VIRTUAL CITIES OF ART AND

IMMERSIVE EXPERIENCE IN GEO-REFERENCED COMMUNITIES

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Summary: this paper describes an R&D project carried out in framework of the European Project IRMOS, whose objective to enable real-time interaction between people and applications over a Service Oriented Infrastructure. The challenge is the development of immersive educational tools approaching Virtual World applications with open sources technologies. The aim is the construction 3D virtual museums/historical buildings where communities can meet for an edutainment/infotainment experience as well as artistic and touristic/commercial opportunities. The main innovation is the blend of virtual world with real world, geo-referencing real users through mobile phones GPS-enabled and mapping their avatar in the virtual world. Remote users will be able to virtually follow the visit of the on-site users and interact with them. The technological infrastructure covers several tools: content packaging, virtual world engines, mobile applications, proficiency tracking (SCORM), service oriented architecture, real-time servers. The prototype is under development using the products Wonderland, Learn-eXact, J2ME applications, virtualized server infrastructure.

Key Words: Virtual Worlds, immersive education, eLearning, SOA, real-time, 3D, GPS, positioning, geo-referencing, community, tracking, mobile applications, SCORM, Wonderland, Learn-eXact, J2ME.

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The IRMOS Project is a 36 month, 12.9M euro project awarded by the European Commission to a Consortium of 13 leading European organisations. The project aims to develop 'real-time' interaction between people and applications over a service oriented infrastructure (SOI), where processing, storage and networking need to be combined and delivered with guaranteed levels of service.

Within the scope of the IRMOS Project, Giunti Labs is developing one of the user scenarios for Interactive Real-time Location Based Learning, integrating its Harvestroad Hive Digital Repository and learn eXact Mobile Learning technologies with the Wonderland and Darkstar Virtual Worlds and collaboration platforms by SUN, running on top of the IRMOS SOI infrastructure.

1 – THE IMMERSIVE EDUCATIONAL APPROACH

1.1 – The challenge

Education is getting more and more importance in today activities, and the possibility to teach and learn in an intuitive fashion is very attractive. Virtual Worlds constitute a valid candidate for enabling natural and immersive education paradigm.

The specific field of art education is particularly suitable for virtual worlds, since it refers to three-dimensional objects like monuments, statues and urban architecture.

Let us depict a scenario: a teacher is walking around the Coliseum in Rome with his mobile device GPS enabled. In the meanwhile, some students are at home (or other remote location) and have been invited by the teacher to browse an internet page where the Coliseum is reconstructed as a Virtual World. The teacher's movements are reconstructed in real-time into the virtual world and the students can see the teacher's avatar moving. Teacher and students can interact for explanations, questions, discussions. The interaction may be both written and vocal. When the teacher goes nearby a work of art, he can invite the students to start a lesson. Individual students play their lesson by themselves, while continuing communication via chat. A touristic guide approaches the teacher and he is invited to join the virtual world by connecting through his mobile phone, in order to appear in the virtual world as an avatar selling souvenirs to the students.

1.2 – The technologies

The above scenario should be supported by an infrastructure enabling several technologies:

- three-dimensional virtual world rendering
- real-time management of avatars' movements and gestures
- instant communication and messaging within a community
- geo-referencing of the virtual world
- geo-localization of the users in the real world
- binding eLearning contents to 3D objects
- binding eCommerce transactions to Virtual World Community.

1.3 – The players

The main stakeholders in the development of these kinds of application are:

- 3D designers, for supplying the world definition
- Learning contents developers
- Geo-localization providers (GPS for outdoor applications, WiFi for indoor applications)
- Technology providers, for supplying Virtual Worlds as a Service
- Community keepers, for supplying streaming communication
- Mobile operators, for supplying wide band data transfer

