Designing a context-aware architecture for emotionally engaging mobile storytelling

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Abstract. This work illustrates the design of a context-aware software architecture supporting the narration of interactive stories for mobile users. The peculiarity of this work is the use of an extended set of context dimensions, including the surrounding environment and the user social network, for enhancing the engagement and the emotional impact on the users experiencing the story.

Keywords: context-awareness, emotionally engaging interaction, mobile devices, social network, storytelling

1 Introduction

The main goal of this project is the definition of a software architecture for supporting the creation and the delivery of narrations for mobile users, whose evolution is determined by the context. In particular we consider those dimensions of the context - such as the weather, the time of the day or the temperature - that may enhance the emotional impact of the content communicated to the user. Such dimensions often are not considered, because their monitoring may require a set of sensors that usually are not embedded in most devices. The architecture described in this work takes advantage of context data available on the web for overcoming this problem. Besides, the interactive story is here treated as an experience to be virally communicated and shared by a community of users that is considered also as an additional dimension of the context influencing the access to specific fragments of the narration. A small group of potential authors has been involved from the start of the project, before the development of the software prototype. The result was an evolving development process, where the contributions of computer science specialists and users were integrated and produced a result that - in a following preliminary validation phase - was judged satisfying in terms of expressivity, and which is open to further conceptual and technical advances.

2 Related Work

The notion of context has been exploited by several authors [7] [13] that have analyzed and used different dimensions of it, including the location, the user, the device, the network and the time. Context-aware applications guide the user experience in relation to the context sensed, and they may influence both the interaction and the communication of information. Research on the adaptation of the information presented to the user in relation to the context has been developed particularly for the hypermedia and the web [3] [16], but a wide number of studies have focused also on the domain of the so-called mixed reality, that includes all the different blendings of navigable real and virtual environments. The location has been one of the most explored dimensions of context. Early works include the Active Badge system [22] for locating people inside a building by means of a wearable badge and delivering services to them. Location awareness is used in many applications related to the cultural heritage domain - such as museum guides [11] or educational games for enhancing the visits to archaeological sites [2] - and to tourism. Another dimension of the context, the user history, has been considered for adapting the content presented to the users, for example enabling its proactive presentation in relation to repetitive behavior patterns [6]. Other dimensions, such as the weather or the temperature, have been investigated in a number of research works, including [9] and [15]. As stated in the introduction, in most situations the values related to these variables can't be sensed directly by sensors embedded in the users' devices. That is the reason why some researchers have proposed software architectures [9] that abstract the sensor components and rely on different methodologies for acquiring the values, including the web access. In most cases the knowledge of an extended set of context dimensions is used for informative purposes, such as indicating to tourists specific indoor or outdoor attractions in dependence of bad or good weather conditions. Most of the studies and applications developed so far - especially those ones targeted to mobile devices - have focused on providing appropriate information to the users, lowering their cognitive load, but have been rarely focused on the emotional use of the context. One of the few exceptions is a recent work [20], that emphasizes the emotive potential of the context for augmenting or diminishing the user engagement.

The exam of narratology, that is the study of the structure of the stories, and of its influence on the design of interactive stories has been an important component of our work. An interest survey [5] analyses the theories developed by famous authors from the classical age to contemporaneity - including Aristotle, Propp, Greimas, Barthes and Bremond - in order to find the most suitable for the interactive storytelling domain. Our approach focuses on the studies of an Italian researcher, Cesare Segre [21], that we chose because of its generality and adaptability to different literary genres. Most of the approaches for building models and software architectures for interactive storytelling are focused on the proposal of drama managers (i.e., software components controlling the development of narration on the basis of the story developed by the author) [14] or autonomous agents influencing the evolution of the story [19]. Some of the applications for managing interactive stories have used location awareness for delivering appropriate information to the user. Hansen et al. [12] introduce the concept of location-based Mobile Urban Dramas, where the city becomes the stage for

