Design, prototyping and evaluation of SIMpliCity: an NFC system for the mobility of citizens

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ABSTRACT

SIMpliCity is an application developed in the RFID Lab of CATTID (Centre for the Applications of Television and for Distance Learning Techniques), research centre of Rome University "La Sapienza", that helps tourists in their sightseeing around the city and offers value-added services for both tourists and local citizens, thanks to the use of mobile phones equipped with Near Field Communication technology. This paper describes the application's architecture, together with the first usability test conducted on it. We exploited users' suggestions arising from a deeper analysis of the results in order to redesign the application, increasing its performance, moreover obtaining more flexibility and reliability. The result is the upgraded version of the system (we called it SIMpliCity 2.0), described in par. 4. This upgraded version has been tested too with real users. The results of this second test are reported and analyzed in par. 5.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *evaluation/methodology, graphical user interfaces, prototyping.*

General Terms

Prototyping, Design, Evaluation, Reliability, Verification.

Keywords

Near Field Communication, simplicity, touch paradigm.

1. INTRODUCTION

Over the last few years, a huge set of wireless technologies has been made available to a wide range of users. Among them, Bluetooth, Wi-Fi, Radio Frequency Identification (RFID) and Near Field Communication (NFC). Thanks to a wireless technological infrastructure and to the growing availability of mobile devices supporting these technologies, the users have become more and more "mobile", becoming able to perform day-to-day actions anytime and everywhere. One of the challenges this scenario presents to developers is to provide the right information in the right place, in order to avoid the "information overload". Another challenge is to design a user interaction that is as intuitive as possible, in order to grant naïf user the possibility to use new technologies.

In order to face these challenges we have built a system based on NFC infrastructure that helps people to move within the city, providing them information related to the place they are currently in, contemporarily reducing the cognitive load necessary to interact with the service. An NFC-based interaction, in fact, allows the user to replicate the act of "touching" an object to interact with it, in the same way that people reach a switch to light a room, or press a button, to move the elevator towards a given floor. Conversely, even if a Bluetooth-based interaction is related to the user's position too, it is not immediately perceivable for the user because it is not possible to associate its operation mode (scanning the surroundings), to an action occurring in the real life [1, 2].

From technical point-of-view, NFC is a standard-based radio frequency communication technology, operating at 13,56 MHz, in the High Frequency band. Compared to other RFID technologies, the NFC interface overtakes the distance between a reader (active device) and a tag or transponder (passive device), as a mobile phone provided with NFC technology can alternatively act both as an active reader and as a passive contactless card.

The communication mode selection mechanism has been specified by International Organization for Standardization / International Electro-technical Commission (ISO/IEC) in 2005 (ISO/IEC 21481:2005) [3], a year after the NFC communication protocol interface has been approved by the ISO/IEC itself (ISO/IEC 18092:2004) [4].

NFC-related standards are also acknowledged by European Telecommunications Standard Institute (ETSI) and European Computer Manufacturers Association (ECMA).

The opportunity to use the same mobile device to interact both with a passive tag and with an active reader, makes possible to design a virtually limitless set of applications: payment, ticketing, access control, content distribution and smart advertising are only some of the potential use-cases. A mobile phone provided with the NFC interface, in fact, could connect to a web page by scanning an RFID tag, moreover it could be used as a payment card and also as a virtual payment terminal, or could even facilitate the pairing of Bluetooth or Wi-Fi enabled devices [5, 6].

Nowadays, most NFC pilot projects are focused on ticketing and payment as isolated applications, using the NFC phone in card emulation mode. On the other hand, the projects that exploit the RFID reader capabilities embedded into an NFC device [7, 8] don't take care of the smart card emulation mode.

Even if users declare to appreciate this type of applications [9], this scenario does not give users the perception of the real potential of NFC technology as a combination of different communication modes. The system we've designed exploits the whole capabilities of NFC technology as it combines both the active reader mode and the passive card emulation mode.

