SoilGolf: a mixed reality game for the World Soil Museum

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Abstract

SoilGolf is a mixed reality game for educational purposes. The design integrates the subject matter (soils as a resource for life) with features of a virtual golf course into an engaging outdoor activity in the real world using geo coordinates. We tested the design of the game with two techniques and evaluated their usefulness for the development of games. Some technical difficulties in implementation are discussed.

1 Introduction

The World Soil Museum, owned by ISRIC-World Soil Information, has recently moved to a new building located at the Wageningen University campus [1]. The museum's mission is to demonstrate the importance of soil as our life support system and to exhibit the wide range of soils in the world with their different properties and management requirements to the general public.

The World Soil Museum was interested to explore the use of interactive technologies to engage visitors directly before or after a visit to the museum. Although the museum is open to the general public, most visitors are school pupils, university students, and (international) researchers.

Together with the Team Spatial Knowledge Systems of Alterra, Wageningen UR, the idea was launched to develop a game that would appeal to a young audience, extend the length of their experience at the museum, and highlight the monoliths as main elements of the museum collection. The next paragraphs describe the design and testing process and the resulting design of the SoilGolf Game. We assess the usefulness of two evaluation techniques appropriate in the design phase, the think-aloud method and the playtesting technique.

Figure 1: The interior of the World Soil Museum in Wageningen.

Figure 2: The World Soil Museum on Wageningen campus.

2 The design process

The design process took place in a small team which allowed a flexible strategy. First, we determined the expectations of the World Soil Museum about the users and their experience of the game. Next, the designer of the team presented a number of different concepts meeting these expectations. The museum selected one concept for further elaboration. After analysis of the user requirements for this concept, the gameplay and screens were created. We assessed the gameplay with the playtesting method using real props [5], and the design of the screens using the think aloud method [9]. The game design contains a number of important technical challenges which might complicate the implementation. To assess their feasibility, a software developer developed partial prototypes. These are however outside the scope of this paper.

2.1 Determining the game requirements

The World Soil Museum recently redesigned its exhibition. It displays a unique collection of soil monoliths, which forms the nucleus of the museum collection. A soil monolith is a vertical slice of soil preserving a soil's colours and layered horizons in position. To enhance the visitor's experience and engage them more deeply with the topic, the museum offers new, visually attractive interactive displays that put the monoliths in context (Figure 1). These explain the relevance of soil to modern-day global challenges such as food production, biodiversity and climate change, and provide background for the soil monoliths that are on display. The first requirement for the game was to use new technology to continue the look and feel of the exhibition. Secondly, the game should appeal to young people, especially first year students of Wageningen University, who visit the museum in the context of their study programme. Moreover, the game should prolong the visit to the museum; by its originality make the visit more memorable; introduce or repeat some of the important themes, and offer some physical activity, preferably outdoors. Player experience goals were defined broadly, as engaging, challenging (but doable for every player), and creating interest in the topics of the soil museum.

2.2 Target users and their demands

To understand the preferences of the target user group, we used the so called Persona technique. Personas are descriptions of persons that are representative of a typical, desired, user group. The description includes for instance interests, computer skills, and knowledge of the domain. Once created and made believable and appealing with photos, Personas facilitate communication in the development process. As Pruitt & Grudin explain, without Personas, teams routinely make decisions about features and implementation without recognizing or communicating their underlying assumptions about who will use the product and how it will be used [8]. Personas help to focus attention on a selected audience, and prevent developing an application for a vague user group or 'everyone'. They make implicit assumptions on users visible; steer choices (prioritize specific requirements) and support evaluation and assessment of the product.

The Personas developed for the World Soil Museum game were especially useful for determining the gaming interests of the target user group, and the types of mobile devices and smartphones they own.

