A Pervasive Role-Playing Game for Introducing Elementary School Students to Archaeology

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Abstract

This paper presents ongoing work on the design and prototyping of a pervasive, role-playing game for elementary school students. The game takes place in a designated space presented as an excavation site, in which students become acquainted with a number of principal roles and tasks taking place in archaeological fieldwork. The educational goals are to introduce students to fundamental archaeology concepts and to inform them about the historical background of a specific site and the discovered artifacts. The game apparatus consists of a mobile application (android), a number of small wireless sensors (beacons), tangible models of the antiquities and simplified prop tools of the archaeological equipment (3D printed). The paper outlines the main design concepts, technologies used and gameplay and reports on a preliminary evaluation.

Author Keywords

Pervasive games; serious games; role-playing games; mobile; wireless sensors; beacons; interaction design for children; archaeology; cultural heritage.

ACM Classification Keywords

H.5.2. Information interfaces and presentation: User Interfaces – Input devices and strategies;
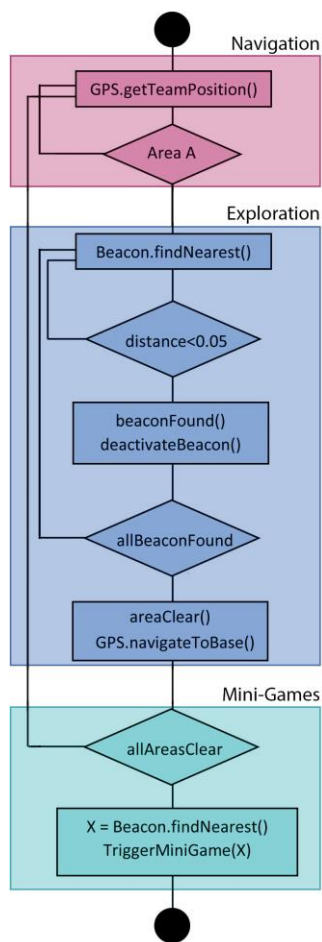
Figure 1. Architecture

Introduction and Related Work

Over the last two decades, the development of various mobile devices, location and sensing technologies have made mobile games possible in various contexts including cultural heritage [1,2,8]. This emerging trend, often called *pervasive gaming*, extends the user experience of the real world and blends storytelling and gameplay with physical, digital artifacts and places [3,11]. In cultural heritage, pervasive games may contribute to visitor experience by providing entertainment, learning and social interaction within a cultural context [1]. Researchers are often referring to *serious games* in cultural heritage, as those *"developed with the intention to be more than entertainment"* [5,10] and thus engaging users to learning activities through gameplay [12]. These usually focus on providing historical reconstruction and heritage awareness [4,9], and in some cases they augment cultural artifacts and spaces with narratives [7].

This paper investigates non-formal learning, sensitization and engagement of children in (real or fictional) excavation sites through a pervasive mobile game. Children take active roles within a team of archaeologists in pursuit of excavation, collection and basic understanding of antiquities. The main ideas for this game have been validated by various contextual research methods and interviews with educators, archaeologists and museum curators. A preliminary evaluation with students has identified several positive aspects of the user experience especially about the user interface and interaction design, as well as areas of further improvements.

Design and Prototyping

Our aim was to design and implement a pervasive game that affords an engaging roleplaying experience blended with the specified educational content. In the course of our work we had to face a number of challenges, such as: a) to select tasks that successfully combine the physical and digital space, b) to introduce the appropriate learning content in the story and gameplay, and c) to make the tasks and user interface intuitive and engaging for elementary school children.

The iterative process we used for the design and development of the prototype consisted of the following steps:

- to specify the educational goals of the game using research and interviews with experts,
- to determine the requirements and specifications of the system and interface using data gathering, data modelling and information design methods, and
- to design the game rules and challenges following the Mechanics, Dynamics and Aesthetics (MDA) framework [6].

Figure 2. Basic user interface elements.

The learning content involved generic concepts related to archaeological fieldwork, as well as information about a specific archaeological site and the discovered artifacts. The game introduces the basic roles involved in archaeological excavations and their respective duties. The fictional excavation site as well as the exhibits included have been modelled based on the site of Chalandriani in Syros. Related information and stories are included in the game.

The main design decisions we took for the functionality and interface of the environment were: a) to include easy and unambiguous tasks, b) to support collaboration between children, c) to switch between all roles during the game, d) to use engaging elements such as playful colors, animations and audio feedback (Figure 2 and 3), and e) to offer rewards for successful task completion.