2. APPLICATION DESCRIPTION

SIMpliCity is a system targeted to tourists and to local citizens for easily moving within the city. Due to the use of mobile phones NFC enabled and of Smart Posters provided with passive tags (Figure 1), SIMpliCity highlights the most famous points of interest of the city and guides the people within the town streets, giving them the possibility to obtain the public transportation path to reach that place, and providing them information about restaurants, shops, offices and public services (e.g. post offices). Moreover, allowing them to call a taxi in an automatic way, lifting the difficult of the foreigner tourists that could not know to explain where they are.

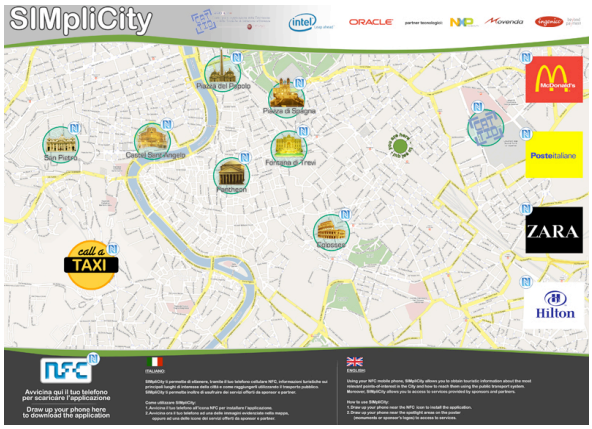

Figure 1 - SIMpliCity Smart Poster

From architectural point-of-view, SIMpliCity is based on client-server architecture, made of three main components:

- a MIDlet, which provides a friendly GUI that helps users to access services as obtaining information on how to reach highlighted places using public transport system, calling a taxi and obtaining information (both touristic and historical ones) on selected places. Each request is performed using a wireless connection (GPRS / EDGE / UMTS);
- a Cardlet, which securely stores and manages user's personal information (bank account and related passwords). Both MIDlet and Cardlet are stored on the user's mobile phone and they are part of the client side;
- "Server-side" - SIMpliCity that receives user requests, performs web requests using the information received by the MIDlet and replies with information about the requested service. Connection between server and mobile client is established via a mobile wireless connection.

Request's details are managed by the MIDlet that, in turn, recover them from the tag of the Smart Poster, so that user can access services with not much cognitive load such as typing words, remembering syntax etc…

3. FIRST SET OF USABILITY TEST

The beta version of SIMpliCity has been tested with 15 users according to the principles described by Jakob Nielsen [10]. Before performing the test with actual users, we analyzed the interface prototype with two usability experts. The analytic method used to perform the experts' evaluation was the Cognitive Walkthrough [11]. We asked usability experts to perform a set of actions (i.e. download the application from the Smart Poster, get a direction from Termini train station to Coliseum, ask for historical information on Pantheon, find the nearest post office and so on) trying to act the part of different types of users, from the technology-novice to the high-tech person. Experts detected the main usability problems and reported them to the project team. The primary problem detected by usability experts was the information organization: some times menus were unspecific and located in a hard way to reach.

After experts' evaluation, we asked 15 users, different for age and ability in using mobile technologies, to perform the same tasks. 7 of the users are Foreigner, while 8 are Italian. We report users' sex, age, educational qualification, job picture and nationality in Table I.

