Intrusive Evaluation of Ambient Displays

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ABSTRACT

Ambient display is a display, which sits on the peripheral of user's attention. Currently, the research on ambient displays is still in initial stage, so few evaluation styles are available to evaluate ambient displays. Our previous research (Shen, Eades, Hong, & Moere, 2007) proposed two evaluation styles for ambient displays: Intrusive Evaluation and Non-Intrusive Evaluation. In this journal, we focus on the first style by applying two intrusive evaluation case studies. The first case study compares the performance of three different peripheral display systems on both large and small displays. Our results indicate there is a significant difference on a primary task performance and a peripheral comprehension task between large and small displays. Furthermore, we have found that distraction may be composed by display-distraction and self-interruption, and that animation may only influence the display-distraction. In addition, a measurement of efficiency derived from cognitive science is proposed. The second case study focuses on exploring the correct disruptive order of visual cues (animation, color, area and position). Our results show that the correct disruptive order of visual cues in ambient displays is: animation, color, area and position. Furthermore, we also revealed how display-distraction influences the comprehension of ambient display. In addition, this case study further amended the measurement of efficiency, which was proposed in previous case study, to improve its accuracy.

Keywords: Ambient Displays, Animation, Case Studies, Cognitive Science

INTRODUCTION

Human vision is composed of two parts: foveal and peripheral. Foveal vision has a narrow angle (around ten degrees) but supports higher visual acuity (Peripheral-Vision, 2006). In contrast, peripheral vision covers a wide angle but has lower visual acuity.

In the past thirty years, many research areas have dealt with foveal vision. Examples include information visualization and human-computer interaction, where almost all research concerns displaying information through foveal vision. On the other hand, few researchers have concentrated on the peripheral vision. The reason is principally that, until recently, a computer user typically had only one screen and foveal vision can cover a large proportion of this screen (see Figure 1).

Figure 1 shows a typical scenario for foveal vision with a single user and a fifteen inch monitor. The largest viewing angle in this scenario is about thirty degrees. The foveal vision of a single person can reach about ten degrees and the user can easily and quickly shift focus from

Figure 1. A typical setting for foveal vision
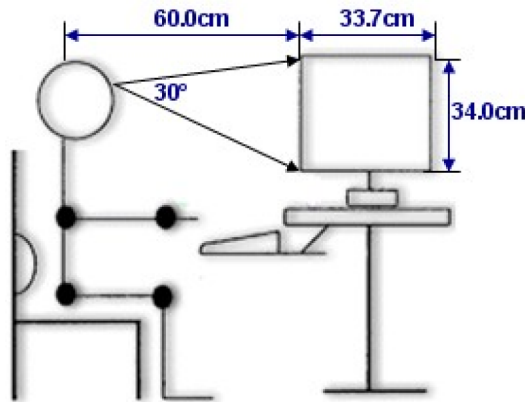
peripheral vision to foveal vision to cover the remaining twenty degrees.

The current trend in displays is to have bigger and bigger screens, but the price of such screens is decreasing. In the near future, the development of technologies (for example, E.INK and Flexible Displays (E.INK, 2006)) will enable information to be displayed everywhere. For example, information can be displayed on the walls, tables, curtains or even clothes. Holmquist and Skog (2003) points out that when information can be displayed on clothes, the computer designer will become a fashion creator. All these new techniques lead to a new world where foveal vision can only cover a small part of the display; this forces user to engage peripheral vision to retrieve, understand and remember information.

The importance of the peripheral vision to some extent comes from the ubiquitous computing dream. Weiser (1991) first defined a term "Ubiquitous Computing", which proposes a new research area in his journal "The Computer for the 21st Century". Weiser (1991) believes that "the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it".

Following his dream, many pioneers of ubiquitous computing have created a number of terminologies (for example, disappearing computing (Russell, Streitz, & Winograd, 2005), tangible computing (Ishii, 2002), pervasive computing (Hansmann, 2003), peripheral display (Weiser & Brown, 1996), ambient display (Wisneski et al., 1998), informative art (Redstrom, Skog, & Hallnas, 2000), notification system (McCrickard, 2006), or even ambient information system (Pousman & Stasko, 2006)). Streitz, Magerkurth, Prante, and Rocker (2005) even divides the Weiser notion of "disappearance" into two trends: *mental disappearance* and *physical disappearance*. Mental disappearance makes users feel that there are no computers, because they integrate into the real life environment smoothly. Physical disappearance actually shrinks the size of computer components (for example, using PDA to replace a normal desktop computer).

In this journal, the first trend of Streitz (that is, mental disappearance) to design and evaluate two ambient display case studies is followed.

RELATED WORK

Research on ambient displays is still immature, and thus there is no universally accepted definition available. Ullmer and Ishii (2002), Matthews et al. (2003), Mankoff et al. (2003) and Stasko et al. (2004) proposed their own

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