the drama, and the user participates to a play where the actors voices can be heard through her mobile phone headset as she moves through the town. Another interesting project, iLand [8], permits to narrate - to users equipped with mobile devices - stories related to the oral culture and traditions of the island of Madeira, delivering content related to specific locations.
The role of the emotions in the computer human interaction has become increasingly important with the pervasivity of computer systems, that go beyond the limits of work environments. A number of works focus on the so-called affective interaction [17], where the emotional information is communicated by the user to the system in order to improve the interaction. In this work, we share the interest for the user emotions but, rather than studying the means for capturing them, we consider the emotional role that may have the context, associated to a narrative content, for obtaining an emotional engagement of the user.

3 Defining the conceptual model

Fig. 1. Two snapshots of the same location during the day and the night.

In a previous work [4] the exam of the narrative theories led us to consider the studies of Cesare Segre [21] as one of the most interesting starting points for defining a model of interactive story. The segmentation process of a literary text described by Segre - that leads to identify the main *sequences* of the narration and their relations - was the basis for the model of story defined in [4]. The initial formalization was modified for modeling also stories characterized by a non-linear narrative structure. The Segre's sequence was mapped to the main structure of the interactive story, that we named *scene*. Scenes may originate a complex narrative structure that may be navigated following different paths. The key components of the Segre's sequence were mapped to the two main components of the scene, the *scenery* and the *situation*. A single scene is characterized by a scenery and by one or more situations. The scenery is the passive part of the scene, and it includes the components of the physical environment, such as building and trees. The situation is the active part of the scene, and it corresponds to the Segre's concept of *event*, that represents facts happening inside the story. Each situation is anchored to a specific location inside a scenery and is associated to a definite interactive content. In a certain phase of the narration only a subset of the

situations are active and deliver their content when the user enters the associated locations. The entrance of the user and the following interaction usually modify the subset of the active situations, according to the branching structure designed by the story author, and bring the story in a new state. We may classify this model as location-aware and drama manager inspired. In this work we tried to go a step further. Everyone can experience that a fragment of story communicated to the user in the location determined by the author can have a stronger emotional impact. But the final strength of this impact may greatly be enhanced (or diminished) in relation to the different conditions of time, weather or other dimensions of the surrounding context, as it can be seen in Fig. 1, where the same phrase - *the mad man is wandering through the park* - read in the same location but in different light conditions may cause varying emotional reactions. That is the reason why in this work we enhanced the previous model, increasing the dimensions of the context that regulate the access to the situations. Another feature introduced in this work was the role of the social community in the enjoyment of the narration. While in the previous work we described stories designed for single user interactions, in this paper we considered the possibility for the author to deliver a story for a community of users. The primary role for this community is the sharing of the users' experience, not only for helping other users to discover fragments of content available in specific context conditions, but also for achieving a deeper cognitive and emotional comprehension of the experiences lived by its members. The community represents also an additional dimension of the context that may be used by the story creator for enabling the access to specific fragments of the narration depending on the actions of the community members.

4 Experimenting the Conceptual Model

Because one of the goals of this work was to focus on the narrative expressivity and the emotional engagement of the stories designed with our system, we decided to actively involve from the start a small group of potential authors. We communicated to a small group of students of the Fine Arts Academy of Venice (3 students aged 20) the initial design choices, as described in the previous section, and we asked them to design an interactive story based on an extended set of context types, including location, time, weather and interactions of the users' community. We chose as the location for the story San Servolo, a small island in the Venice lagoon near San Marco square (see Fig. 2 on the left), characterized by a group of buildings immersed in a gracious park. In the past century the island was the site of an asylum for mad men that were treated with various methods, including the cruel electroshock but also the music therapy and the rehabilitative work. The results of the students work came in the form of a story called *San Servolo, travel into the memory of an island*, focused on the life on the island at the times of the sanatorium. The narrative structure proposed by the students was based on a set of ten situations associated to eight locations of the island (see Fig. 2 on the left), often characterized by visible landmarks.

