Integrated Interaction with Large and Small Devices

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ABSTRACT

Smart cities large events have led to the ubiquitous deployment of public display systems, supporting the ambition to improve visitors experience and providing services which fit users' individual needs. In this context, we developed a personalized information service that integrates touch and touchless interaction, respectively on personal devices and large public screens, transforming public displays to something that makes a step towards innovation.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: Multimedia Systems, User Interfaces

General Terms

Human Factors, Design, Experimentation

Keywords

Motion-based touchless interaction, large screen, mobile devices, personalization, recommender system, mobile interaction

1. INTRODUCTION

As the streets of Milan fill up with visitors for the fashion exhibitions taking over the city during Milan Fashion Week or for the next world's fair Expo 2015, there is the emerging need to support masses, matching offers to users and personalizing recommendations. This situation has resulted in various experiments with new types of interactions, supported by developing new media tools. Among them, public screens are becoming a consolidated technology available in indoor and outdoor exhibitions and, enriching their well-known advertising component for new challenging purposes, can bring new interaction paradigms into people's habits. As a matter of fact, whether they are static or dynamic, or whether they are enabled to allow interaction mechanisms to publicize contextual information or broadcast news on subway platforms, the majority of digital public displays currently remain not smart enough to understand users' needs and interests. To address this problem, we firstly started exploring public-display installations' potential with evocative touchless experiences, which allow to overcome aseptic issue, since users mostly take care not to touch any non-sterile surface; then, we tried to focus on personalization, bringing the estimate of users' demographic information on the big screen via image recognition. However, while conducting our study, we realized that many issues would be overcome by the introduction of personal device usage in this kind of interactions.

Including a mobile device offers numerous advantages:

- allows a precise knowledge of user's profile;
- overcomes the privacy issues, you can take contents on your device instead of sharing them with everyone on a public display;
- allows pocket experiences, you see details on a public environment and you "take" them home (taking away the experience);
- allows multiple interaction paradigms, you can use the mobile device as a remote controller of the big screen, having a modality of interaction (naturalness of use of the medium) to target people less suited to the use of gestural-based interaction.

Given these considerations, we enabled the use of personal devices (smartphones, tablets, wearable devices, etc.) to enrich our framework.

2. RELATED WORKS

Several interaction techniques using mobile devices with large screens have been proposed [4][1]. SWINGNAGE [5] allows interaction between smartphones and large screen displays targeting digital signage, so that user downloads detailed advertisements from the display to the phone. Similarly, Muta et al. [3] propose a system that supports multi-user online shopping via tablets and large screen displays. Tacita [2] is designed to enable viewers' mobile devices sending customization preferences directly to cloud-based applications that produce the content for the display. However,

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these systems do not focus on user-specific information or, if they do, they require explicit effort from the user to specify his preferences. We, on the other hand, propose a system that aims to capture implicitly, or with user's zero-effort, his personal profile information, providing him with highly customized content to be consumed in structured and meaningful ways on small and large devices.

3. OUR FRAMEWORK AND APPLICATIONS

3.1 System Architecture

The general software architecture of our framework is depicted in Figure 1. Applications modules can be hosted both on users' personal devices (*Mobile App*) and on public large screens (*Screen Application*). The application running on public screens exploits Microsoft's Kinect motion sensing technology to detect users' presence and to implement touchless gestural interactions.

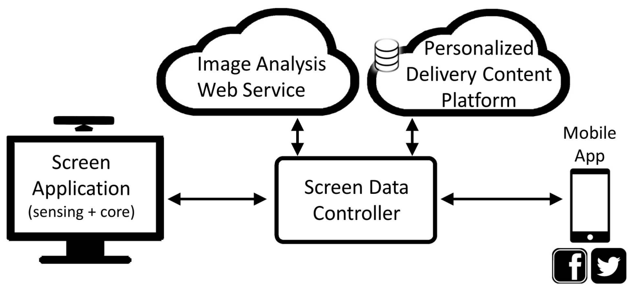

Figure 1: System Architecture

In particular, the *Screen Application* available in our system is a component that includes both the motion sensing and the core modules: the former interacts with the depth image sensor in order to obtain the data of the users' presence in front of the screen and to detect their movements, while the latter deals with the page navigation and contents visualization.

The *Screen Data Controller (SDC)* is a centralized module that answers to the requests of the various applications modules, i.e. it manages different Screen Applications (one for each available screen), manages users' presence in front of a specific screen, delivers proper contents to the most appropriate screen, enables to follow a user during his screen by screen interactions, etc. In a scenario where the user doesn't have a Mobile App installed on his device, the Screen Application exploits the Kinect sensor to capture an image of people detected in front of the screen and send it to the SDC that interrogates an external *Image Analysis Web Service* to estimate profiles data (gender, age range, etc.). According to this estimation the SDC invokes the *Personalized Delivery Content Platform* (the module that incorporates the available recommendation algorithms) to obtain the proper contents to be delivered on the large screen. In this case the personalization level is quite basic, for example every woman recognized around her thirty will obtain the same suggestions.

