

# Interoperability in virtual world

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**Abstract.** Recently we have seen a growing use of virtual worlds (VW) in many areas like marketing, e-commerce, games, social interaction and education. The virtual worlds offer many resources to engage their users (named avatar) like freedom of movements, teleport yourself to other local, communicate with other inhabitants (both text and voice messages), capacity to create, modify and destroy objects and the possibility of programming behaviors to these objects via scripts. The amount of resources "in" the world is great. This measure will be bigger if adding the resources "out" the world. Both resources (in and out) need ways to communication. Our interest on VW applications to education goals, rises the necessity of understand the model, protocols and ways of communication these "virtual worlds" with the "real worlds".

**Keywords:** virtual world's communication, Open Sim, Second Life, real world to virtual worlds, R2V.

## 1 Introduction

If we can say: the life imitates video, and then we can say that the real world going to virtual world and vice versa. A long time the movies carry us to worlds where the reality is overtake, no are limits to interactions with objects and inhabitants and the human communicate with computer from some way.

Experiences that involve the human brain connection with computers and virtual reality are the recurring theme in the movies. Many current research to connect real and virtual worlds, already presented in the cinema, like communication (as showed in the 1992 movie *The Lawnmower Man*), teleportation (as depicted in the 1982 movie *Tron*), one world affecting the other (as viewed in the 1999 movie *The Matrix*) and the human feelings and behaviors (as showed in the 2009 movie *Avatar*).

Recently, games are using the real devices to improve virtual interaction player-environment-others players. Two well-known samples are Nintendo Wii and Microsoft Kinect. Wii use sensor-based technology to scan accelerometers and movement sensors to synchronize the motion of the game character with the real motion of the gamer [1]. Kinect apply camera and real-time vision processing to recognize user

movements and microphones that calibrate the player voice to control an avatar or an object in the virtual world according to the movement of gamer [2].

Besides, VW technology has been applied in many areas with differing goals. The companies using the lands to publicize and more deep sense, test the acceptance their products or services [3]. The lands are fertile ground to create, innovate and disclose objects with the brand, concepts and values of the companies, reinforcing their influence with the costumers. Others actions can involve sales, discounts, awards and competitions. The flexibility and velocity to update the objects and lands with the costumer's desire are great reasons to firms be in VW.

The individuals, through her/his avatar, can market in these worlds too [4]. At the same time that real market happens out of virtual worlds, the virtual commerce happens in virtual worlds. People create and sale objects, terrains, avatars and all items there are in these environment. People might want just fun, meeting other people and play in the world without worrying with theoretical or technical issues [5]. A great number of people have these behaviors in the VW's. Make friends, know different cultures, be accepted in the groups, share interests and be part of something are causes to persons leave aside technical aspects and focus in personal relationship.

The education is an area that receives a lot of effort to use the virtual worlds resources. Attractive visual, flexibility, availability, simplicity, interaction, collaboration, cooperation, media support, freedom creative, and free virtual worlds servers are some arguments to teachers employ VW in their classrooms and students want access it. According [6], VWs are good resources to achieve educational goals because they have persistence (effects of actions remain in the environment even if the user leaves), access and availability 24 hours a day, seven days a week; allow social interactions; their 3D graphical environments would improve interaction and sense of realism; is possible to see, hear and touch virtual objects as well as create, edit and manipulate them as if they were physical objects. These technologies also allow teachers and students the use of innovative learning strategies: practical training, group work, discussions, field practices, simulations, and visualizations of concepts.

Many researches about communication among real and virtual worlds and ways to exchange information between these environments are in progress. In [7] is proposed a method to transform sensed information from real world to standardized XML instances and to control virtual world objects. Sensor data imported into the multi-user 3D environment that mirror a real-world chocolate factory and its processes are presented by [13]. The problems and difficulties of data exchange between virtual worlds and the real world, comparison between different fundamental approaches of realizing communication channels and outline a general method for designing interfaces between virtual worlds and real-world data spaces are described by [8]. Provide an understanding of virtual wealth, its related virtual world, and its relations to real world; arguing that the realization of virtual wealth in both virtual and real worlds is necessary and possible is aims of [9].

The need for ontology services, the several approaches for associating ontology concepts with objects and locations, discussion how to populate common-sense ontologies using data harvested from real and virtual worlds are showed in [10]. The virtual campus project which builds a 3D virtual campus of the Chinese University of Hong Kong (CUHK) in networked virtual worlds and where users can immerse in

virtual CUHK with an avatar and experience virtual education and other diverse campus activities is reported in [11]. The collect of information about network traffic to balance the client-server response in Massively Multiplayer Online Games (MMOGs) is depicted in [12].

Understand the influence of real world house price on virtual world land price with data collected from SecondLife.com and federal housing finance agency of USA and finding that land price in virtual world is significantly associated with real world land price is account by [14].