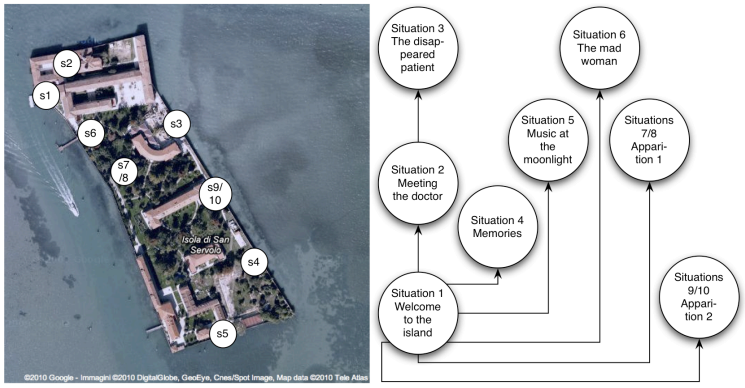

Fig. 2. An aerial view of the island - evidencing the locations associated to the situations defined in the narration - and a logical scheme of the relations between the situations.

The students designed a set of narrative paths, requiring the access to specific situations before the delivery of the content associated to other situations. Fig. 2 on the right shows a logical scheme displaying, through the use of arrows, where an ordered access to situations is required. Some situations are associated to the extended set of context dimensions described in the previous section: a mad woman of the asylum tells her story next to the sculpture in the park, but only in the afternoons; a piece of classical music - reminder of the music therapy used for the guests of the institution - can be heard by the users facing the south side of the Venice lagoon, but only during the nights characterized by the absence of clouds. Finally, situations 7 and 8 embody the so-called *apparitions*, where the guests of the asylum appear to the users wandering through the park, presenting themselves during the night as mad men and during the days as men recovered from their illness. The students produced a detailed storyboard for the content of each situation that was the basis for the creation of ten associated video contributions. Their work gave a practical demonstration of the expressive potential of the context-aware story model and indicated where to focus the development. For example the story imagined by the students showed that they were more attracted by the different dimensions of the environmental context rather than by the complexity of the content to deliver. As a matter of fact, the content produced by them was rich from an emotional and narrative point of view, but had a simple technical structure, being composed by single videos for each distinct situation. As a consequence, in the following implementation phase, we focused on the implementation of an expressive set of rules related to the context. We decided to maintain the simple video container suggested by the students for the delivery of the narration. This decision had significant consequences on speeding up the implementation of the user interfaces, helping also their portability towards different client software platforms.

5 The Software Architecture

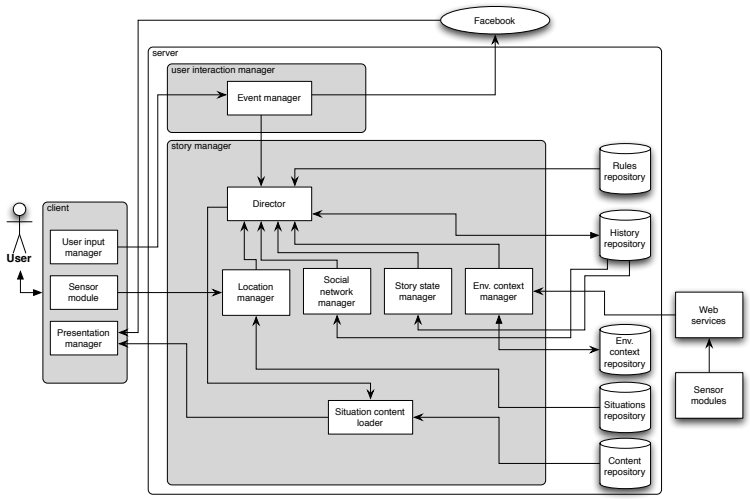

Fig. 3. High-level view of the software architecture.