Table 1 - Users' picture

User	Sex	Age	Educational qual.	Job picture	Nationality
1	M	29	Doctor's degree	Employed	Italian
2	M	19	Graduated	Student	Foreigner
3	M	25	Master's degree	Employed	Italian
4	F	55	Bachelor's degree	Employed	Italian
5	F	25	Graduated	Student	Foreigner
6	M	36	Master's degree	Employed	Italian
7	F	26	Doctor's Degree	Unemployed	Foreigner
8	M	22	Bachelor's degree	Student	Italian
9	M	30	Master's degree	Employed	Foreigner
10	F	25	Graduated	Student	Italian
11	M	28	Bachelor's degree	Unemployed	Italian
12	F	27	Bachelor's degree	Student	Foreigner
13	M	37	Master's degree	Employed	Foreigner
14	F	20	Graduated	Student	Italian
15	F	30	Master's degree	PhD student	Foreigner

First of all, we asked users to fill in an entry survey, necessary to assign people to specific classes and categories, depending, among others, on their age and on their ability in using mobile technologies. After completing the entry survey, a test session was performed. The test session for SIMpliCity was composed by six tasks, during which we tried to reduce the gap between simulation and the real environment and asked the user to speak loud. At the end of the test session, users were asked to fill in the final questionnaire that investigates their impressions in using the application.

Of course, the entry survey and the final questionnaire are useful for statistic purposes, but it's even more useful to collect all the user's impressions while he/she is actually using the application, in order to not lose their percepts at the interaction time, moreover to be able to verify the validity of the declarations written in the questionnaire. That's why it's very important to have powerful tools for recording user's action during the test session.

3.1 Usability tools

To record actions performed by users, we used a set of tools specifically designed for testing applications on mobile. We now report a short description of the tools used:

- wireless micro-cameras to invisibly watch the user without making him/her feel observed;
- an handy camera to record actions that take place in large environments;
- a point-of-view camera to see what's happening in front of the user himself, understanding where he/she is focusing his/her attention. Thanks to its ergonomic design, the point-of-view camera allows an hands-free video capture;
- screen cast via Bluetooth to record what's happening on the screen without disturbing user's interaction.

3.2 Usability results

On the basis of what users stated in their questionnaires and what they expressed while performing the tasks, we collected a set of suggestions for improving SIMpliCity application. One of the most recurring problem users encountered was related to the organization of information, as noticed also by usability experts. Giving an example of that, we placed a selection menu at the end of a long text describing point-of-interest history, in this way trying to encourage user to read the whole text before selecting another choice. Users didn't show to appreciate this feature; they preferred instead to have short texts and more fragmented information. The small size of the screen represents a difficulty in reading long texts, as reported by one of the users. Another problem was related to the navigation flow: three of the users (20% of the total) felt lost while interacting with SIMpliCity, and exited the application unintentionally. On the other hand, nine of the users (60%) appreciated the intuitiveness of the interaction, based on the "touch paradigm", and the speed in retrieving information from the smart poster. These impressions, stated in the application "strength point" question, were confirmed by the answer about the level of difficulty in using SIMpliCity: 70% of the users considered it "low", while 15% regarded it "null" and 20% reckoned it "medium". No one answered that the level of difficulty in using the application was "hard".

Finally, almost all users (90%) thought that SIMpliCity could be integrated with traditional, paper-based, tourist guides, rather than totally substitute them.

4. REDESIGN

After analyzing users' impressions, we redesigned the application, moving it from the beta version to SIMpliCity 2.0. The redesign phase was planned to target the following objectives:

- increase the portability of the application;
- refine the information structure, together with the GUI;
- improve the navigation flow;
- improve the reliability of the application.

In order to increase the portability of SIMpliCity on all NFC-enabled devices, we formatted the information written in the tags according to NFC Forum Standards [12]. Moreover, we modified the way SIMpliCity retrieve information about points-of-interest and bus routes: the beta version made use of high level display and the information was retrieved performing an <*http request*> to a remote server; the replies of the server were defragmented and then embedded into display (Figure 2). This solution was limited in terms of graphical appeal and also in the flexibility of the navigation structure. Using the response to an http request means we had to keep to the limitations to the high level display: classes associated with the high-level interface handle the pixel-level detail necessary to draw objects on the screen (such as radio buttons, list, and so on). The programmer basically calls methods and lets the methods handle display so having very little influence on their visual appearance [13]. This was the main reason why most of the users complained about the navigation structure.