The personalization level could strongly be improved including the user's mobile device in the loop. The Mobile App allows the user to provide some profile data or to connect the app to one of his existing external social network account (e.g. Facebook or Twitter). These profiles contains a larger and more precise set of attributes: gender and age are precise and no more an estimation and many other information can be used to better customize the delivered contents (e.g. pages liked on Facebook, people followed on Twitter, etc.). To connect the user's Mobile App to the nearest large display any wireless proximity technology can be exploited. In our setup an NFC tag is present on every screen; the Mobile App uses the information stored in the tag to access the SDC RESTful APIs and through them it transfers to the screen the user profile registered on the smartphone.

Moreover, the possibility for the user to access personalized contents through his personal device overcomes common concerns about privacy. Many feedbacks from trial users reported that the visualization of personal suggestions on shared public screens is often seen as a privacy intrusion since the contents would be visible to other people nearby.

3.2 Developed Applications

To validate this approach we implemented two Mobile Apps addressing two different domains: tourism in Smart Cities and fashion showrooms in Smart Retail environments. Both applications are built on top of the previously presented framework.

3.2.1 Mobile App for Tourism

In this scenario a tourist is visiting Expo 2015 and while moving between the pavillions he interacts with the available public screens to obtain recommendations about Points of Interest (POIs) to visit in Milan. The developed Mobile App allows the user to register on the system using one of his social accounts and to obtain personalized suggestions on his smartphone. If the user allows to transfer his profile to the public screen, the personalized contents will be delivered on it and the system will be able to track his interactions following his visit screen by screen. In this way the system will be able to increasingly refine the provided recommendations since user's previous interactions contribute to better profile him.

3.2.2 Mobile App for Fashion

In this scenario we added to the previous one the possibility to use the personal device to play with the environment. The Mobile App is used to better enjoy the shop catalog, to simplify the item selection and to integrate gamification features like photos sharing (for instance photos taken while wearing the shop clothing) to the public screen or to social networks or getting pictures from the screen to the personal device.

4. EXPERIMENTAL SETUP AND USERS' FEEDBACKS

A case study has been conducted with the collaboration of Laurapunto clothing store. The event was held in Milan on 16 October 2014 when Laurapunto presented its new autumn-winter collection to its regular customers by means of our technology. Two interactive screens have been deployed in the shop and two cameras per screen were placed to capture the users' body movements and actions from two different angles (perspectives): *the frontal view*, recording the user's behavior (or moods) while s/he interacts with the screen, whereas, *the back view* capturing the user perspective, that is the content shown on the screen along with the corresponding user actions. Therefore, video analysis and pictures analysis were carried out by human inference for evaluating our system from an user-centric point of view. To perceive in a glance the real-world scene, we report some details: 72 pictures were taken through the Mobile App, in which 41 females and 15 males were captured, some of them appearing multiple times; instead, among 103 pictures taken from the screens, we could detect 170 females, 95 males and 112 passers-by, again with some repetitions.

The users' reported feedbacks could meet the following goals and expectations: *i)* to raise users' curiosity and attention on products inside the shop, *ii)* to attract and keep users interact with the system, *iii)* to allow simple patterns of interaction leading to fast learning outcome and *iv)* to achieve users' attitudes towards and acceptance of the new information system.

5. CONCLUSION AND FURTHER WORKS

Our framework enables a personalized exploration of items through several channels on public screens and personal devices. Its centralized management screen navigation, its Kinect sensor management module and the total separation of application logic and user interface, enable its use in different application domains, i.e. tourism and fashion, already set up in public spaces. It supports different interaction paradigms, touchless gestural interaction or touch interaction using personal devices, targeting several users (novice and expert, privacy-conscious and privacy-indifferent, young and adult) simultaneously.

We are now focusing on two main aspects to be able to provide better recommendations: *i)* discriminating between individuals and groups movements and interpreting them in order to understand users' social aspects and *ii)* enriching the mobile app implicitly inferring users' preferences from their social networks. In addition, we intend to investigate more sensors built on smartphones, ranging from cameras to accelerometers and gyroscopes that can track the movement of the phone itself, in order to define new interaction paradigms for sharing content from personal to shared devices and viceversa: grasping, shaking and rotating could be some of the interaction options we are considering.

6. ACKNOWLEDGMENTS

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