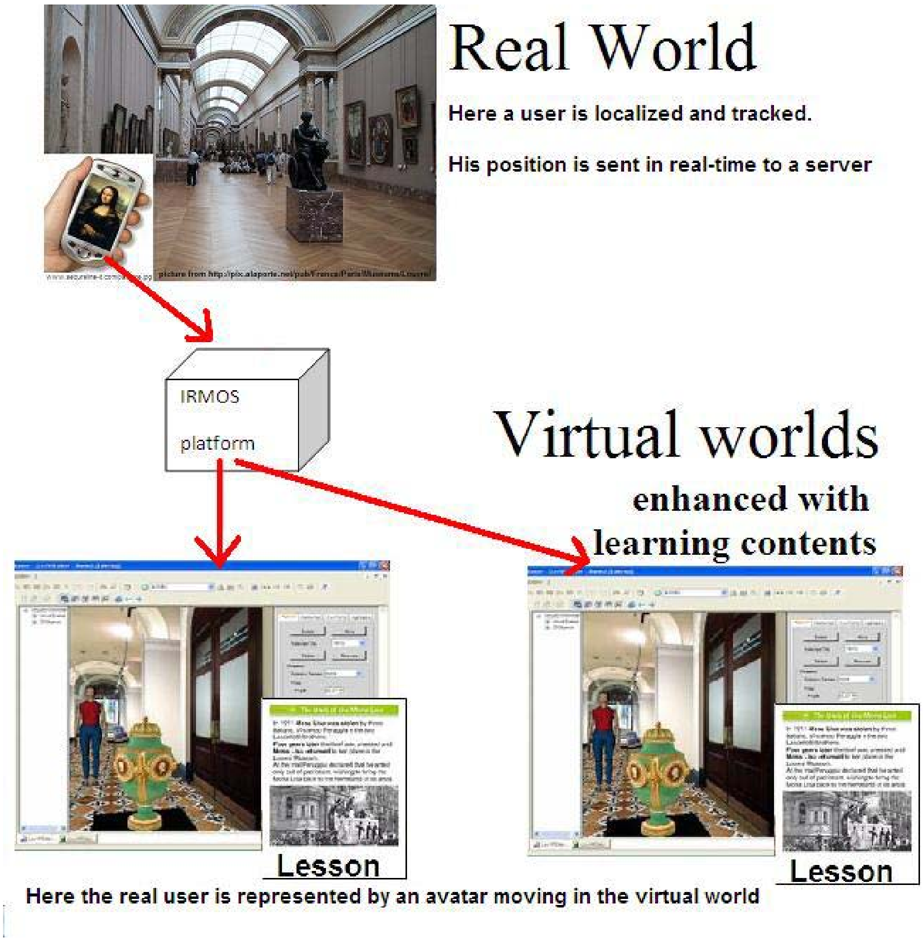

Fig. 1 : Blending real world with virtual world in an educational scenario

2 – VIRTUAL CITIES OF ART

2.1 – The educational value

Virtual cities of art have a great educational potential. The most immediate application is virtual school-trips in which students are guided through a learning path including lessons and tests. One of the most interesting aspects is the possibility to control the student proficiency and track his learning.

From the pedagogical point of view, virtual worlds offer a great stimulus for learners, for instance “opening” the access to new city districts only after having completed the visit to the previous district and passed the assessment tests.

2.2 – The artistic value

Virtual cities of arts offer also new chances to artists, allowing them to set up exhibitions without the burden to ask permissions and transport materials. A possible scenario is that of an emergent young painter that organises a picture exhibition placing his artworks under the Tour Eiffel or in front of Tate Modern Gallery of London.

Each artist can send invitations to join a show, in which he will be present (as an avatar) for explaining and presenting the artworks.

2.3 – The touristic value

Virtual cities of art have a great impact in touristic business, allowing various form of eCommerce: museum visits with entrance fee, souvenir sale, postcards sending, retail of physic products, e.g. selling T-shirts with Pisa Tower.

3 – BLENDING REAL USERS IN VIRTUAL WORLDS

3.1 – Geo-referencing assets and users

One of the most innovative aspects of this kind of application is blending real users moving in the real world with virtual users that are interacting with their computer.

Two main issues are involved:

- Geo-referencing 3D assets: this implies that the representation format should support the geo-coordinates attribute. One of the most used formalism is KMZ format, an XML-based language schema for expressing geographic annotation and visualization on Web-based renderers.
- Geo-referencing users: this implies the localization of users and the tracking of their movements. Two possible technologies may be adopted:
  - GPS localization for outdoor positioning, in this case the data are natively expressed as geographical coordinates.
  - WiFi triangulation for indoor positioning, in this case the data are initially referred to a local origin and should be further mapped to geogra-phical coordinates.

3.2 – Interaction model

The merging of real-world users with virtual-world users raises the issue of interaction among people using different devices and diverse technology infrastructure.

In fact, real-world users are penalized by the fact that Mobile Devices have limited computing power and slow/expensive connection, therefore they should interact with minimum data processing/transmission. The virtual world is not worthy to be reproduced on the mobile device, so the community should not be represented by avatars, but as a list of names.

Moreover, the movements of the real-world user are difficult to be captured, especially the gestures like hands movement or face expressions. Hence the mobile application should be equipped with a set of commands for allowing the user to point objects and express body orientation.

The business model should also introduce further functionalities to permit a fluid sale activity, for instance sending a photo of the T-shirt on sale.

