Multidisciplinary Experience in the Creation of Pervasive Games for Interactive Spaces

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Abstract. In this article, a multidisciplinary experience with designers and developers to create pervasive games prototypes for an Interactive Space is presented. The Interactive Space, in which the experience took place, and the toolkit that the developers used in order to implement the games are explained. The different sessions with designers and developers are also described in detail, together with the game prototypes that resulted from the experience.

Keywords: Pervasive games · Interactive spaces
Multidisciplinary experience · Design

1 Introduction and Related Work

Since Weiser first post-WIMP discussion [1], designers of interactive applications are showing a growing interest in creating interfaces that integrate physical manipulation with interactive surfaces and responsive spaces that embody digital information. This is being reflected in the emergence of Interactive Spaces (IS) [2]: Distributed User Interfaces supporting several ways of interactions in digitally augmented rooms. Initially, ISs have been applied to explore new possibilities of collaborative work and meeting rooms [3] but more recently they are being considered as the ideal environment for the creation of pervasive games [4], since IS offer new possibilities to digitally augment the traditional game: on the one hand, ubiquitous technologies embedded in IS allow the identification and tracking of the physical playing pieces as they are manipulated by players; on the other hand, these technologies also allow the system itself to "intervene" in the play space. This is the case of pervasive games, an emerging field in the computer entertainment area that aims to eliminate the gap between traditional games and videogames [5].

During the last years an increasing number of projects and prototypes of pervasive games in ISs [6–8] can be found. However, the progress in the development of pervasive games is slowing down because of the multiple challenges that this kind of games brings to both designers and developers, due to the great variety of interaction paradigms that this kind of games involve and the difficulties of developing applications where so many innovative technologies converge.

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In this work, we describe an experience that was carried out with designers and developers in order to create pervasive games for an IS. In Sect. 2 we briefly present our IS. Section 3 presents the software toolkit created to facilitate the prototyping of pervasive games. Section 4 covers the experience that was carried out together with the games that resulted from it. Finally, Sect. 5 is devoted to conclusions and future work.

2 The Juguemos Interactive Space

Our IS consists on a room of 70 m^2. Embedded on it there is a set of sensor devices that allow different ways of interaction: **four tabletops** for tangible interaction, **three Kinect sensors** for gesture interaction, and **a Real-Time Localization System** (RTLS) for embodied interaction (see Fig. 1).

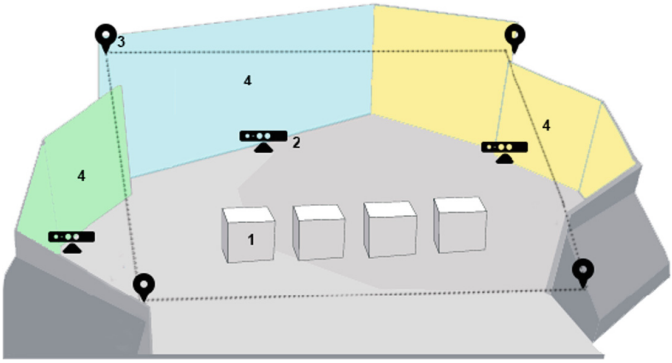

Fig. 1. Interactive Space schema. 1: Tabletops; 2: Kinect; 3: RTLS 4: Video projection on walls.

Regarding the display technologies that are integrated in the IS, there are three video projector screens that cover the surrounding walls, tabletop devices display images on their surface, and audio feedback is provided on all the IS area and on each tabletop device.

This is our current IS configuration, but it is quite flexible and new devices can be added and integrated at any moment as required by the specific pervasive game. This is possible thanks to a software toolkit that has been also developed in parallel, and which is presented in the next section.

3 The Juguemos Toolkit

The Juguemos toolkit has been designed to make it easy the prototyping of applications for IS. It is based on a centralized network architecture in which a software **Broadcaster** is connected with the host application and with each of the hardware devices integrated in the IS (see Fig. 2).

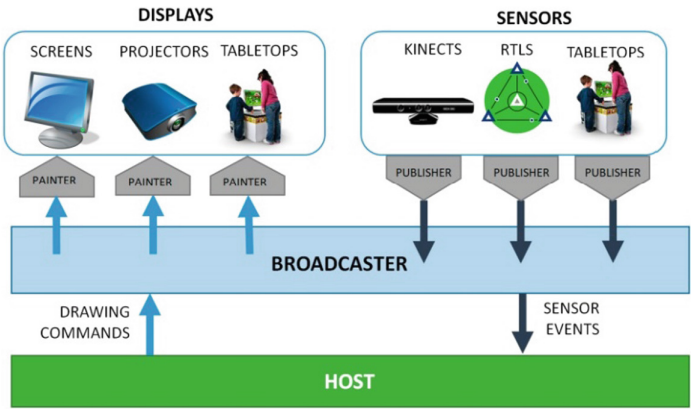

Fig. 2. Schema of the toolkit architecture

Each display device has associated a software process (**Painter**) in charge of painting visual information or playing audio streams in the specific display device, and each sensor device has associated another software process (**Publisher**) to deal with the specific hardware issues of the corresponding device. All devices of the IS are connected to a local network by Ethernet or Wifi. The broadcaster keeps an UDP network socket with each Publisher and with the **Host**, the application in charge of managing the game logic.

4 A Multidisciplinary Experience to Create Pervasive Game Prototypes

Juguemos IS and toolkit have been designed to provide multidisciplinary teams of designers and developers with the adequate tools to foster collaboration and creativity during the ideation, design and prototyping processes of innovative pervasive games [9]. To prove their usefulness, an experience with a multidisciplinary team was carried out in the IS.