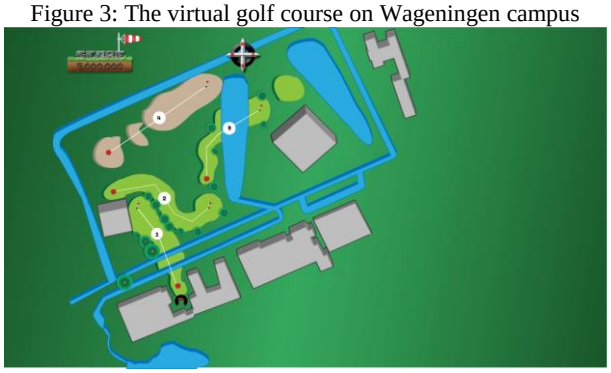
2.3 Mixed reality games

The World Soil Museum wanted a game that involves a pleasurable outdoor activity and at the same time creates more interest for the themes presented in the museum exhibition. A mixed reality game was expected to provide the best opportunities to achieve these goals. A mixed (or hybrid) reality game is a game which takes place in both reality and virtual reality simultaneously. Bonsignore et al. define mixed reality games as "goal-directed, structured play experiences that are not fully contained by virtual or physical worlds [3]. They transform existing technologies, relationships, and places into platforms for gameplay."

2.4 Design of the SoilGolf game

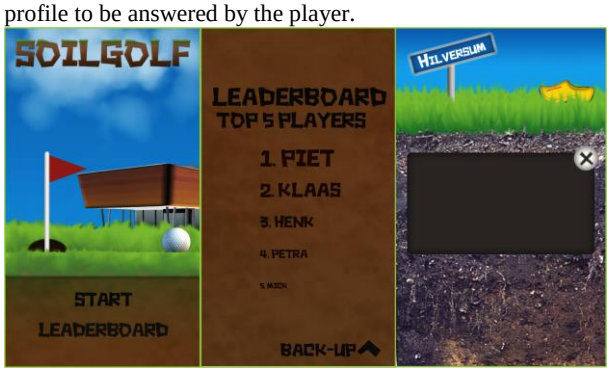
Of the ideas developed by the team's designer, one was selected for further development. The gameplay of this design is based on golf. Players hit a virtual golf ball with their smartphone over a virtual golf course, which is projected on their smartphone overlying a part of the university campus on which the museum is located (Figure 3). The course consists of four holes. Each hole and its surrounding area (fairway, putting green) represents a different area of the Netherlands, that shows distinctive geographic and geological features, and has a distinctive soil profile.

Figure 3: The virtual golf course on Wageningen campus



The score is determined by the number of strokes the players need to reach the hole, and the number of questions, related to the soil profiles of the museum, they answer correctly (Figure 4).

Figure 4. Screenshots of the SoilGolf game. The text box on the third screen contains a multiple choice question on a soil profile to be answered by the player.



While playing, the player's position is located through the GPS of the smartphone. Also the location of the virtual golf ball is georeferenced after every stroke. The player is directed to the location of the golf ball by the device using the GPS. When (s)he is near one of the four holes, the display shows a 3D representation of the environment. This 3D environment shows the real environment, including the buildings on the campus, but also added elements that belong to the specific area in the Netherlands. The soil profile becomes visible when the ball descends into the hole. Figure 5 shows a 3D model of one of the buildings on the campus, and a windmill in a cartoon style, matching the overall design of the game.

The screens were created with Photoshop, to which

animations were added in Flash. The 3D models were created with Autodesk 3Dsmax. For the virtual golf course Illustrator was used.

Figure 5. 3D models developed for the game, showing a building at the campus (top) and a windmill added to the virtual representation of the golf course.

The accelerometer in the phone measures the speed and direction of the stroke. The number of strokes required to hit the ball into the hole determines the score. Moreover, with every stroke that is unsuccessful, the player must answer a question relating to the exhibition of the World Soil Museum. When the player hits the ball into the hole, (s)he must answer one final question on the soil profile shown when the ball has descended into the hole.

2.5 Using smartphone sensors

Currently accelerometers, gyroscopes, compass sensors, cameras and GPS receivers are integrated in smart phones at reasonable costs, size and battery life. Each sensor has its own strength and weaknesses, but a close integration may enhance the total performance. Accelerometers commonly find usage as acceleration and tilt sensors but because they cannot distinguish between motion by gravity or human movement, a combination with gyroscopes provides better motion-based sensing. To compensate for the relative output from gyroscopes, compass sensors are used to provide absolute heading using as known reference the magnetic north. Motion processing software allows integration between the sensors in determining the movements of the device.

For the SoilGolf game the GPS receiver detects the location and motion of the player. In theory the sensors of a smart phone should be able to support the other functionality needed for the game. However from the first explorations carried out, we realized the game requires more complex aspects of motion detection. For example, we must somehow determine the impact of actually hitting a golf ball, since the ball is virtual and no real impact can be detected by any of the sensors.

