To Virtualize or Not? The Importance of Physical and Virtual Components in Augmented Reality Board Games

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Abstract. Whereas traditional games have employed entirely physical interfaces, computer games provide a generally virtual alternative. Motivated by interest in supporting conventional gameplay in the computer environment, we investigate the benefits of game interaction techniques based on gestures applied to tangible objects, comparing the user experience with that resulting from more virtualized interaction. Our study is applied in the context of a basic roll-and-move game and German-style board game, Settlers of Catan. User preferences and quality of player interaction, revealed through our experiments, suggest a number of important design factors relevant to the decision of digitization for game interface components. Significant findings indicate a preference for tangible components for complex interaction tasks.

Keywords: Augmented Reality, Tangible User Interfaces, Augmented Gaming, Multi-user Interaction

1 Introduction

Computer games can be extremely powerful and dynamic, simulating complex physical environments, modeling situations that are impossible in real-life, and taking on the role of either moderator, intelligent opponent, or both. Moreover, the computer can automate repetitive, mundane tasks such as shuffling, point-counting, and memorizing rules, factors that may detract from the enjoyment of certain games. Despite their design flaws, computer games have thus been highly popular for several decades, and for many players, a preferred alternative to traditional board games. In the computer domain, input devices such as keyboards, mice, and hand-held controllers were until recently the norm, substituting the natural interaction techniques from the physical world with often arbitrary mappings to complex game actions such as lifting and throwing objects.

We are interested in the impact of interaction techniques on the success of different forms of games, in part to learn whether this explains the success of gesture-based

platforms, but more significantly, in the hopes that a better understanding of these issues can inform the design of games that appeal to even wider audiences.

2 Related Work

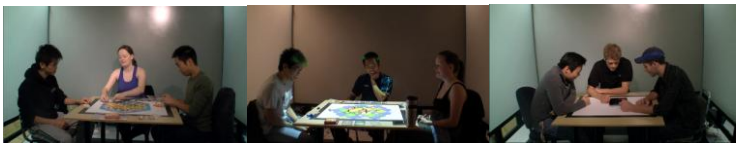
As an alternative to both traditional board games and purely computer-focused video games, hybrid board/video games offer the potential to enhance the social gaming experience of the physical world with the benefits of computer augmentation. This is typically achieved by a tangible user interface (TUI) paradigm, which couples physical game pieces to the computer through some sensing mechanism. Using these pieces as input devices that afford manipulation, spatial reasoning skills can be exercised while parallel operation and collaboration is supported between single and multiple users (Fitzmaurice, Ishii, & Buxton, 1995) (Underkoffler & Ishii, 1999). In addition, augmented or mixed reality techniques can provide real world interaction in a more integrated manner than can a pure video game. Typically, graphics are projected into the same space where the tangible interfaces are used, e.g., on a table. The combined interaction-display format of tangible user interfaces with augmented reality, or Tangible Augmented Reality (TAR) (Billinghurst & Kato, 2002), enhances face-to-face communications of multi-player games, while allowing players to interact in a natural manner. This idea of merging pre-existing, everyday knowledge with digital interaction techniques arises from the Reality-Based Interaction (RBI) framework, which provides techniques for analyzing and comparing components used for this style of interaction (Jacob, et al., 2008).

3 Experiments

Within this RBI framework, we designed a TAR system to investigate the important question of whether tangible or digital components are preferred in social gaming situations. In general, we believe tangible components will be favored due to their affordances for natural interaction. Digital equivalents may be considered if they greatly improve efficiency and ergonomics, or decrease cognitive load. From a gaming perspective, computerization should be used to reduce the number of fatiguing or menial tasks and provide passive assistance such as organization and notification in strategic situations. Our hypothesis is that non-strategic (or "set") actions such as game setup and piece sorting will favor automation through virtualization. Moreover, for situations where strategy or multi-player interaction is required, we expect that tangible objects will be preferred due to their assistance with planning through spatialization (Kirsh, 1995) (Kirsh & Maglio, 1994) (Patten & Ishii, 2000) and support of parallel actions between multiple people (Fitzmaurice, Ishii, & Buxton, 1995). To test this hypothesis, we designed a Settlers of Catan TAR prototype that facilitates the use of tangible objects in addition to automating and assisting players on low-cognition tasks. Traditionally, Settlers is a multi-player strategy game that involves cooperation, negotiation, and logic.