Because of the limits of the space we'll focus mainly on the high-level description of the software architecture (Fig. 3). The *director*, the main component of the *story manager* implemented on the server, decides which content to deliver to the client after matching the current values of the context variables with the set of context-related rules defined in the authoring phase for each situation. While the current location value is retrieved from the user device, most of the values of the environmental context are retrieved from different web services. This reasonable solution allows to define a simple and modular software architecture with a noticeable increased number of context dimensions available for narrative purposes. Besides, all the interactions of the user and her community are logged for being matched with the rules related to the user and the community histories. For example the user may access certain situations only if she has already experienced a subset of other situations. Besides, in the current implementation, in order to promote the use of the social network for composing the different fragments of the narration, the author may specify a rule that inhibits the delivery of content of a certain situation when such content has already been delivered to a given number of users. The discussion space of the community, accessible from the user client interface, takes advantage of the Facebook social plugins [10] for permitting to all the people experiencing the story to write comments and to read the thoughts of the other users. All the comments written by the users authenticated with their Facebook account are visible also in their Facebook profiles, contributing to spread the interest about the interactive story towards their social network (including of course the users that access Facebook from desktop platforms). Generally speaking, in the current implementation the condition for the delivery of the content of a given situation can be informally expressed as follows:

deliver content of situation$_i$ **if** *current location* = location of situation$_i$
and *current weather* = type of weather$_k$ **and** min time$_i$ < *current time* < max time$_i$
and min temperature$_i$ < *current temperature* < max temperature$_i$
and (cont. delivery for situation$_{i,j1}$ **and** … **and** cont. delivery for situation$_{i,jn}$ = true)
and *current num. of deliveries for situation$_i$* < max number of deliveries for situation$_i$

where situation$_i$ ∈ set of situations S, type of weather$_k$ ∈ set of weather values W, min time$_i$, max time$_i$, min temperature$_i$ and max temperature$_i$ depend from situation$_i$. The set {cont. delivery for situation$_{i,j1}$, …, cont. delivery for situation$_{i,jn}$} expresses the state of content delivery for a subset of situations $R_i \subset S$ and different from situation$_i$.

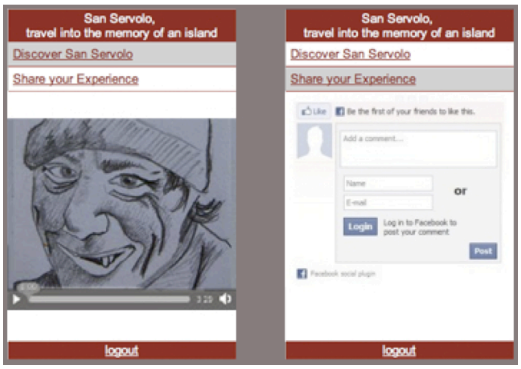

Fig. 4. Screenshots of the browsing interface for mobile devices.

All the components of the proposed architecture have been implemented using standard web technologies, including a JSP application server connected to a PostgresSQL DBMS and to a web server. On the client side, the use of HTML5 has permitted a rapid implementation of the prototypical interface, displayed in Fig. 4. After the required registration, the user activates the *Discovering San Servolo* function and starts wandering through the San Servolo island for capturing the fragments of the narration. Each time the system recognizes the context conditions for displaying the interactive content associated to a specific situation, such content is delivered to the client, as shown by Fig. 4 on the left. The user can decide at any time to switch to the second function of the client application, *Share your experience* (Fig. 4 on the right), for sharing her thoughts with her social network. The software architecture was preliminary tested with another group of students of the Fine Arts Academy (6 students, aged 20). After the test the users filled in a brief questionnaire. All the users gave a positive evaluation of the narrative expressivity allowed by the software architecture and of the possibility to share the experience. The early involvement of users resulted in a smooth development process, but also stimulated new ideas, as the application of the architecture to new domains. Other groups of users are currently experimenting the application, and we hope to have further interesting feedback for improving the quality of the system. I gratefully acknowledge Alessia Bort, Paola Bressan, Giorgia Franchin and Giorgia Sportelli for their contribution to the elaboration of the case study and to the creation of the software prototype.

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