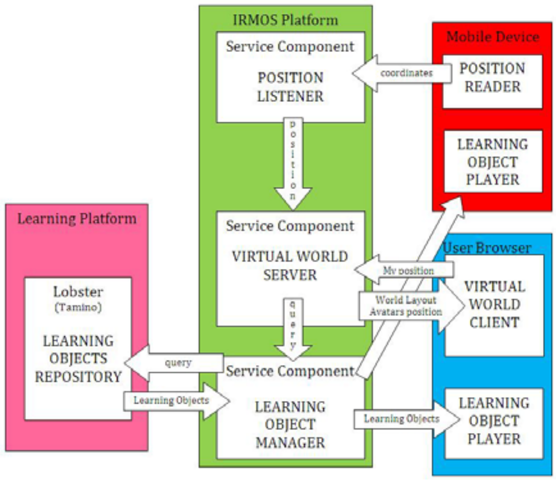

Fig. 2 The system architecture

4 – TECHNOLOGICAL INFRASTRUCTURE

The deployment of a virtual City of Art, requires the following technological infrastructures:

4.1 – Content management

Content management tools include:

- Packaging tools for the creation / editing of eLearning contents including several multimedia assets (hypertexts, images, videos, audios) as well as assessment tests and learning tracking. The SCORM standards fully accomplish the above requirements, including the interoperability among several LMS/LCMS platforms (Learning Content Management Systems).
- Content provider, for supplying contents to the remote users.
- SCORM tracker, for keeping track of the learner proficiency.
- Content player, a light software module, often web-based, for playing lessons and perform evaluation tests, keeping track of the learner proficiency.

4.2 – Virtual World Tools

Virtual world tools are structured in several components:

- World Editors, for the creation /editing of three-dimensional assets: monuments, streets, buildings, statues, and any other physical object.
- World representation, a standard interoperable formalism for representation of 3D assets, the most attractive is COLLADA, a royalty-free XML schema that enables digital asset exchange within the interactive 3D industry.
- World server, for supplying 3D assets to the remote users.
- World player (called also world-clients), for rendering the world on the end-user platform. This component should be linked to the Content Player. In Web-based architecture the world player itself may be supplied by a specific server, supporting the download.
- Community server, for dispatching avatars positions and instant messaging among users. This component should be linked to the mobile devices.

4.3 – Mobile Application

The Mobile Application includes simple basic capabilities:

- Geo-positioning through GPS (could be embedded or connected via Bluetooth)
- Community manager, for providing awareness about other people joining the session in the virtual world. This component should include some commands for acting the movements that are not detectable by GPS: rotations, gestures, facial expressions.
- Content player, for sharing the learning experience with the other users.

4.5 – Service Oriented Architecture

The peculiarity of the application in which several users interact simultaneously to join a common session in a specific timeframe imposes a service-oriented architecture. Each user has the role of a client that connects to a server platform asking for diverse services: world provisioning, community management, content delivery, SCORM tracking.

4.6 – Real-time requirements

The blending of virtual world with real world imposes some real time constraints, for supporting the fluidity of avatar movement, with particular concern to the real-world user, whose walking speed must be respected and correctly rendered into the virtual world.

It is important to understand that this requirement is not for a strict real-time, but for a soft real-time with the special constraint of Quality of Service agreement. Let us consider the case in which the user walks very slowly inside a museum, in this case it would be preferable to negotiate with the service provider a slow response time at a cheaper fare.

On the other hand the high number of joined people raises the issue of bandwidth and concurrent tasks, therefore a cloud-computing infrastructure might be requested.

5 – THE PROTOTYPE

In the scope of the IRMOS project, Giunti Labs has been developing a prototype addressed to the creation of Virtual Silent Bay in Sestri Levante (Genoa, Italy).

Fig. 3 the Mobile side of the prototype

The demonstrator prototype will allow a user to move close to the Abbey Annunziata and retrieve several kinds of educational contents, selected on the basis of user profile (language,

age, preferences, position) and of the equipment capability (desktop, mobile, connection speed,...).

Fig. 4 prototype of the virtual Annunziata Abbey

Most of the adopted technologies are open source, in order to allow a common benefit of the research activity.

In particular, the adopted technologies are:

- eXact Packager, Giunti's tool for content editing and packaging.
- HarvestRoad Hive, Giunti's Federated Digital Repository System for managing on-line contents in learning systems, corporate training and knowledge management initiatives.
- eXact Mobile, Giunti's Java application for real time positioning and content playing. Based on J2ME technology is can be deployed on a wide range of devices.
- Wonderland, Sun's open source platform based on Java for collaborative 3D virtual worlds.
- Darkstar, Sun's open source software infrastructure for massively scalable online games, virtual worlds, and social networking applications.
- SketchUp, Google's 3D modelling toolset designed for architects; it includes features to facilitate the geo-reference of 3D objects.
- Irmos, the platform for Interactive Real-time Multimedia Applications on Service Oriented Infrastructures, where processing, storage and networking needs to be combined and delivered with guaranteed levels of service.

3 - CONCLUSION

Virtual Worlds technology is today mature for allowing applications that go beyond the gaming and entertainment. Thanks to the Mobile technology and infrastructure, it is now possible to create innovative applications enabling new educational and business paradigms.

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