The Art Collector: An Accessible and Adaptable Augmented Tabletop Art Quiz

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Abstract. Ambient Intelligence and Mixed Reality, through the integration of digital and physical augmented artefacts as interactive objects, are radically changing the landscape of computer games. Research is exploring these possibilities in a number of directions, including traditional tabletop games. This paper aims to bring innovative MR game technologies to the cultural heritage sector. Art Collector is an augmented tabletop game that transfers a traditional quiz to the augmented digital world. The game can take different instantiations through a map creation approach, while important playing actions such as throwing dices and moving pawns are performed in the physical world. The game employs UI adaptation to cope with the needs of a diverse user population. In the case of children, content adaptation is employed to support content and quiz presentation aligned with the characteristics and knowledge of each user group.

1 Introduction

Ambient Intelligence (AmI) presents a vision of tomorrow where 'intelligent' environments react in an attentive, adaptive and active (sometimes proactive) way to the presence and activities of humans and objects in order to provide appropriate services to the inhabitants of these environments [9]. AmI moves forward from traditional interaction techniques to altering interaction itself. In this context, Mixed reality (MR) refers to the merging of real and virtual worlds to produce new environments and visualisations where physical and digital objects co-exist and interact in real time [8]. In this novel interaction environment physical objects loose mass while part of them is transferred to the digital world, but at the same time their shape, texture, and weight is still considered an important aspect of their existence. This paper explores the exploitation of MR opportunities in the cultural heritage domain, and especially in the field of educational games for all age groups and abilities. Art Collector is an adaptable augmented tabletop game based on a knowledge base of visual arts, which employs state of the art technologies in the domain of multi touch interaction and physical object recognition.

2 Background & Related Work

MR refers to the merging of real and virtual worlds to produce new environments and visualisations where physical and digital objects co-exist and interact in real time [8]. MR in the context of gaming has focused both on developing frameworks for the development of tabletop collaborative games and on the actual development of games that combine augmented tables together with mobile devices [1]. RFID technology has been proposed for the creation of mixed reality games which allow the existence of various augmented physical objects in the game's space [2].

Games that are designed to be played in an ambient environment often employ MR as a means of merging virtual and physical worlds. Examples of such games to date include: (a) Virtual Hockey that is based on the HI-SPACE's framework [3] is a fast paced, two-person game that combines aspects of an air hockey table and pinball, (b) KnightMage on the STARS platform implements a basic set of rules for medieval hack'n slash style role-playing adventures and (c) Monkeybridge [4] is a multiplayer game, where users place real and virtual objects on a physical surface, thus influencing the behaviour of the characters.

Regarding game adaptation research has employed computational intelligence techniques to build quantitative models of player experience that could be explored in the context of dynamic adaptation and personalization of gaming experiences [10]. Furthermore in the domain of game content generation the execution of evolutionary and other metaheuristic search algorithms has been also explored [11].

This paper presents an approach offering: (a) game development based on a generic knowledge base for cultural heritage, thus providing dynamic game generation allowing players to experience the game differently each time, (b) UI adaptation to support the needs of diverse users including children and (c) scalability and extensibility.

3 Art Collector's Design

The main concept behind the design of Art Collector was the creation of an augmented table top quiz game playable by up to four players regardless of their age. Additionally, two main requirements were also specified prior to the conduction of the UI design of the game: (a) the integration of physical objects to offer MR alternatives to the objects used in traditional table top gaming and (b) the use of a deployment hardware in the generic form of an interactive table surface.

Art Collector presents a map of a country or a continent as it was during a specific art period (for example Europe during Renaissance, modern Europe, etc).A track is presented on this map passing from the main focal points of the specific period. The interaction with players is carried out through (a) augmented dices, (b) augmented player pawns, (c) on-board touch screen controls, and (d) speech recognition. Each player throws the dices and the system based on the location of the player's pawn and the type of pawn used (for example, specific pawns may be linked to specific age groups) generates questions that are related to the specific art period and location on the game map, and are personalised to the user's specific profile as identified by the

pawn. Correct answers allow the player to continue by re-throwing the dices while wrong answers pass the turn to the next player. The player who manages to move his pawn to the finishing line first wins the game. An indicative game board is presented in figure 1 (left), while the same figure (right) presents the game rendered on an interactive table-top surface (Samsung SUR-40).

Several adaptations are supported by the game for players with disabilities. When no touch interaction is feasible, game rendering is performed automatically for the player, while physical objects are replaced with digital ones. Answering to questions takes place using speech recognition. This is also the case with severe visual disabilities. For other cases of mild visual disabilities such as reduced visual acuity, cataract, etc., UI adaptation is employed to fine-tune the presentation of the game. Such adaptations include font resizing, UI and text colour optimisation, transparency removal, scaling of control elements and question prompting, etc.

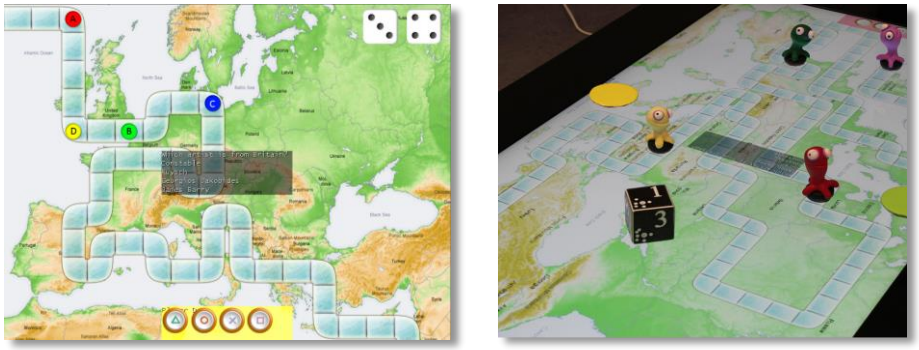

Fig. 1. The "ArtCollector" prototype (left: An example game map loaded to the game, right: The map rendered on a Samsung SUR-40)

The design phase was conducted through a series of low fidelity prototypes, initially created using paper based medium. After this phase, the second UI prototyping phase was conducted using digital media. Several UI prototypes were created focusing both on defining the means of user interaction and on identifying potential functional and accessibility requirements of the game. From these prototypes the ones that integrate the majority of the functionality on a single UI screen were selected in order to cope with the increased requirements for accessibility. This option was also preferred so as to resemble as closely as possible the setup of traditional table-top games.

After selecting a set of design prototypes, heuristic formative evaluation was used for evaluating them in terms of usability. Thirteen issues were identified in total, five of which were marked as major usability problems. These issues have been addressed to form the final UI prototypes.

The AR objects created and used for Art Collector include pawns, dices and player identifiers. Two variations of pawns were created: one set for children and another one for adults. These variations together with alternative game maps are used to adapt Art Collector to: (a) the age of its players, allowing also mixed games between adults and children, and (b) the accessibility requirements that users may have. Pawns are hand-crafted using polymer clay [5]. For the dices stretch balls in the form of cube

were used. All these objects were tagged using byte tags provided by the Microsoft Surface SDK [6].

4 Discussion & Future Work

This paper has presented an approach the development of accessible and adaptable augmented educational table-top quiz games. Art collector features an innovative approach to the model based dynamic generation of quiz games together with advanced UI adaptation and content personalization facilities. Based on these prototypes, the first working demo of the game was developed and is currently deployed in a simulation space at the FORTH-ICS Ami facility [7]. Recently, Art Collector has drawn the attention of local authorities visiting the Facility, resulting in the deployment of the game in the context of the renovated Vikelaia public library of the Municipality of Heraklion in the near future.

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