Framing Meaningful Adaptation in a Social Context

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Abstract

Research has shown that we unconsciously interact with computers in a social manner. We speculate that viewing adaptive interfaces in a social context can be a helpful framework for design. We can create meaningful adaptations – natural and intuitive – by examining how humans adapt to social cues in social situations. This paper will briefly outline the background of computers as social agents, as well as list potential applications of design.

Keywords

brain-computer interface, social, physiological computing, fNIRS, adaptive interface, passive user input

ACM Classification Keywords

H.5.2: User Interfaces: Input devices and strategies.

General Terms

Human Factors

Introduction

In 2008, the HCI lab at Tufts University defined reality-based interfaces (RBI) as a unifying concept for describing post-WIMP interfaces based on real-world interactions [1]. These interfaces have the advantage of utilizing skills we naturally obtain – naïve physics, body awareness, environment awareness, and social awareness – to influence design for interaction in emerging interfaces.

Because of their close coupling to the real world, reality-based interactions tend to be natural and intuitive, offering a starting point for constructing meaningful interaction in physiological computing. However, it is not immediately obvious how to construct adaptations that mirror interactions that are grounded in reality. For example, how do we take advantage of basic physical interactions in an adaptive environment?

As we look towards adaptive interfaces that respond to physiological input, it is still not clear how to leverage some of these natural skills. While naïve physics and body awareness shed light on the appeal of interaction techniques such as tangible interfaces or gestural interaction, they become more difficult to define in an adaptive environment without severely disrupting the user's mental model of the interface. However, it appears reasonable for a computer to be attentive to our social needs, responding both implicitly and explicitly to our situational user states.

Social Skills and Awareness as a Framework for Adaptation

For nearly two decades, researchers have identified the computer as a social agent [2]. Interactions with computers are fundamentally social, and social responses to computers appear to be both automatic and unconscious.

Consider the moments when users verbalize frustration with their computers, despite knowing that their computers are not listening. Regardless of the level of urgency or frustration in their voice, the computer remains stagnant. Now, contrast this with a normal social setting, where people generally notice and react appropriately to social cues. Despite our natural inclination to interact with computers in a social manner, the computer does not respond or react in kind. It does not adapt when we are frustrated or understand when we are tired the way a human might notice, and as we are naturally inclined to expect.

Social responses to computers are both powerful and automatic, and viewing the computer as a social actor helps us explain *why* adapting to user state is important. However, examining social dynamics and social behavior can also lend clues into *how* the computer should respond.

Social Rules and Social Cues

In the past, adaptive interfaces have often been considered obtrusive, disrupting the user's mental model by changing the visual environment of the interface during interaction [5]. However, placing these adaptations inside of a social context, this level of disruption is not surprising. We do not expect our visual environment to radically change as we communicate with another person. Consider how distracting it would be to suddenly spin in a circle during a conversation, or why it can feel rude when someone pauses to answer a phone mid-conversation. There are social rules and etiquette that we adhere to and expect others to adhere to as well. When these rules are broken, we become upset or confused. So if we are subconsciously applying social rules to computers, then adaptations that adhere to those rules should feel more natural and intuitive.

In *Computers as Persuasive Social Actors*, BJ Fogg identifies psychology as one of five categories of social cues (the other four are physical cues, language cues, social dynamics, and social roles) [5]. Psychological social cues include the detection of preferences, humor, personality, feelings, empathy, etc. Corresponding with our own work, we shift from broad descriptions of socially sensitive adaptive interfaces, to more specific examples, using functional near-infrared spectroscopy (fNIRS) to detect brain states in the user.

fNIRS Background

Over the past few years, the HCI lab at Tufts University has researched using the brain as passive input to adaptive interfaces using fNIRS [3]. fNIRS is a brain-imaging technique that uses near-infrared light to measure the concentration and oxygenation of blood in tissue at depths of 1-3 cm in the brain. In comparison to other popular brain-imaging techniques, fNIRS is more robust to movement artifacts that can disrupt electroencephalography (EEG) or functional magnetic resonance imaging (fMRI). In direct contrast to EEG, fNIRS has higher spatial accuracy, allowing more localized observations about brain signals, but has a slower temporal accuracy, with delays upwards of 6-8 seconds. fNIRS researchers have been able to distinguish between levels of spatial and verbal workload, visual search, different types of interruptions, preference, induced emotion, and response inhibition [3].

How Should We (Socially) Adapt?

To illustrate how social adaptations may influence interface design, we present three examples of fNIRS measurements, proposed adaptations, and their corresponding social situation.

Summarization

Measure: fNIRS has been used to differentiate between different classifications of interruption, as well as varying levels of workload in the prefrontal cortex [3].

Summarizing information gives us a quick recap of previously digested information or a simplified version of current information. If I am telling a story to someone who is suddenly interrupted, I am likely to give a quick summarization of the last portion of my story. Similarly, if a computer user is distracted from the screen, we might be able to give a summary of the user’s context in the program upon return.

In addition to establishing context, summarization can be used to minimize disruption. If I need to update someone about a sporting event who is deeply involved with a task, I am likely to simply tell him or her the current score of the game – the most basic representation of the game’s state. In a less demanding situation, I might go into more detail about the match, such as describing how each team scored or commenting on key plays of the game. In a computer scenario, we may be able to summarize information the user is monitoring dependent on his or her workload in a primarily task.

Filtering and Prioritizing

Measure: fNIRS has been used to identify varying levels of workload in spatial memory, verbal memory, and visual search tasks [3].

We naturally filter and prioritize data when we are forced to interrupt someone. If a musician is in the middle of a performance, I will not interrupt him to give instructions on how to make breakfast the next day. However, if his house is on fire, I might make an exception. Similarly, users often become upset at computers when they disrupt our workflow for trivial reasons. If we can measure various kinds of workload with brain-imaging devices, we can identify the appropriate moments to display email notifications, or ensure that only the most important emails cause the user to be interrupted when he or she is concentrating.

Personalized Information

Measure: fNIRS has been used to identify induced preference levels in the prefrontal cortex [6].

If I am engaged in conversation with someone and he or she appears to be particularly interested in the subject matter, I am more likely to pursue that direction in conversation. Similarly, if we can detect preference or levels of engagement, we can gently guide future interaction by influencing recommendation engines or creating a preference-guided search.

Conclusion

Physiological computing often does not look for the same social cues as a human identifies – body language, tone of voice. However, both humans and physiological computing look to identify user states – frustration, fatigue, interest, etc. In the previous section, we suggest adaptation techniques that mirror our social adaptations and adhere to implicit social rules and etiquette. Furthermore, we speculate that identifying their place in a social context may help us understand why they do not seem particularly disruptive. Examining social behavior and surveying the social psychology literature may lead to new types of adaptations that are natural and intuitive.

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