Two interesting proposals involving haptic stimulation could be viewed in [15], where one of the virtual avatars kisses the other in Second Life, an event is triggered and this event is decoded by our system to send haptic based kiss to the real user via the Bluetooth-enabled neck piece hardware. The other proposal [18], aims facilitate the communications of emotional feedbacks such as human touch, encouraging pat and comforting hug to the participating users through real-world haptic stimulation by the development of a prototype that realizes the virtual-real communication through a haptic-jacket system. Both works indicate some of the potential applications like distant lover's communication, remote child caring, and stress recovery.

In [16] is presents a novel system for detecting the real-world activities (events) using visual means (surveillance systems) over an area of the building and sending relevant information to the Virtual World Servers for recreating the events in Virtual World representation of the same area. The human moves like entry, exit, standing, walking, bending are captured and sent to virtual world server via HTTP messages.

Infer the human activity from environmental sound cues and common sense knowledge as an inexpensive alternative to expensive sensors and discuss the challenges to implement such a system from the signal processing and agent based system was writing by [17].

Following the concept of Internet of Things (IoT), some researches employ common devices to collect data from real world and send it to virtual worlds. In [19] is showed a scenario where context data collection from mobile devices can be used for augmenting virtual worlds with real-life data. Life-logging elements are used to control an avatar, in a virtual world, as a way to replay experiences. The mobile smart phone equipped with the context collection daemon which constantly monitoring the location of the device from the Global Positioning System (GPS) and the songs played by the standard media player of the phone. This information is send to Virtual World Server via HTTP web interfaces.

Using smart phones too, [20] presents a proposal for the use of 3D worlds to enhance the interface of mobile-learning applications. Some specific test results are shown for every component available to construct 3D worlds and the result is an expanded interface where more information is displayed in the same space related to the subjective 3D perspective.

Expanding researches possibilities, [21] describe how technologies like Ubiquitous Intelligence, Cyber-Individual, Brain Informatics, and Web Intelligence can be integrated together and fit into a seamless cycle like the one proposed in the Wisdom Web of Things (W2T). To achieve this goal, are showed two cases studies with communication between real and virtual worlds. Thus, is clear that the uses of VW are growing and expanding in many areas. To full use of virtual worlds, is necessary to communicate real and virtual worlds. This paper explores the communication ways

from real world (material devices and resources) to virtual world (avatars, objects and scripts) using the Open Simulator server, also called OpenSim [22]. OpenSim was used because it is very popular and free software. Moreover, it is applied in many researches, has wide documentation, wikis, and blogs, has users and developers' large base and is compatible with Windows, Linux and Mac OSX platforms. We think that our examples should work at Second Life server [23] too, but they have not been tested yet.

The reminder of this paper is organized as follows: in Section 2 are described the strategies of interoperation in a virtual world, Section 3 shows the results achieved and Section 4 ends with conclusion and future works.

## **2 Interoperation in a Virtual World**

This section lists the communication protocols available in OpenSim and describe applications of some theirs. As are many possibilities, we stay with those used in subject cited below.

### **2.1 Communication in the World**

The user can communicate with others users across her/his avatar or by script programming inserted in the object. Most simple way is the chat. Chat is available at bottom part of the viewers and allow to sending broadcast message typing the text into chat box. This communication utilizes the channel 0 to chat to all nearby avatars and objects. Text sent by chat through channel 0 can only be perceived by avatars within 20 meters (in virtual world metric) of the sender [25].

Users also can employ the Communication viewer's menu or similar. Most viewers have menu that allow set the chat status (away, auto respond, unavailable), classify chats by friends, contacts, groups and connect he/she thus. The classified people can be found via map's search. Also, lists of gestures that trigger the avatar to animate, play sounds, and/or emit text chat. Voice resource can be turn on/off to detect nearby.

In the virtual world, the avatar communicates with objects by "touch". Touch happens when avatar click on the object and it have a script that execute an action. To [25] `touch_start ( )` event is triggered by the start of agent clicking on task. When the avatar touch an object, a stars stream follow from avatar to object, wrapping this object and after that the programmed action (script) is executed.

The objects also communicate with avatars. According [25] the event `state_entry ( )` enable executing actions when it is detected the proximity of the avatar. Function `llSensor ( )` is a sensor that detects all avatars/objects and agents with a given name within 15m of the sensor. As soon the object identify who touch it. This information could be check with a list of authorized avatars to realize a specific action.

In addition to avatars, objects can communicate with other objects. One way is the event `listen ( )`. As [26] the `listen ( )` event handler is invoked whenever a chat message matching the constraints passed in the `llListen` function is heard (received). The channel the chat was picked up on, the name and id of the speaker and the message are passed as parameter in `llListen` function. Therefore, an object with function

llListen( ) in event state\_entry( ) will 'listen' all messages sent to that channel and execute the corresponding script providing a response .