The team was composed of five Graphic Design students of the 4th year at the School of Arts in the University of Plymouth (UK) and six Computer Engineering students of the 4th year at the School of Engineering and Architecture (EINA) of the University of Zaragoza (Spain). Neither of them had previous experience on ubiquitous technologies or on the prototyping of pervasive games. The experience was organized in four different sessions that are explained in the following subsections.

4.1 First Session

The six Computer Engineering students attended to a 3 h practical session in the Juguemos IS so that they could familiarize with the ubiquitous technologies involved and with Juguemos toolkit. Each student had to follow a guided exercise in which they had to complete a simple pervasive game by using the Juguemos toolkit. The exercise

was divided into four tasks with increased complexity that had to be completed in order to progress to the next one. Only two students completed the last task in three hours, but the main concepts and skills required to prototype a pervasive game in our IS using our toolkit were successfully transmitted to all students, as it was demonstrated in the fourth session.

4.2 Second Session

We organised a 2 h session in the Juguemos IS with the five Graphic Design students. They were introduced to the physical affordances of the ubiquitous technologies integrated in the IS, in order to bring physical interaction to pervasive games. We also showed them different examples of pervasive games developed for our IS.

4.3 Third Session

The third session lasted 3 h and took also place in our IS. This time both computer engineers and design students worked together (see Fig. 3 Left). The eleven participants were disposed in two groups of 5 and 6 people respectively: 2 designers and 3 developers in one group, and 3 designers and 3 developers in another group. The designers were the ones in charge of thinking about the game concept, to choose the interaction paradigms that were going to be used, and to create the graphic resources of the games. Accordingly, the developers listened to the designers' ideas to decide if they were feasible to be developed using the Juguemos IS technologies and toolkit. The ideas that the two groups came up are:

1. **Car races** (group 1): From the start they decided that they wanted to do a car race game for four players, by making the most of the four tabletops of the IS. The group defined the interaction creating two physical objects to control the direction and the velocity of the car. Both designers and developers had many doubts about the physical affordances of the tabletops despite of the explanations of the previous sessions, so it was necessary to show them practical examples so that they understood what kind of interactions the tabletop supported.
2. **Building a car** (group 2): originally, the idea was to make a construction game, without defining yet what was going to be built. The first idea was to build a house but the designers were having many doubts about the pieces that were going to compose it, so they eventually decided to build a car after hearing the concept that the other group had come up with. After some group discussion, the group chose to create a gesture interface based on the Kinect sensor.

At the end of the third session, two perfectly defined concepts of games had been created and the required graphic assets were also developed by graphic designers (see Fig. 3 Right). Since this was going to be the last session in which the designers were going to be present, they gave us their opinion regarding the experience. They all agreed that they have learned about the possibilities of the tangible user interface design, and that they would be interested in continuing working with the Computer Engineering students.

Fig. 3. Different moments of the third session. **Left**: multidisciplinary discussion of concepts. **Right**: graphic designers generating graphic assets with the technical supervision of developers

4.4 Fourth Session

The last session was carried out just with the Computer Engineering students. Neither of them had any particular difficulties to integrate the different sensors necessary for their concept (tabletops for the first group and Kinect for the second group). Figure 4 shows the developed games running in the IS. In the "Car Races" game, players use the tabletops to drive their respective cars with two different objects that control the car's velocity and direction (see Fig. 4 Left). Regarding the "Building a car" game, players use their hands to "grab" the car pieces that appeared on the projection screen to "put" them on their corresponding place of the car shape (see Fig. 4 Right).

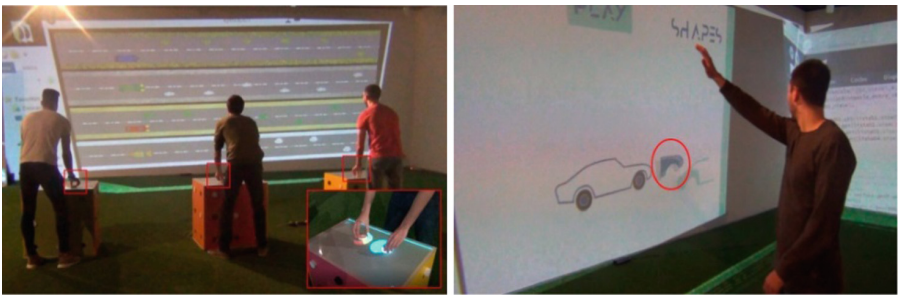

Fig. 4. Pervasive games created. **Left**: car races. **Right**: build a car

As a result of this last session, both groups managed to implement completely functional prototypes of the games in three hours. Videos of each concept were recorded and sent to the design students in Plymouth, who showed their satisfaction when seeing their concepts running.

5 Conclusions and Future Work

In this work we have presented a multidisciplinary experience that took place between Graphic Design and Computer Engineering students to create pervasive games. The experience took place in an Interactive Space, equipped with several sensors and

displays, and with a toolkit developed to make the coding of pervasive games easier. Both multidisciplinary groups were able to come up with a functional prototype of an IS game. However, this was possible because the ideas presented by the designers were supported by the IS existing hardware: if different physical interactions had been proposed, the complexity would have notably increased, since the design and implementation of applications that include ubiquitous technologies keep being a challenging task that requires advanced qualifications and supporting tools.

Regarding future work, we plan to carry out a more exhaustive and lengthy iterative design experience to see how the space and the toolkit support creative multidisciplinary cooperation in the design of pervasive games.

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