Dual Monitors Support Group Awareness in Multiplayer Computer Games[1]

Minh Hong Tran[+], John Craick[++], Yun Yang[+], Gitesh K. Raikundalia[+++, +]

[+]Centre for Internet Computing and E-Commerce (CICEC)
Swinburne University of Technology
{mtran, yyang}@it.swin.edu.au

[++]Swinburne Usability Laboratory (SUL)
Swinburne University of Technology
jcraick@swin.edu.au

[+++]Internet Technologies & Applications Research Lab (ITArl)
Victoria University
Gitesh.Raikundalia@vu.edu.au

Abstract

This paper reports our exploratory study that investigates the potential of dual monitors in facilitating multiplayer computer games (MCG's). We conducted a laboratory experiment of MCG's played with single and with dual monitors. Dual monitors were used to display awareness information about team players. Participants showed overwhelming interest in playing games with dual monitors. Overall, they found dual monitors useful in supporting their games as dual monitors facilitate team communication and stimulate informal communication.

Keywords

Dual monitors, awareness, multiplayer computer games, laboratory experiment

1. THE STUDY OF DUAL MONITOR GAMING

In recent years, multiplayer computer games (MCG's) have become one of the most growing communities on the Internet reaching millions of PC users worldwide. MCG's have become part of our entertaining culture, especially for teenagers (Aarseth 2001, Fromme 2003). Conventionally, most of current multiplayer games support only a single-monitor gaming mode. Many games even try to cram as much of the game's interface onto one screen as possible. Consequently, in some cases it is hardly to see the game for all the menus.

Dual monitors have been used in single-user environments including individual offices such as Kimura (MacIntyre et al. 2001) and InfoCanvas (Miller and Stasko 2001). The recent field study conducted by Grudin (2001) shows that dual displays are not used merely to provide additional space, but are more about structural workspace partition. That is, in a dual-display configuration the main monitor is often used to show a primary task while the secondary monitor is used for secondary tasks. His study shows that dual-display workstations make life a lot easier when dealing with everyday applications such as office programs, graphics, etc.

Today, almost all video cards (e.g., NVIDIA[2], Matrox[3]) provide a multi-display feature that offers simultaneous connectivity for two monitors. Also, prices of monitors have recently dropped enough to make dual-monitor environments affordable. We believe that many multiplayer games would benefit from a dual-monitor setup. Dual monitors allow a structural separation between primary information and secondary information in a game. The first monitor shows the main game activities as in the usual fashion, and the second monitor displays secondary information such as team communication and information about other team players. Taking Age of Empires[4] as an example, in a dual-monitor mode the ongoing game can appear on the primary monitor, while a large version of the game map and chat windows can be showed on the secondary display. This would significantly reduce the number of annoying and distracting clicking between windows.

Inspired by Grudin's study and the promise of dual-monitor gaming, we consider that it is worthwhile to conduct the study of MCG's with a dual-monitor setting. The purpose of this study is to explore the use of dual monitors in MCG's. We used dual monitors to display secondary information of the game; that is *awareness* information (Carroll et al. 2003, Gutwin and Greenberg 2002, Lai et al. 2002, Smith 2002) about other team players.

1.1. Multiplayer Computer Games

The experiment was conducted using two commercial MCG's of different genres: Counter-Strike[5] (CS) and WarCraft III[6] (WC3). CS is a first-person-shooter (FPS) game that features one team playing the role of terrorist

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[2] http://www.nvidia.com/

[3] http://www.matrox.com/

[4] http://www.microsoft.com/games/pc/age2gold.aspx

[5] http://www.counter-strike.net

[6] http://www.blizzard.com/war3/

and the other team playing the role of counter-terrorist. WC3 is a strategy game that requires players to lead their civilisation and to defeat the opponent in a military campaign.

1.2. Experimental Design

We conducted 2 pilot tests with 6 participants and 10 full test sessions with further 40 participants. Each full session involved 4 participants who were divided into 2 teams; each team was located in one test room and visually isolated by a large screen divider (Fig. 1).

Each participant was provided with one PC and two identical 17" monitors—a primary monitor that participants used to play the game in the usual fashion and a secondary monitor showing a cloned view of their team player's primary display (Fig. 2). A head-and-shoulders view of each participant was recorded using a Webcam mounted on top of the participant's primary monitor. This view was used to identify participants' pattern of use of their second monitor.

Fig.1: Monitor setting in one test room

Participants were recruited from the University, game cafes, online game forums, and word-of-mouth. All participants had played the two games for at least 6 months. In this study, we set no gender balance target and accepted volunteers as they came. Consequently, the final figure of 2 females and 38 males is unbalanced, but it may reflect the balance in the playing population for these games.

