Multimedia Contents Provision Using Bluetooth for Cultural Heritage Applications: the MID-Blue project

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Abstract. The paper describes the MID-Blue (Multimedia Information Distribution over Bluetooth) system architecture as a dynamic guidance system for museum visitors based on Bluetooth connection. It provides specific contents related to the user position also using streaming video. This feature is still not diffused among Bluetooth technologies and could be more useful than other alternative solutions in museum contexts where it is necessary to delivery short-range information. The architecture overview underlines the components involved for supporting video streaming functionality over Bluetooth describing the first prototype implementation.

Keywords: Video streaming over Bluetooth, museum, RTSP, culture heritage.

1 Introduction

This paper describes a dynamic guidance system for museum visitors: MID-Blue (Multimedia Information Distribution over Bluetooth), a mobile Bluetooth based system for managing and providing multimedia information and contents.

Recent studies [1] show the growing trend of using mobile technologies in Italy: more than 20 million of people in Italy have at least a smartphone. Using smartphones guidance system in museum context can avoid cognitive overload of visitors, by allowing them to use their own device.

Many applications have been developed for smartphones to give users the possibility to use geo-localized information: social network (Facebook or four square) and information provider (Aroundme). Related to the specific context, different technologies have been used in museums guidance system such as optical signals (i.e. infrared), and RFID (Radio Frequency IDentification). Each of them has some limitation that will be describe in the next paragraph. An alternative can be represented by the Bluetooth technology. It is ideal for use in confined spaces and it also allows the transmission of data up to the speed of 721 Kbps [1]. The short-range distance (but not as short as for infrared) of Bluetooth is useful for delivering the right information related to the object close to the user, since the system has the possibility to infer (based on signal strength) the distance between the device and the transmitter. These features allow MID-Blue to provide specific contents related to users' position.

The MID-Blue system introduces an innovative method to provide information through streaming videos on Bluetooth. This is a new feature that is still not so diffused among Bluetooth technologies, and could be very useful for exhibitions in museum where it is necessary to delivery short-range information.

This paper will start from the state of art related to the guidance systems in museum and after that it will describe the MID-Blue project, describing the system architecture and how it can be an alternative valid solution in this specific context.

2 State of art

This section defines a first a framework for the application of multimedia technologies in museum contexts. Then it will illustrate the state of art for technologies related to the guidance systems.

Recent studies [3] show how a high percentage of visitors (about 75%) before starting their tour in the museum go first to the information desk. This highlights the necessity of an orientation guide to avoid confusion sense in museum users.

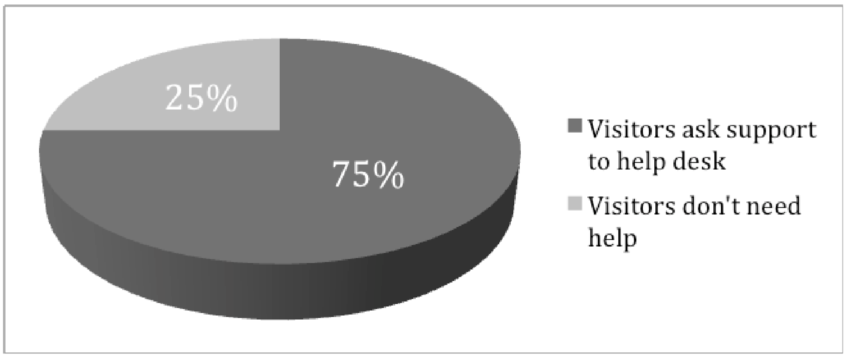

Fig. 1. Percentage of visitors in Italian museum that ask support from the help desk

Another research [4] highlights the importance of first impact of users with museums: the lack of and introduction in orientation in the space and the understanding of location and paths of exposure spaces affects the satisfaction level and generates sense of boredom and discomfort in users.

The lack of an adequate information support is the most visible critical issue and usually one of the first obstacles to increasing the number of museums visitors. A research of cultural Heritage ministry [5] shows how timetable and continuity of the opening times, facilities and basic services of the museums are acceptable. Audio guidance, multimedia station, digital catalogues, and contents in foreign language cannot usually be found on Italian museums.

The research of Cultural Observatory of Piemonte show how captions and information panel are examined on average by half of visitors, while Solima [6] reveals that the average time dedicated to read the information panel is less than 30 seconds in respect to the time of reading (50-70 seconds).