Other cases show that technical developments are taking place very rapidly, and we expect to solve these problems in the near future. We mention just a few examples, related to transportation and CO2 footprint [4,6], monitoring of human behavior [7], and human health [2].

3 Testing the prototype and gameplay

Developing the game with the required functionality and 3D environment requires a considerable budget. Therefore, any testing possible in the earliest phases is important.

We decided to use two different methods for testing. For evaluating the graphics design and the interface we conducted the think aloud method using a sequence of screen shots, followed by a few specific questions on the interface design. We assessed the appreciation of the game play with the playtesting method, using (physical) props as substitutes. Three students, considered representative of the target user group, were asked to participate in the tests.

3.1 Think aloud method

The think aloud method is a widely used evaluation technique to reveal mental models of users of software applications [9]. The participant is asked to perform a task with an application or go through the required steps using a prototype. While doing so (s)he verbalizes expectations and thoughts about the interface, her or his reactions to mistakes, confusion, etc. This technique often offers explanations for unexpected actions or difficulties, and the appreciation or frustration of the user.

This evaluation was conducted using a proto app on an Android smartphone. Participants interacted with three screens: the start-up screen, the leader board screen (Figure 3), and the map of the golf course (Figure 2). On start-up, a golf ball rolls into the screen. When the player presses the button leader board, the ball falls down into the ground, and reveals the leader board. On pressing the start button, the ball is hit over the building (the World Soil Museum) and the map of the virtual golf course appears.

The think aloud test followed by questions revealed some unexpected but important issues. For instance, the participants did not notice the animations when they pressed a button; they did not recognize their starting point or tee on the golf course; and they did not recognize some of the buttons as interactive elements.

3.2 Playtesting

Testing the gameplay early in the design stages of a computer games is not a simple task. The gameplay is linked closely with the graphics and interaction offered in the game, but even a rudimentary interactive prototype requires considerable investments. However, a physical prototype and thus a playable version of the core game mechanics can be created, which allows the designers to evaluate their ideas with participants. Fullerton explains that using a paper and pen, index cards or even acting out the game mechanics, the designer can perfect the simplistic model even before programmers or graphic artists are involved [5]. The designer receives instant feedback on what players think of the game and can see if they achieve the player experience goals they defined for the game.

For our playtest, we instructed the participants to throw a small ball into a plastic flowerpot placed about 6 meters away. When the ball missed target, the player was asked to answer a multiple choice question (on general knowledge) within 10 seconds. A wrong answer led to points deduction. This was repeated 5 times, or until the ball was thrown into the pot. If

the player did not succeed in 6 throws, (s)he had to start all over again. Points were awarded only for reaching the target, with a bonus for accomplishing the target under par (so fewer throws than a number pre-set in the game).

The playtesting revealed several points for improvement. The most important was that the players became annoyed when points were deducted for missed throws and wrongly answered questions, whereas no points were added on right answers. Secondly, the participants were not pleased they had to start over starting all over again if they did not reach the target in 6 throws. Both issues affect the player experience goals negatively, and an important conclusion therefore was that we needed to adjust the scoring system to reward the players instead of 'punishing' them for failures.

The players found the succession of throwing and asking questions engaging, which supports the core idea of the gameplay.

4 Conclusions and further development

The design of the SoilGolf game as a mixed reality game successfully meets the needs of the World Soil Museum by highlighting the soil profiles, and through offering a playful outdoor activity for the target user group. The think aloud method and playtesting applied as evaluation techniques in an early stage were effective in identifying strengths and weaknesses in the design and gameplay, before any technical implementation was started. We recommend using these techniques in the early stages of game development and to repeat them when the design and game play are adapted. Although we expect that technical developments will allow us to develop the game for smartphones in the near future, our first step will be to implement a simpler version of the game. To avoid the technically complex implementation of the swing, in this design players make progress towards the holes by answering multiple choice questions on soil themes. Correct answers reward the player with an animation of the ball towards the hole (and eventually into the hole) and a new location, closer to the hole. They walk in reality and move over the virtual golf course towards this new tee for their next 'swing', which preserves the mixed reality features of the game.

5 Acknowledgments

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