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Short Presentations

MUST System - Location Based Services and Multilingual Simultaneous Transmission for Tourist Fruition

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Abstract

The following is a presentation of the "MUST" - Multilingual Simultaneous Transmission - system that provides radio transmitted (PMR-PLL) audio tracks up to a distance of 100-200 meters in open areas in eight different languages simultaneously. This innovative system, developed with a unique integration of technologies, provides comments, descriptions, and/or background music to groups of users in various types of situations that have been activated using LBS (Location Based System) technologies. The contents can be activated in LBS mode using GPS technologies in open areas while in indoor environments RFID technologies are necessary. The main advantages of this solution are: the low cost of the client devices (audio receivers), joined by the economic advantages of digital audio track self-production; high transportability; the possibility of extending the system's functionalities; the high number of supported system clients: more than 100 receivers can be used simultaneously and the number of simultaneous audio languages can be extended further. The next development of the synchronized video streaming functionality gives MUST more advantages and implementation possibilities.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [Multimedia Information Systems]: Hypertext navigation and maps J.0 [Computer Applications]: General, field sciences J.5 [Arts and Humanities]: Archaeology H.3.4 [Systems and Software]: Distributed systems H.5.1 [Multimedia Information Systems]: Audio Input/Output

1. Introduction

The following is a presentation of the "MUST" - Multilingual Simultaneous Transmission - system that provides radio transmitted (PMR-PLL) or cable transmitted audio tracks in eight different languages simultaneously. Cable transmission system is the best solution for in-door or on-board applications where there are several seats with head-phones output, while the radio solution can be used in open areas where users can move up to a distance of 100-200 meters from the transmitters rack. This innovative system, developed with a unique integration of technologies, provides comments, descriptions, and/or background music to groups of users in various types of situations that have been activated using LBS (Location Band System) technologies and can be set to manual, semi-automatic or completely automated mode. The contents operated in LBS mode can be implemented using GPS technologies in open areas or RFID technologies in closed environments. The system is equipped with its own highly flexible software that can be individually compiled to suit specific commentaries regarding the archaeological area, or theme park, being visited. It is therefore possible to use a single system to provide an audio-guided service in 8 different languages by selecting the route-monument-work of art option of the specific commentary required. The MUST system and its management software have been developed to meet the various and diversified needs of the tourist sector. MUST offers two system options: a fixed centralized option that restricts transmission of all the equipment to within the 200-meter range of the radio signal and a mobile, portable option that can be carried in a backpack or trolley. The system was developed to meet the specific needs of simultaneous transmission of audio content to groups of people of various nationalities and languages. The systems currently present on the market are for the most part conceived to provide pre-recorded or live commentaries but do not offer simultaneous commentaries in different languages. Figure 1 shows the flight-case containing the equipment, receivers, and audio transmitters.

2. Description of MUST

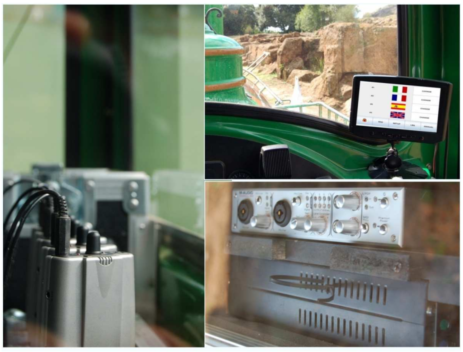

Figure 1: MUST *system.*

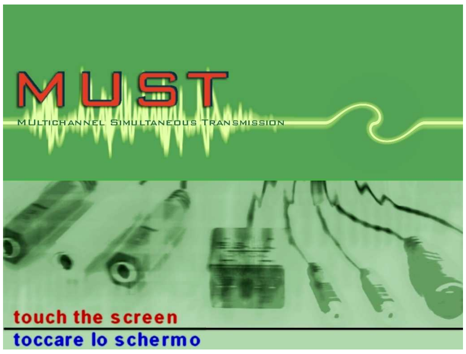

Figure 2: MUST *logo.*

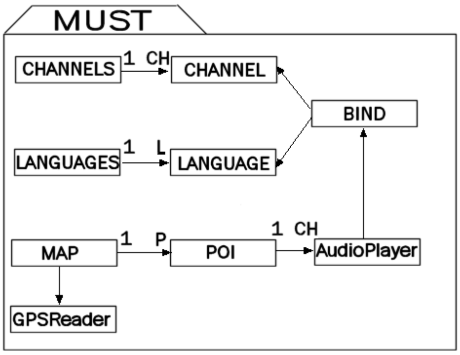

Figure 3: MUST *Class Diagram.*

The MUST system was created as a device to enrich the valorisation and tourist fruition project of the UNESCO site at the Etruscan "Banditaccia" necropolis of Cerveteri (Rome). The particular characteristics of the area, a tuffaceous plateau of about 10 ha with some 400 monuments including tumulus and hypogeum tombs immersed in a unique