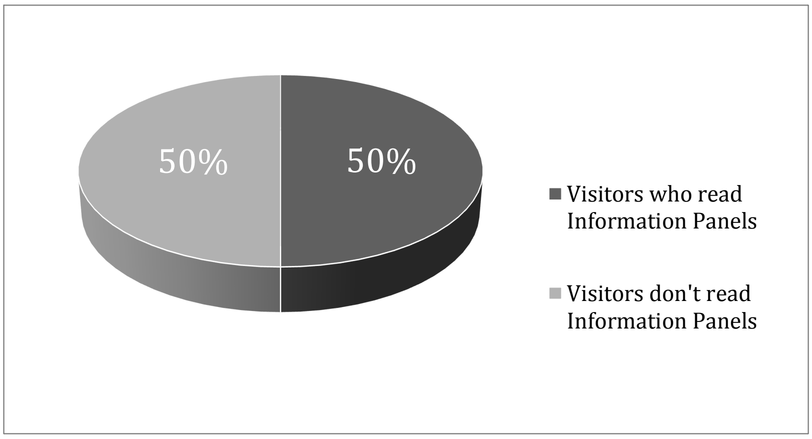

Fig. 2. Percentage of visitors of museums that read information panel

This is due to the density of texts and images of panels that causes difficult for users in reading relevant information. So it can be useful to give information on multiple level of in-depth examination in order to allow users to have different information related to specific interests, attention levels and the available time customized for different targets of visitors. Technologies are perceived as an opportunity for increasing the quality of life; furthermore young people prefer an indirect usage of cultural heritage [7]. Therefore it is possible to deduct that there is a percentage of young people who are inclined to visit a cultural venue if this is combined and supported by new technologies. The lack of specific technological skills induces museums to develop partnerships with "technology provider" such as universities, research centres and private and public companies operating in the ICT sector. In recent years there has been a growing interest in applying technologies to the cultural heritage sector. By now the focus is more on restoration and conservation activities [8] rather than on fruition.

Using Smartphone guidance system in museum context can avoid cognitive overload of visitors, by allowing them to use their own device [9]. Many applications have been developed for Smartphone devices to give users the possibility to use geo-localized information: social network (Facebook or Four Square) and information provider (Aroundme).

Related to the specific context, different technologies have been used in museum guidance system such as:

- Optical signals [10] – the main disadvantage of optical signals (such as infrared) is that the line of sight between the emitter and receiver can be occluded; also, the infrared signal range is small, forcing the visitor to get close to the emitters;
- RFID [10] – promising technology, but not yet available in smartphones;
- Bluetooth technology.

Against the others, Bluetooth finds it ideal application in confined spaces, it is capable of transmitting data up to the speed of 721 Kbps, and it is a global standard targeted to low cost, small sized, and very low power consumption applications [1, 12, 13].

The short range distance covered by Bluetooth technologies is useful for delivering the right information related to the objects close to the user, since the system has the possibility to infer (based on signal strength) the distance between the device and the transmitter. These features allow providing specific contents related to the user position.

The MID-Blue system introduces in respect of similar systems [1] an innovative method to provide information through streaming videos over Bluetooth. This feature is still not diffused among Bluetooth technologies, and could be very useful in museum context where it is necessary to delivery short-range information. The next paragraph describes the architecture, describing the components involved for supporting video streaming functionality.

3 Architecture Overview

As described before, this system aims to provide multimedia contents distribution to the users in a small and delimited geographic area (as museum, archaeological area, trading fair, exhibition, etc.) using the Bluetooth connection presents in almost all mobile personal device (smart-phone, cellular phone, PDA, etc.).

The use of Bluetooth connections allows the system to guess how far is the user from the point of interest through the signal strength. In this way the system can provide a list of content only related to what is close to the user (a picture, a statue, a painting, etc.). The use of this system aims at substituting the use of audio/video tours or guides (organization ownership) with the use of personal devices (users ownership) for cultural heritage applications.

Beyond savings in terms of buying and management of equipment, the use of personal devices allows to:

- Improve the user interaction experience (the user is more confidence using their own device compared to i.e. the museum video guide);
- Update the multimedia contents very quickly and make them available almost in real time.

From a software perspective, the system involve only Open Source Software (OSS) solutions, allowing to avoid sophisticated constrains related to the licenses management. The multimedia contents managed by the system regards only this three kind of format:

- Text;
- Image;
- Video.

The system is based on a client/server architecture in which the server is the multimedia content provider, and the client is the personal device. From the server side we have the following software components:

- LINUX Operative System;
- Bluecove library for managing Bluetooth connectivity;
- Java virtual machine (the MID-Blue server is developed in JAVA);
- Darwin Streaming Server (the video/audio streaming service).

The architecture design plans the possibility to use more than one server (actually one for each location/room), and each of them is interconnect with the other ones through the Ethernet cable or Wi-Fi network. Each server manages a subset of content related to the location in which it is, in this way the content among the server can be different. Only the information concerning personal devices of the users that agree to interact with the system must be shared among all the servers.