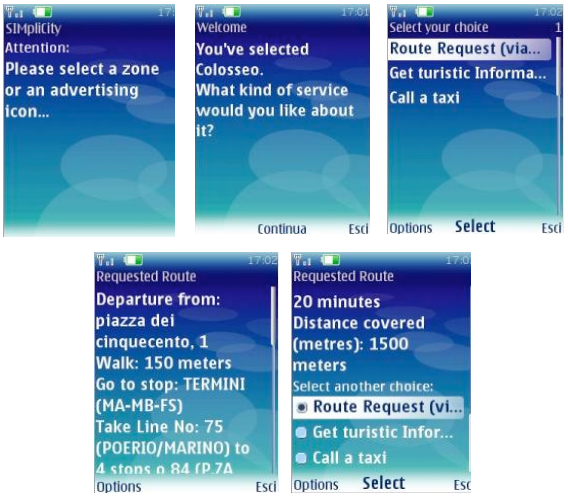

Figure 2 – SIMpliCity beta version

Conversely, SIMpliCity 2.0 retrieve information launching the browser of the mobile phone and connecting to a specific URL, obtained from the tag. Web pages containing the information are in a specific format for mobile so that displaying information is optimized for small screens. Moreover the interactions steps before launching the browser were designed using low level display: providing a pixel-level control of the application, a low-level display offers a more individual experience, so that all objects shown on screen are completely

under control of the programmer [13]. In this way all graphic

Figure 3 – SIMpliCity 2.0

objects are positioned in the optimal way (Figure 3).

To move from an http request to a browser-mediated interaction is an essential step to improve both the GUI and the navigation flow of the application.

Finally, to improve the reliability of the information displayed, we retrieved information about bus routes straight by the mobile site of the roman public transport company [14]. Our idea is that people trust what they already know, so finding a familiar logo while interacting with a new service using a technology they've never heard before, makes them feel more at ease.

5. RESULTS OF THE SECOND SET OF USABILITY TEST

After redesigning SIMpliCity application, we performed a new set of usability test, involving 15 users: 10 of them had already used the beta version, while 5 were completely new to the application. All the ten users involved in the first set of usability test declared to appreciate the version 2.0 more than the beta. None of them felt lost while interacting with the system and they all successfully managed to complete the tasks assigned (the tasks were the same as the previous set of tests). Of the five new users, three encountered some problems in performing the first task, as they needed to become familiar with the basic features of SIMpliCity. Nevertheless, once learnt how to interact with the system, they had no particular difficulties in completing the tasks. The other two users had no particular problems at all.

When asking about the information completeness, 70% of the users stated it as "good", while in the beta version the percentage of the users who considered it "good" was lower (30%). Moreover, three of the users (20%) declared to appreciate the interaction with the roman public transport mobile website, as they were already familiar with that and they trust it, confirming the project team idea about the importance of the presence of a familiar item when using a totally new service.

6. CONCLUSION AND FUTURE WORK

In this paper we have described the design of an application able to offer services of public utility. In order to set SIMpliCity as pervasive as possible we decided to invest all in the "simpleness", so we made use of technologies already known by people as GPRS / UMTS connection and SMS, and of NFC technology, whose ease-of-use is guaranteed by the paradigm of touch and by the possibility of automating actions decreasing the cognitive load of the user. Because of this, we took care especially of the usability tests conducted on SIMpliCity. The results revealed that SIMpliCity is successful because it provides already known useful services in a completely new way, meeting users expectations without making hard the use of new technologies. We are currently working on creating a unique platform, called SIMpliLife, able to interface several applications and so to manage many kind of services. SIMpliLife will be a sort of "suite" of NFC applications (SIMpliCity, SIMpliTravel, SIMpliPay, SIMpliAccess) based on the same architectural principles and on a similar GUI so as to give the users an homogeneous user experience.

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