Figure 4: MUST *Binds Configuration.*

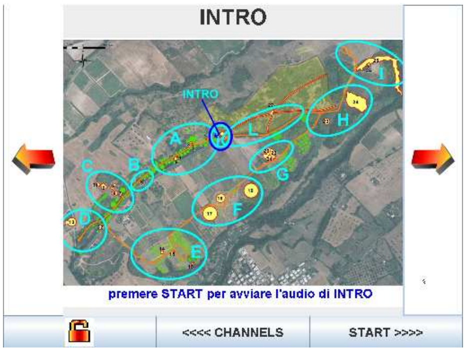

Figure 5: *The Manual selection of POI.*

landscape, made it necessary to develop an innovative audio guide system that could furnish simultaneous transmissions in up to 8 languages. The tour of the monuments runs along 3.7 km route onboard a light-electric train where the users/tourists are equipped with audio guides that describes the site in their own language. MUST offers two distinctive system options: the first system (management and control system) is made up of: a Mini PC with specific software for

Figure 6: *POI's contents controls.*

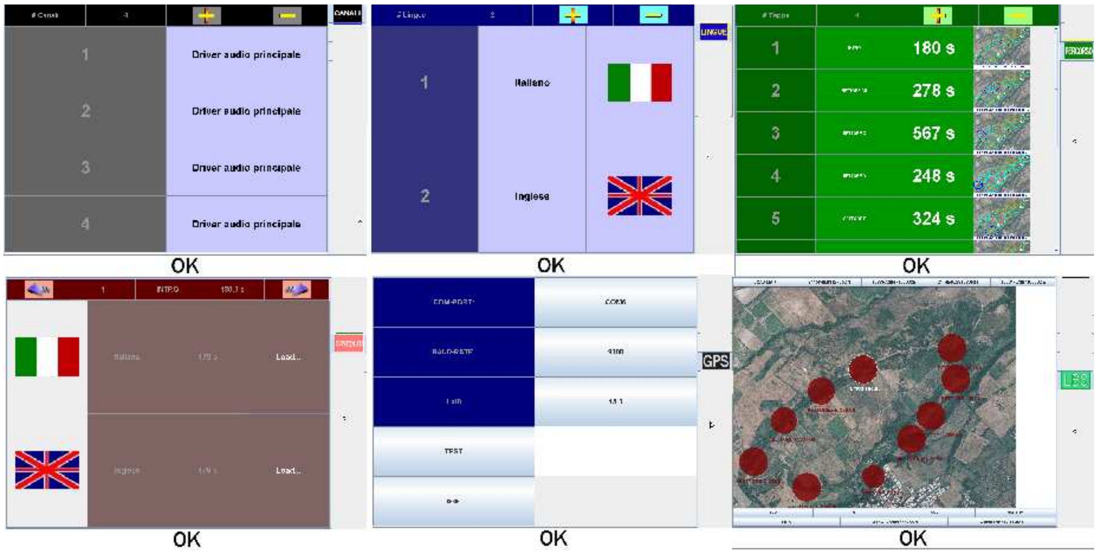

Figure 8: *MUST's Configuration GUI*

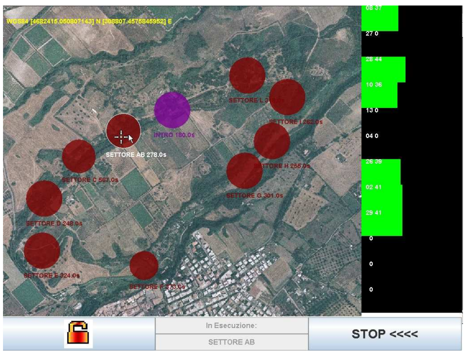

Figure 7: *The LBS execution modality.*

the management of multilingual audio sequencing of the relative area being described; a Touchscreen to facilitate use by the operator. An audio card able to distribute up to eight audio tracks simultaneously to the transmission system is connected to the Mini PC. This first system is contained in a sturdy flight case that can be transported manually for software maintenance or upgrading. Three power supply system options were applied: 220V to the network, 12V (6A), and a self-contained system with rechargeable batteries. The second system (Radio transmission and reception system) has up to a maximum number of eight transmitters (PMR or PLL) connected to the first system and the relative receivers - unlimited number - equipped with ergonomic earphones that are distributed to the users. Users can choose the transmission in their own language by selecting from the options found on each receiver. The second system is contained in a case that can hold up to 36 components (ex. 6 transmitters and 30 receivers) and has a battery recharging function that can be connected to the electrical system. If the tour guides need to intervene 'live' with non pre-recorded commentaries, they can connect a microphone to the audio card or disconnect from the central control system and connect directly to the relative transmitter at any moment. For applications in large open areas with different multilingual description sequences, the system can also use a GPS system connected to the Mini PC that activates the audio commentary of the relative object/location that the users are viewing thereby reducing the need of intervention by the tour guide. This configuration, designed especially for Spatial Information Management (SIM), has made it possible to develop a completely automatic process for the integration of heterogeneous data to the system. For applications in indoor environments, MUST can be integrated with synchronized multimedia content management functions for the audio for videos or for wireless transmission towards palm receivers or smartphones.

3. LBS-GPS Application

Location Based Services (LBS) are added value services that use the knowledge of the geographical position of a mobile user to dynamically provide the necessary requirements to the user depending on their location and the characteristics of the surrounding context. In general, the Location Based Services combine information regarding the geographical location with other types of information regarding the surrounding context and environment. These services are usually based on the use of a communication network and one or more localization technologies combined with Geographic Information Systems (GIS) that manage data collection and how it is presented to the final user. Furthermore, in some cases added value application solutions integrated with the technological infrastructure and GIS systems are also