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Accessing Map Information Using NFC-Based User Interfaces for In-Situ Learning Environments

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ABSTRACT

Maps have been used by teachers for centuries to manipulate information related to geographical locations. This paper presents a novel way to interact with maps through the combination of mobile devices and the Near Field Communication (NFC) technology. This proposal provides teachers and students with the ability to retrieve and store information related to geographical locations defined in a traditional paper map. Consequently, the information that is exchanged among teachers and learners is contextually enriched with a reference to a geographical location in a physical map. This interaction mechanism is an interesting way to encourage in-situ learning scenarios, such as teaching Geography lessons in museums, art galleries, historic buildings or outdoor scenarios, etc. Thus, this article describes an application that employs a NFC-based interaction mechanism to browse geographical information in physical maps. It also presents the hardware and software infrastructure required support this application. Finally, it analyzes the result of a preliminary usability evaluation of the application.

KEYWORDS

Mapping Application, Near Field Communication (NFC), Quick Response (QR) Codes, Radio Frequency Identification (RFID) Technology, Usability Testing, User Interfaces

INTRODUCTION

"Free-choice" learning is defined as the kinds of approaches to learning that occur in museums and elsewhere outside the school and the college system (Kadyte & Akademi, 2004). According to Bloom's (1956) viewpoint, learning occurs in three different domains: cognitive, psycho-motor and affective. Hawkey (2004) states that the formal sector traditionally emphasizes the former, while museums and galleries have significant potential for the latter. Therefore, the "free-choice" exploration of exhibits is classified as an informal activity performed by learners formally affiliated to a school or institution.

Teachers and students have been using maps to relate information to geographical locations for centuries. The most popular material employed to build traditional maps is paper. Although traditional maps are useful to expose static information; they are not good enough to show dynamic information

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(i.e. the weather evolution on a geographical region within a time span, or the urban evolution of a city in a time span). A workaround to represent dynamic information in traditional maps is achieved using sequences of maps that represent the static information of a region at different times. The main drawback of this alternative is the substantial amount of paper required to build these maps. The physical dimensions of traditional maps are another constraint. For instance, it is difficult to have annotations in more than 2 languages at the same time in the same traditional maps due to the space required to display them. Digital maps provide the solution to this problem.

The Via Michelin Maps & Route Planner (https://www.viamichelin.com/), Google Maps (https://maps.google.com) and Microsoft Bing Maps (https://www.bing.com/maps/) are Web applications that expose dynamic information using maps. These maps enable users to store and retrieve information related to geographic locations such as bars, airports, train stations, public buildings, and museums. And the amount of information managed by these applications has almost no limits.

The use of digital maps running on stationary devices, such as desktop computers connected to projectors or smart TVs, is suitable for large classes where the focus of the matter is the same for all students. Although this approach is still widely used, it is not suitable for "free-choice" informal learning scenarios requiring a direct interaction with learning artifacts. The use of mobile devices to interact with physical objects, such as traditional maps or slides projected on the wall, encourages the "free-choice" learning improving students experience.

Conversely to projections on the wall, one of the limitations of mobile devices is the screen size which shrinks the view of the learning object from learners' perspective. As mobile devices usually employ virtual learning objects, instead of physical objects, the experience is reduced to the device display only. To expand learners' view, this proposal employs a hybrid approach where learning artifacts are not confined to virtual or physical media, exclusively.

The combination of physical and virtual learning objects to create hybrid learning artifacts enables students to get information from different types of interaction surfaces at the same time: a virtual interaction surface provided by at mobile device and a physical interaction surface represented by a map made of paper. This combination results in the implementation of a Distributed User Interface (DUI) that use different technologies to enhance the learning experience.

Villanueva et al. (2013) define the Distributed User Interface concept as a state of user interfaces where their interaction components are distributed across different interaction surfaces running in their own execution environment. The goal of this system is the definition of a hybrid system that enables users to explore physical maps using mobile devices providing users with extra information. The Near Field Communication (NFC) technology is employed to support the symbiosis between the physical and virtual interaction surfaces. Based on García et al.'s (2016) study, this technology offers a reliable mechanism to implement novel interaction techniques.

This article is organized as follows. It starts describing the "approach and remove" interaction metaphor to "grab" information from physical objects. Then, it describes the User Interface (UI) of the NFC Map Explorer Application as well as the infrastructure required to support the metaphor and the application functionality. Afterwards, it summarizes the preliminary usability evaluation performed on a prototype of the system to evaluate the viability of this proposal. The benefits of using the "approach and remove" metaphor to interact with physical objects as well as the comparison between this solution to other alternatives, are also discussed in this text. Finally, conclusions and future works are presented in this paper.

THE "APPROACH AND REMOVE" INTERACTION METAPHOR

The NFC technology enables high frequency short-range wireless communication to exchange information among devices. This technology is integrated into several mobile devices, and it is supported by Application Programming Interfaces (APIs) available on most popular operating systems such as, iOS, Android and Windows Phone 7.