3.1 Settlers of Catan Prototype

The comparison study for Settlers of Catan is presented on the classic board game version, our developed TAR version, and a digitized version on the Apple iPad. As we move from the classic to the digitized version, the number of tangible components decreases as the amount of automation and rule enforcement increases. Fewer rules are enforced when tangible components are present to accommodate rich object manipulation techniques. For tasks where no tangible handle is available, computer automation and rule enforcement are used to guide and inform the player of the actions available.



(a) (b) (c)

Fig. 1: Settlers of Catan Classic, TAR, and Digital mode.

3.2 Design

The experiment comprised the three conditions as described above. Our subject pool consisted of nine participants, two female and seven male, ranging from 23 to 30 years of age. The participants were randomly assigned to one of three groups of three players. The groups were presented with every condition, with each group experiencing the conditions in a different order. A modified Latin square was used where each condition appeared in every slot of the ordering. The post-test questionnaire was completed immediately after each gameplay session. Once all three conditions were complete, players were asked to choose what they considered to be the best overall condition. The post-test questionnaire was comprised of questions from FUGA's Game Experience and Social Presence in Gaming Questionnaire (GEQ and SPGQ) (de Kort, IJsselsteijn, & Poels, 2007) (IJsselsteijn, et al., 2008) and O'Brien's User Engagement Scale (O'Brien, 2010).

4 Results and Analysis

The questionnaire was comprised of two high level categories: personal game experience and social experience. These reflect the single-user experience and between-player experience, respectively. One or more questions make up each of the listed sections in both personal and social game experience.

The responses within each category were averaged to form the associated mean score, as shown in Table 1, separated by subject and condition for analysis. As seen, the TAR condition was rated the highest most frequently in the questionnaire, an overwhelming preference that was also reflected in the qualitative feedback. All

players chose TAR as their favorite condition in the final questionnaire. In general, players found tangible components essential for complex interaction tasks such as negotiation and resource trading. At the same time, players preferred the efficient, automatic board setup for its organized presentation where the board components could not be disrupted. The computer-assisted task of illuminating dice rolls was also desired because it located and reminded players to collect resources.

Questionnaire Results			
Section	Mean		
	Classic	Digital	TAR
Personal Game Experience			
Perceived Usability	3.04	2.11	3.59
Aesthetics	3.94	3.56	4.28
Focused Attention	3.67	2.89	4.44
Sensory and Imag. Immersion	3.78	2.94	3.83
Endurability	4.33	2.83	4.50
Negative Affect	2.78	1.78	3.00
Positive Affect	4.17	3.28	4.50
Social Experience			
Empathy	3.33	3.19	3.83
Negative Feelings	3.37	3.22	2.96
Behavioural Involvement	3.85	3.26	3.89

Table 1: Mean score averaged over all subjects.

5 Conclusion

The study described in this paper tested different implementations of Settlers of Catan to determine the appropriateness of digitizing various physical elements commonly used in board games. Our approach in this regard is to retain tangible components used for making strategic choices while digitizing pieces used for simple, mundane tasks such as the ones required for board setup. These qualities resulted in the TAR condition being the highest rated in many portions of the survey and unanimously chosen by players as their favorite. Preference of tangible components over digital equivalents for complex interaction tasks such as card trading was demonstrated by the significant differences between the virtual and tangible (identical in both classic and TAR) conditions in many areas of the questionnaire.

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