From the client side, the personal device has to have the following software for hosting the client component of the system:

- Software to manage the blue-tooth connection (each personal device has one if the blue-tooth characteristic is present);
- Java support (the MID-Blue client component is a midlet Java application);
- CLDC Framework 1.1 (Connected Limited Device Configuration - needed to implement the midlet application);
- MIDP 2.0 profile (Mobile Information Device Profile - needed to implement the midlet application);
- OBEX service for file exchange through Bluetooth connection.

Since the exchange of file, as picture or text, by using Bluetooth [14] is a common procedure for the personal device users, for the video there are some limit due to the storage and timing (connection time) constraints. For this reasons, starting from the literature on streaming over Bluetooth in the last ten years [15, 15, 11, 18, 19], we planned to design and implement a streaming video functionality over Bluetooth connections.

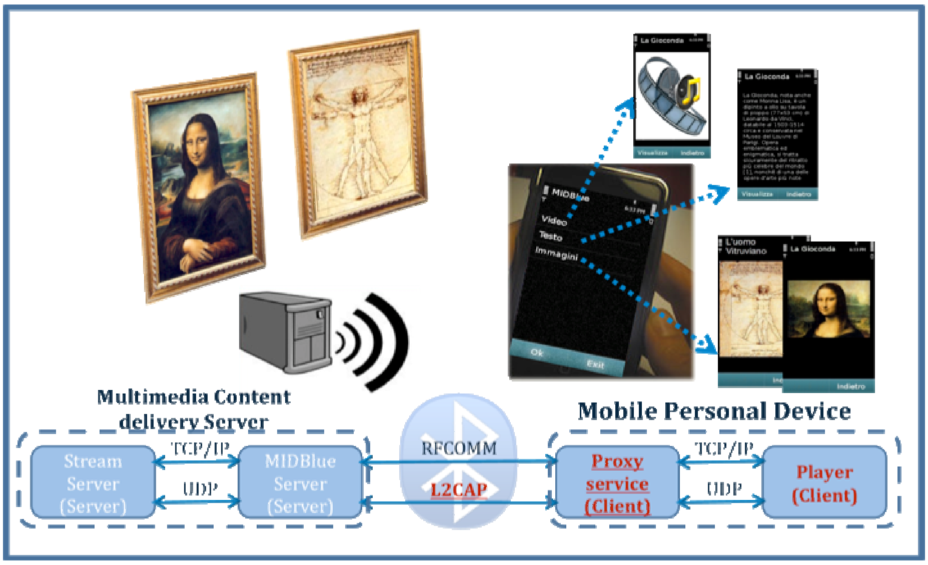

Fig. 3. MID-Blue architecture schema

According to the MID-Blue architectural overview shown in Fig. 3, the protocols used for the communication between client and server for provide and use streaming video are:

- RFCOMM (Bluetooth) – to exchange message for controlling the video streaming and to send/receive the picture or text file;
- OBEX (Bluetooth) – for providing the client application to the personal device;
- L2CAP (Bluetooth) – for the video streaming support at layer two;
- RTSP (over IP) – streaming protocol.

Using Streaming functionality via L2CAP allows to hide the peculiarities of the Bluetooth low-layers, thus making it possible for existing applications to run over Bluetooth links without deep modifications. In this way it is possible to use streaming client/server application designed to work over the IP protocol, as the RTSP streaming server.

The RTSP[1] protocol is based on combination of TCP and UDP protocol over IP: through TCP it is possible exchange messages for controlling the video flow, while UDP transports the real content of video.

Using the Bluetooth as layer-2 connection, the TCP messages can be encapsulated in RFCOMM packets while the UDP video content in L2CAP. This is possible using a proxy on client side as showed in Fig. 3.

On personal device, the proxy service is listening on port 81 for requests from the client media player (i.e. Realplayer[2]). When a request is received, it activates three

[1] http://www.ietf.org/rfc/rfc2326.txt
[2] http://www.real.com

communication channels with the MID-Blue server (on server side through Bluetooth) in this way:

1. TCP – RFCOMM: for the RTSP requests and streaming control
2. Two UDP – L2CAP: for audio and video streaming

On the server side, the MID-Blue Server is listening for request on the above mentioned channel, and upon reception of a request it forwards it to the Darwin Streaming Server, that provides the video/audio streaming service, using two UDP ports for content streaming, and one TCP port (port number 554) for streaming control.

4 Discussion and Conclusion

This paper briefly describes architecture of the MID-Blue platform, confronting it with the state of the art of similar systems. In particular, the paper describes how the streaming video over Bluetooth is implemented for carrying out the first prototype, and discusses the advantages of this kind of system against other possible alternatives for the provision of multimedia contents for proximity cultural heritage applications.

The MID-Blue project is still underway, therefore the conclusion of development phase and the project validation through experiments or simulations are candidates for future research efforts.

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