physical signals directly related to attention, such as eye-movement, blink and facial temperature, changes in attentional states can be recognized and utilized as input modalities into our system.

Attention

Cognitive scientists have devoted their efforts to understanding what is happening with received information in the human brain. How do we choose, process, store, and use them in order to recognize objects, communicate, or navigate through our environments [2]? In order to decide which information out of the virtually endless supply we should choose, humans have developed a complex selection process, called attention. "Attention solves the problem of information overload in cognitive processing systems by selecting some information for further processing, or by managing resources applied to several sources of information simultaneously." [4] This definition explains the limited availability of attentional resources, i.e. every human naturally manages and applies attention to certain information of interest.

In order to enable people to gain better control over their attentional resources, and thus make them more efficient and more effective, we have to come to understand that we must manage and economize the use of this cognitive resource.

Eyewear for Implicit Input

Most of the sensory information is received through the head. This makes it an ideal location for tracking and enhancing cognitive functions. Our focus is to investigate eye-blink and facial temperature, that can reveal information about attention. Results of controlled lab studies have shown first evidences for correlations between social and cognitive functions and physiological expressions [1]. Most experiments are designed to take place in constrained laboratory settings. Contrary to this, and to the best of our knowledge unique in the field so far, we are using unobtrusive head based sensing devices in order to enable testing in everyday situations. According to the National Eye Institute, 64% of the adult population in the USA are wearing eyeglasses [6]. This is a significantly higher ratio than the 41% of Americans wearing watches [10]. We believe that this shows the great potential of smart eyewear such as J!NS MEME smart glasses for our purposes, Figure 1, 2.

Figure 1: J!NS MEME

Figure 2: J!NS MEME and closeup on the EOG electrodes

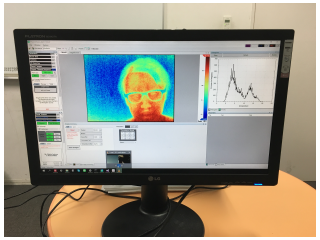

Figure 3: Facial Thermography

MEME are sensing devices rather than computing appliances. All necessary applications and programs are running on connected smartphones, tablets, or computers. Therefore, a lot of room in the frame could be saved that would have usually been necessary for bigger batteries. The form factor of sensing eyewear, and the immediate proximity of the sensor to physiologically active facial regions, e.g. measuring facial temperature changes (Figure 3), make these spectacles the ideal devices for the implementation in everyday situations.

We are intending to use fluctuations in the attention patterns of the viewer and let the system respond by altering the settings of presented contents. This system breaks the boarders of traditional passive media presentation and enables researchers, content producers, and others to incorporate sensing of physical signals in a multimedia platform, and therefore creates highly adaptive and individualized experiences.

Two-Way Affect Loops

In traditional multimedia environments, engagement is created by effective storytelling and/or interactive content presentation. One example is the consumption of film in its traditional sense. This so called One-Way Affect (1WA) is limited to the film being viewed, and thereby having an impact on its viewers [8]. In contrast, by using physical data obtained directly from film viewers as an input modality to modify film presentation parameters, we extend the 1WA to a Two-Way Affect Loop (2WAL), cf. Figure 4. Here, the film has a particular impact on the viewer, and the viewer's reaction is measured and used to alter the film [7]. In comparison to other attempts on interactive films, where viewers are forced to take active decisions, our system aims at a natural seamless interaction. The possibilities reach from altering video parameters such as frame rates, to added

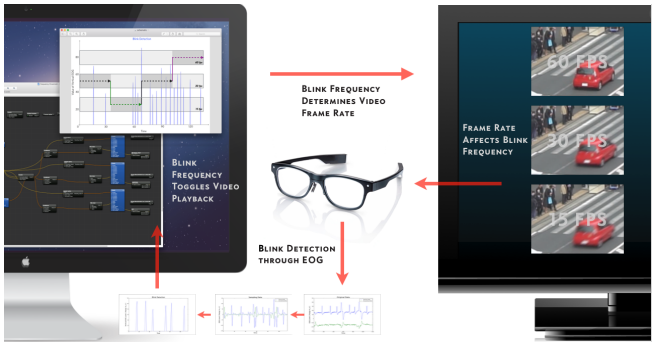

Figure 4: Two-Way Affect Loop using J!NS Meme for Implicit Input

blur effects, varying brightness or resolution. Besides medical applications in therapeutical frameworks, our goal is to use technical modulations to make cognitive processing of information embedded in video more effective, by recognizing periods of stronger and weaker attentional focus. Our prototype utilizes measurements of blink frequencies to toggle between videos with different frame rates in real time when certain defined thresholds are transgressed [9].

Conclusion

We believe that this system breaks the boarders of traditional passive film presentation and consumption and triggers discussion among researchers, filmmakers, and scholars of other disciplines about its potential to create highly adaptive and individualized experiences by using physical data as an input modality. We are introducing a tracking solution based on wearable computing. A major motivation for this project is to make attention tracking available for everyday situations. Therefore, we focus on an unobtrusive solution using J!NS MEME off-the shelf smart glasses. The data gained from J!NS measurements enables us to recog-

nize cognitive patterns that can be used in our responsive media system. This will make countermeasures possible, which can address beginning drops in attentional focus. The return loop of our system allows parameters of media to be influenced by the viewers' physical reactions.

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