1.3. Experimental Procedure

We ran 5 full test sessions for CS and 5 for WC3. Each session lasted for 3 hours and was followed by a 1-hour interview. In each session, the two teams played an allocated game under 4 test conditions. In some conditions the secondary monitor was active and in others it was turned off. Since the length of one WC3 game was generally much longer than a CS game, averaging 30 minutes and 2 minutes respectively, different procedures were designed for the two games, as depicted in Table 1. After each test session, participants took part in a group interview. Since they had all shared the same activity in the game, we considered it would be useful to engage them together in the same interview. This allows us to interact directly with the individual participants and also allows them to react to and build upon the responses of other participants like a focus group situation (Edmunds 1999).

Fig.2: Dual monitors show different views

	S_{1-5}	S_{6-10}	S_n: the nth Session C_n: the nth Condition
Game	CS	WC3	CS: Counter-Strike WC3: WarCraft® III
C_1	00	00	Dual monitors 00: none
C_2	11	11	00: none
C_3	01	11	11: both teams 01: only team 2
C_4	10	11	10: only team 1

Table 1: Test conditions

2. RESULTS

The study overall yielded much data which we are still analysing. This section reports preliminary results from the 10 full sessions regarding trends of usage and beliefs (i.e., how participants used dual monitors).

2.1. Enjoyment of dual monitor gaming

Though the majority of participants had not experienced dual monitors prior to the experiment, their comments reflected the overwhelming interest in playing games with dual monitors. Most participants agreed that dual monitors created a new level of atmospheric immersion in the games. A dual-display mode made them more confident of playing the game especially with a real-time, updated view of what happening to other team players. Besides, participants responded that playing games in a dual-display mode is more challenging and interesting to some extent. Several participants would even consider adding a second monitor to their PCs at home.

2.2. Usefulness of dual monitors

Most CS participants acknowledged that dual monitors were very useful in supporting their game performance. They found themselves more confident when dual monitors were present because they were well-informed of the position and activities of their team players (e.g., where their team players were located in the game and what they were doing). Dual monitors were found useful at different stages of a game. For example, at the beginning of the game, participants always discussed their game strategy and assigned a role to each player. Dual monitors helped them to clarify the locations of team players. During the game, participants mainly used the secondary monitors to quickly identify the location of the other player and to maintain knowledge of other players (e.g., their health and weapons). Near the end of the game, dual monitors were used effectively to coordinate attacks.

Dual monitors were not reported as being useful in WC3 to the extent that they were in CS. At the beginning of the WC3 experiments before the game started, participants were really excited to know that dual monitors showed

their team player's screen and they believed that a dual-display mode would definitely be useful. However, when participants actually played a game with dual monitors, they tended to ignore the secondary monitor. In the interviews, more than 50% of participants responded that they did not use the second monitor much because the nature of WC3 required paying a lot of attention to the primary monitor (e.g., players were required to manage many units of different kinds, and to conduct many activities to gain game resources).

However, few participants reported that the secondary monitor was occasionally distracting them from their game. The secondary monitor drew their attention away from the primary screen. A common negative occurrence was that when participants spent too much time looking at the secondary monitor, they were eventually killed. Also, at some point in the game they were confused between the two screens, especially if they and their team member were in the same location and held the same type of weapon. This caused confusion as to which screen was actually the primary screen that they could control.

2.3. Navigational role of second monitor

The head-and-shoulders video also shows that participants frequently looked at the secondary monitors while talking to the other player. Participants used the second monitor to acquire a real-time understanding of the other player's interaction in a game. At that point, participants of the same team saw exactly the same view and were virtually sighted in the same game context. Team communication was, as a result, accomplished smoothly and accurately. In fact, in all experimental sessions, participants treated the second monitor as a navigator when they wanted to tell the other player about specific game objects and to guide the other player in what to do and where to go in a game. The occurrence that participants watched the same view while communicating was very similar to what happens in face-to-face collaboration, where people often look at the same document side-by-side while discussing it.

2.4. Physical layout of dual monitors

• *Second monitor relative to the primary monitor:* In the default setting, we aligned the primary and secondary monitors horizontally, and the secondary monitor was on the right-hand side of the primary monitor. During the sessions, participants were allowed to move the secondary monitor freely. We observed that in many cases, participants actually adjusted their secondary monitor to create an angle between the two monitors (Fig. 3). Although we have not yet identified the exact value of the most favourite angle, this finding raises interesting insights that should be taken into account when designing applications or hardware for dual monitors.