used. Their complexity depends on the type of service provided. In this specific case, the MUST system includes very simple GIS functionalities, being a tool dedicated non expert users to manage LBS cvonfiguration and monitoring and to link audio contents to the active areas and positions. Once it was coded in audio format, the information was transferred to the MUST system that, using the position given by the GPS, selects the available information in audio format from the WebGIS application called SITAC (Sistema Informativo Territoriale e Archeologico Ceretano [CMR06]) and transmits this information to the user who asked for it through his position. The system used is based on open source software. The data bank developed foresees the use of a common geographic database (Postgress and PostGIS) that can be accessed through a WAN or the Web. Finally, given the necessity to develop a satisfactory and above all low cost system, an economical and compact entry level GPS was used. The geographic position of the user can be obtained by a reference system integrated within the environment (ex. RFID), or by a total reference system (GPS). The services provided are usually personalized to meet functional and content supply requirements as well as fruition modality requirements in response to the user's profile and position at that moment.

4. MUST Architecture

The MUST system has been developed using JAVA. The MUST class diagram (see Figure 3) defines five main components: Channels, Languages, Map, GPSReader and MUSTAudioPlayer. A Channels instance holds a set of references of size CH to instances of the class Channel. Each Channel object defines a target_audio_device_ID (e.g.. an identifier for a hardware audio output channel) and a channelSEQN from 1 to CH. The Languages class holds a set of size L of instances of Language. Each instance defines the triple (languageSeqN, languageID, languageIcon), where a languageSeqN is a sequential number from 1 to L, a languageID is a string (e.g. "Italian") and a languageIcon is a javax.swing.ImageIcon instance (e.g. an image of the Italian flag). The role of the class Bind is to determine the selected language for a Channel. A Map class defines: a set of size P of points of interest (POI),a georeferenced bound and a bitmap representing the interested area. Each POI instance holds: a POI_ID: a unique integer number from 1 to P, identifying the POI, a pair ((Lon,Lat), Radius) where the pair (Lon,Lat) defines the geographical position of the POI, and Radius (the distance in meters from (Lon,Lat)) is the parameter used by the LBS in determining the active boundary of the POI, a set of CH MUSTAudioPlayer instances and a POI_DURATION defining an upper bound for the time duration of the audio files related to the POI. The MUSTAudioPlayer class defines the methods to play(), stop() or pause() an audio content on a Channel in a particular language defined by an instance of the class Bind. The audio files are stored in a folder named "contents". Each audio file name is formatted as "cilj.wav"; where i and j define respectively the corresponding POI_ID and languageSeqN. Finally, the GPSReader class defines a thread for the MUST's LBS execution modality. This thread continuously reads data from a GPS receiver, converts the coordinates in the corresponding reference system, and triggers the activation of a POIp if the distance between the GPS location point and the POIp.(Lat,Lon) is less than the POIp.Radius. When a POI is active, a sequence of calls to play() is made - one for each of the CH Channel instances - and the corresponding audio contents are streamed to the MUST transmission subsystem via the audio players.

