Quantifying User about Attention on Multi-device situation to provide Pervasive Attentive User Interface

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Abstract
Nowadays, the amount of information and the number of devices that people face every day are growing rapidly. People put more effort to deal with a large amount of information provided by those devices and there occurs attentional dispersion. Therefore, Pervasive Attentive Interface (PAI) has become important in order to manage users attention in multi-display environments. The first step to design PAI is identifying the amount of attention per devices and tasks. Therefore, this paper introduces the concept of breakpoint the moments of task switching into modeling attention. In addition, this paper identified users' fine breakpoint through the data gathered from diverse built-in sensors of devices, an eyewear device, and UI events. Through the eyewear device, we could detect more explicit breakpoints compared to previous studies that used only UI events to gather users data. The breakpoint drawn by our method enables to quantify the amount of attention relative to different devices.

Author Keywords
Pervasive attentive interface; Attention; Task Switching; Breakpoint; Interruption; Eyewear computing

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction

One significant characteristic of attention is that there is a limit when a person processes information gathered from all sensorium simultaneously using his (her) attention. Therefore, if a human faces information that exceeds the attention capacity, an attention bottleneck occurs [1]. Therefore, because the information affects as a stimulus, as the number of information human face increases, human got difficulties in keeping attention on one device.

Related Work

Many types of research tried to solve the attention problem using interactive user interface. To solve the attentive bottleneck, some made an attentive interface which lessens the required attention capacity by changing the information to make users easily switch the attention between the tasks and the devices [3, 5, 6]. To solve the attention interruption, some made an interactive interface which forces the user to focus on the main task [4]. However, these studies have limitations the simplicity of their system that does not reflect specific changes of human cognition. They only consider simple interactive features which just reflect physical information such as location, distance or viewing angle without the cognitive information of the user. As these limitations on users' cognitive information, Bulling [2] mentioned that as information and devices increase rapidly, we should move on to pervasive attentive interface which reflects the user's mental information such as cognitive load, free attentional capacity, or even boredom and it would optimize both the information throughput and subtlety. To apply the user's mental information on solving attention problem, we can use the moment of task switching, so-called breakpoint. Most of those research used the concept of breakpoint to find the right time to provide information to the users when they have affordable attention capacity [8, 7, 9].

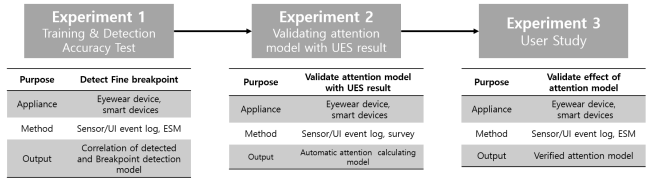

Figure 1: Research Process

Methodology

To apply the user's covert attention which cannot directly be manipulated by an overt physical information, we have to use cognitive information as a factor. Breakpoint, especially fine breakpoint, which can provide detailed covert attention information, is suitable as a factor of the attentive interface. However, there was no research about applying breakpoint on attentive interface. Therefore, in this paper, we use a fine breakpoint to modelling user's attention. Our paper can be divided into three part. First part is about building a fine breakpoint detector and its dataset for the multi-device environment. In this part we use an Experience Sampling Method to collect ground truth of user's breakpoint. Then, second part is to make attention model with breakpoint and other UI event data from devices. After building attention model, we validate it with User Engagement Scale. Last part is about applying our attention model on ordinary attentive interface and make it to pervasive attentive interface. To evaluate users' workload, we collected participants' gazing usage data during the experiment, and we collected respond of NASA-TLX at the end of each experiment. As a result, we could verify that our fine breakpoint detection is accurate and fine breakpoint is useful as a representative factor of user's cognition.

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