Finally, the aesthetic goals we set for our game using the MDA framework were: *discovery, fellowship, narrative* and *challenge*. Based on these goals, we selected and specified the following game dynamics: a) exploration in an open archeological site with hidden artifacts in the physical space (discovery), b) arrangement of children in teams with avatars, role assignment and need for information exchange (fellowship), c) drama tension through audiovisual and tactile feedback (narrative), and d) pressure created by the awareness of opponent play and pulsing animations (challenge).

Game Overview
During the initialization of the game children have to form teams of four members. Each of the teams has a single tablet and acts separately. Team members are assigned the following roles: a) the guide, who leads and identifies possible artifact locations by using the mobile device, b) the excavator, who digs for the physical artifacts using equipment, c) the carrier, who is responsible for collecting and securing items in a backpack, and d) the cartographer who records the position of found artifacts on a map.

The game consists of two parts. In the first part, each team's goal is to search for, and collect hidden artifacts in its assigned excavation area. The physical space divided to four sub-areas and each team has to discover two artifacts in the assigned space. This part of the game is complete once a team clears each of the four sub-areas successively. After each clear, players must return to base before proceeding to the next sub-
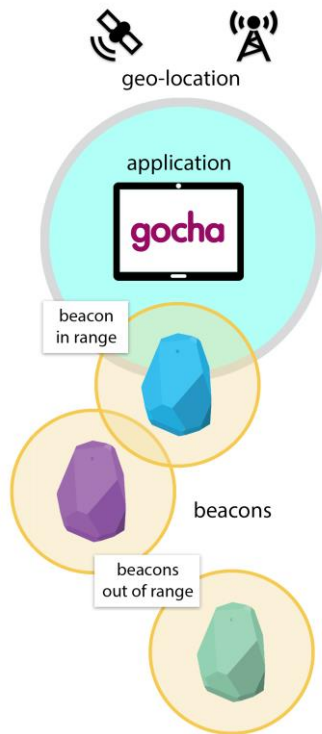

Figure 3 Main game interfaces.

Figure 4 Technologies

area to store their findings in their team's headquarters and rotate roles. The second part takes place with the team back at the base using their findings to interact with the tablet's proximity triggered functions and gain access to mini-games and activities. Each physical artifact can trigger a unique function bound to it within the application. Some artifacts enable players to view educational content and tutorials for activities using the objects (draw something, assemble parts or recreate broken artifacts, combine tools found to perform an action). Others give access to standalone playable mini-games and activities, purposed to simulate the actual use of the real objects or imply their historical meaning.

Architecture and Technologies

The main architecture includes three main subsystems: Navigation, Exploration and the Mini-Games (Figure 1) while other application structures are: Team management, inventory, interface and maps. The interface elements follow flat design for the visuals and are presented on Figures 2 and 3.

Technologies used
The main technologies (Figure 4) used for the prototype are: 1) a mobile application (goChalandriani) running on an android tablet with Android 5.0 OS and Bluetooth 4.0 Low Energy (BLE), 2) location sensing technologies: assisted GPS (A-GPS) of the mobile device for approximating geo-location and a set of small chips broadcasting Bluetooth Low Energy signal called beacons (iBeacons) and their respective Estimote SDK [13]. Beacons have a number of advantages including, secured proximity based communication, indoor/outdoor precise geo-location, wide compatibility based on BLE. The application was developed with Android Studio and interaction design and prototyping

software was used for the GUI. The game apparatus also includes 3D modelled and printed props of (fragmented) antiquities and excavation tools.

Preliminary Evaluation and Future work
We have conducted a preliminary evaluation with two groups of students (average age: 21; four women and four men). All users admitted high engagement with the game while the overall impression was that they enjoyed the challenges, fully understood the rules and roles taken. Users easily realized that the design was intended for young children while they responded positively to the emotional goals of discovery, fellowship, narrative and challenge. We identified a number of areas of improvement including:
the educational aspects of the game and thus to provide mini-games with more direct educational value, to improve interface components to better reflect designed micro-interactions, to fix minor issues in beacon identification when diffraction occurs. Future work also includes plans for the development of a generic platform for cultural heritage and gaming within the context of educational.

Summary and Future Work

We have presented a pervasive mobile game that introduces elementary school students to archaeology. This is ongoing work, which needs to be continued in the directions of UX evaluation with children in different sites/settings. Furthermore, we aim to add extensions with more artifacts (exhibits) and mini-games, based on the installation site. A large-scale future work project would be to design a platform for designing similar games in other contexts or authoring related content by interaction designers and heritage professionals.

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