Fig.3: Layout of primary and secondary monitors

• *Second monitor relative to participants' primary hand:* Most participants wanted the second monitor to be on the side of their primary hand. 70% of the right-handed participants preferred the second monitor to be on the right-hand side of the primary monitor; and 60% of the left-handed participants preferred the second monitor to be on the left-hand side of the primary monitor. In the interviews, participants responded that the games required using both hands to play—the primary hand to control the mouse and the other hand to operate the keyboard. The second monitor was preferred to be on the side of their primary hand (i.e. the side of the mouse) because when playing a game participants did not want to look across their secondary hand that controls the keyboard.

2.5. Simplification of verbal communication

In a dual-monitor mode, participants were more aware of the context in which the other player was situated. We want to bring in Dourish and Bellotti's (1992) explanation of content and character to explain what dual monitors were able to provide. Dourish and Bellotti argued that it is vital to consider as context not just the content (i.e., the precise location of a player and surrounding objects in the case of MCG's), but also the character (i.e., the direction of a player's view in the case of MCG's). The views shown on dual monitors were able to provide participants with awareness of both content and character aspects. That allowed participants to make sense of the other player's activities and, as a result, only short verbal expressions would be required when exchanging messages. Based on the observation notes and recorded videos, we noticed that in a dual-monitor setup, participants used shorter verbal expressions to convey their ideas and asked fewer clarifying questions like "Are you behind me?", "Where are you?" or "Can you see me?", compared to when dual monitors were not used.

2.6. Encouragement of informal communication

We observed that when dual monitors were available, the content of verbal communication between participants of the same team was different, in fact richer than when dual monitors were not used. This was due to the fact that participants knew more about the other player's activities when playing in a dual-display mode. In addition, since dual monitors were able to simplify group verbal communication, participants could quickly talk about various aspects of the game like their health, weapons, money or a specific incident that had happened to one of the players. Such factors were only discussed briefly when necessary in the single monitor experiments. Not only
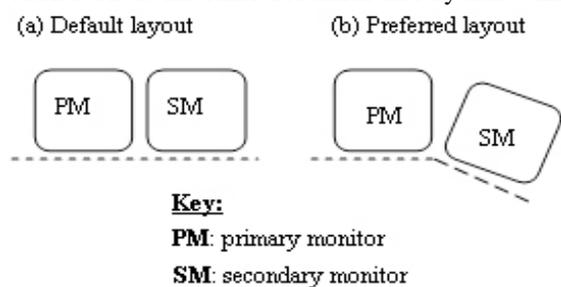
are these factors important performance-related aspects of the game, but they also play a vital role in stimulating informal communication in a game.

2.7. How Participants Adapted to Dual Monitors

We are also interested in knowing how participants adapted themselves and their game strategies to a dual-monitor gaming environment. Although this is not the main focus of this paper we will discuss it briefly. It was instructive to listen to participants' accounts of how they learnt to adapt themselves to the dual-monitor setting. The majority of participants had not previously played games with dual monitors. Thus, it was unsurprisingly that they adopted a range of different approaches in making use of dual monitors. Some participants forced themselves to use secondary monitors. That led to the fact that they spent too much time viewing the secondary monitor on which appeared their team player's screen. As a result, they lost their focus on the game and missed out events happening on the primary display. Then, participants tried to avoid watching the secondary display so that they could pay more attention to the primary monitor. In those cases, dual monitors were found disruptive as they shifted participants' focus away from their own roles, and consequently their performance was impaired.

• *Highly experienced players adapted to dual monitors quicker than less experienced players*: The participants' learning curve depended on their previous game experience: the more skilful a participant was, the faster they became accustomed to the dual-display setting. For skilful players, their good understanding of the game could allow them to take their eyes off the primary display for a quick glance at the second monitor.

• *Adaptation was game dependent*: As mentioned before, WC3 and CS are two very different games; they represented two different tasks in our study. The difference between the two games led to the difference in participants' adoption of dual monitors. It appeared that the CS participants adapted to the dual-display setting faster than the WC3 participants. That would partly explain the previous finding (as reported in Section 2.2) that in the CS game dual monitors were generally more useful in providing shared awareness than in WC3.

3. CONCLUSIONS

This paper has reported our study of dual monitors in supporting multiplayer computer games. Dual monitors were set up to separate structurally the peripheral awareness display from the primary display. We found that: (1) participants really enjoyed dual-monitor gaming; (2) dual monitors were generally reported by participants as being useful in supporting their games; (3) dual monitors played a supportive role in simplifying verbal communication and in stimulating informal communication; (4) participants also found dual monitors useful in supporting tightly-coupled coordination; (5) the secondary monitor that displays peripheral awareness information is preferred to be on the side of the user's primary hand.

As future work, further quantitative data analysis will be carried out. We will focus on analysing the correlation between different experimental variables such as the presence of dual monitors and game scores, and the participants' familiarity with dual monitors.

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