The MUST interface allows a user access to the setup screen, and to the manual or LBS execution modalities. Figure 4 show the first main window where a user can: modify the binds between channel and language; choose between LBS and Manual execution; run the setup phase; exit from the application and lock the touchscreen. Figure 5 shows a POI's choice panel and transmission control for a manual session. Figure 6 shows the "Map" with ten preconfigured POIs. In the same Figure, a particular POI is interested by the presence of the MUST GPS device inside the area of activation. The tourists will listen to the commentary in their preferred language until the audio content will be fully played and/or a new, unvisited POI is reached. If the user selects the SETUP button (shown in Figure 4) a new Window with a tabbed pane of 6 panels appears on the screen. Figure 8 shows an explosion of the configuration GUI, divided in: Channels configuration panel, Languages configuration panel, Tour configuration panel, Contents configuration panel, GPS receiver configuration panel and LBS configuration panel. In the Channels configuration panel, the user can set the number of channels (CH) and their target audio device ID. In the Languages configuration panel, the user can set the number of languages (L), their languageIDs and their languageIcons. The Tour configuration panel allows to define the set of POIs, while the Contents configuration panel allows the user to select the audio files for each POI. Finally, the GPS configuration panel and the LBS configuration panel help the user in configuring the GPS device and in correctly placing the set of POIs on a specific georeferenced map.

MUST uses the JavaSound API [SUN] to handle the different audio streams needed for multichannel broadcasting. JavaSound is a standard Java library (J2SE version 1.3.x and higher) which abstracts the underlying audio hardware and streams, thereby allowing low-level device control and reproduction/recording of different audio file formats, maintaining at the same time the multi-platform capabilities of the Java language. In MUST, each audio stream related to one of the available languages is handled by a custom MUSTAudioPlayer class. Each instance of the class uses the Observer/Observable pattern to report its activity to the rest of the MUST system. Other components of the system, such as the user interface, can register themselves as observers so that they are notified when specific events occur in the audio stream - as an example, when the end of an audio file is reached. Internally, each MUSTAudioPlayer instance employs a local JavaSound audio stream to play the assigned file, plus a local thread to control the audio stream activity at regular intervals, fetching new data from the audio file in the drive and writing that data to the audio hardware. There is thus no need to load the whole audio file in memory, since only a small buffer is used by each player. Audio file length is therefore only constrained by the available disk space. When created, each MUSTAudioPlayer class instance accepts a local audio file name, an audio hardware device name, and a reference to an observer object as the parameters of its constructor, and encapsulates the use of the JavaSound API, so that it is possible to port MUST to a different audio platform by specializing the MUSTAudioPlayer class. Multichannel audio hardware, such as the M-Audio sound card, usually maps its physical outputs to a set of separate audio devices available to the OS. Since each MUSTAudioPlayer class instance handles its own audio stream independently, multichannel audio reproduction is realized by instantiating several MUSTAudioPlayer classes, each assigned to a different audio device representing one of the soundcard's physical outputs. Therefore, MUST is easily scalable to employ as many audio channels as its CPU and audio hardware can handle. Moreover, it is possible to use different formats to encode the audio, as long as JavaSound provides native, platform-specific codecs for them - MP3 format is a typical example. Compressed formats, though, need far more CPU resources to be decoded, therefore uncompressed WAV format is currently employed in MUST to represent audio guides, so that more audio channels can be achieved. This is acceptable, given that there is more than enough space to accommodate uncompressed files in the system's hard drive and that employing a more powerful CPU would pose serious problems to the system's autonomy, heat dissipation and price.

5. Related works

In [GDVG] existing audio guide systems are categorized according to their properties. They are mainly divided in two categories: manual activation and automatic activation systems. Manually-activated audio guides are widely used but they require some learning time. Among groups tour systems, solutions offered by Antenna Audio [Ant] are widespread but require the presence of an operator for each language. Automatically-activated audio guides are easier to use, and in many tourist offices (such as in Venice [APT]) it is already possible to rent a GPS audio guide. To the best of our knowledge, the multilingual radio transmission of audio contents is an emerging technology [Orp]. The combination of GPS and radio transmission technology is yet to be fully explored.

6. Conclusions

Simultaneous radio transmission of commentaries in different languages represents an innovative solution in the field of Multilingual applications, tools and systems for CH. Location Based System (GPS or RFID) integrated in the MUST system allows commentaries to be automatically activated along tourist fruition paths. Another factor characterizing the MUST system is the implementation of low-cost solutions using Location Based and Wireless services to improve the multilingual fruition of cultural resources. The system proposed can be adapted in archaeological sites, museums, theme parks, town and city tours, with or without operator. After the project and applicative stages of this first release, the work group is now elaborating the next phase. The second step foresees transmission not only of audio content but also of multimedia (video, images, 3D reconstruction) content for terminals using the latest developments in technology such as palm pilots and Tablet PCs.

7. ACKNOWLEDGEMENTS

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