## 2.2 Communication Protocols

According [24], OpenSim communication protocols are divided in the following types:

- a - Client-Server protocols: these are communication protocols between OpenSimulator and a client or viewer. This is mainly between the viewer and the simulator, though some traffic also flows directly between the viewer and a grid service. The primary protocol here is the Linden Lab viewer protocol, which is carried into UDP messages (in the case of object updates, avatar position updates, etc.) and HTTP based messages via capabilities.

- b - Grid service protocols: on a standalone OpenSimulator installation, all communications occurs within process. However, with a grid installation the simulators need to communicate with backend services (asset, inventory, etc.) and this is done over HTTP.

- c - Simulator-Simulator protocols: there are some situations in which simulators need to communicate directly with one another: (a) teleports and region crossing (this communication is carried out over HTTP) and (b) instant messaging protocol between users on different simulators (this also covers item giving since this is communicating using the IM infrastructure).

- d - Simulator-External protocols: there are some ways in which the simulator can be examined or controlled externally.

- e - Archiving protocols: people also pass archives containing whole regions (OpenSim Archives - OARs) or inventory (Inventory Archives - IARs) between OpenSimulator installations.

OpenSim presents a set of flexible protocols. It has many solutions to the communication within and out of the virtual world. This work focuses the external communication with the virtual world. A very important protocol to connect external things with the virtual world is the XML-RPC. It is better describe in section 2.3.

## 2.3 XML-RPC

According [27] XML-RPC is a spec and a set of implementations that allow software running on disparate operating systems, running in different environments to make procedure calls over the Internet. It's remote procedure calling using HTTP as the transport and XML as the encoding. XML-RPC is designed to be as simple as possible, while allowing complex data structures to be transmitted processed and returned.

To [25] XML-RPC is a standard for sending Procedure Calls to remote systems. It sends XML data over HTTP that remote system then handles. LSL receives XML-RPC requests and passes them to the prim specified. It may not establish this connection, but it may reply and keep two-way communication with that server.

These responses seem to be able to transport the largest amount of data out of Open Simulator or Second Life.

Both data exchange with RemoteAdmin as XML-RPC requires adjustments in server setup file. Is necessary configuring these modules in OpenSim.ini file. Once the modules are configured, it is possible to communicate using these protocols.

### 3 Real to Virtual Experiments

After enabling communication modules in the OpenSim.ini file and starting the virtual server, we tested the RemoteAdmin protocol. Opening a command prompt, executing RemoteAdmin.exe command with IP server address, port, password, remote administrator's command and parameters the data are send to virtual world server. A figure 1 presents command execution and the server response in the left side, and the result to virtual world viewer in the right side.

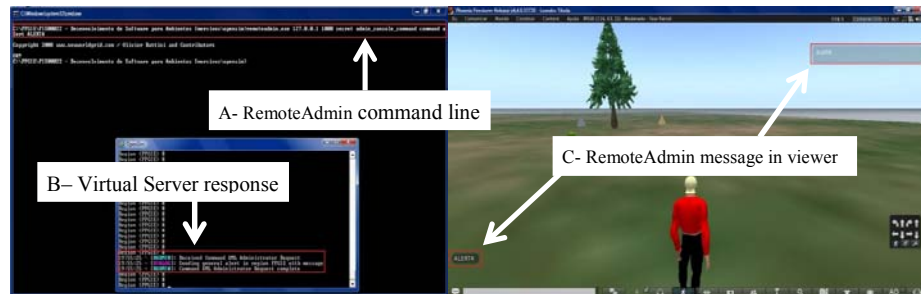


Fig. 1. Simulator-External protocols - RemoteAdmin example.

Second experiment was HTTP request to a WWW server. In virtual world the user type an integer number in a predefined channel. The LSL script sends a HTTP request to a remote server. The WWW server executes the factorial.php script returning the factorial value of the number received. The figure 2 presents the result of the request, after the avatar has touched the object.

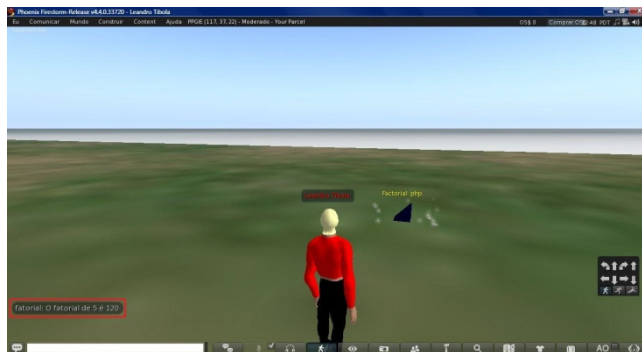
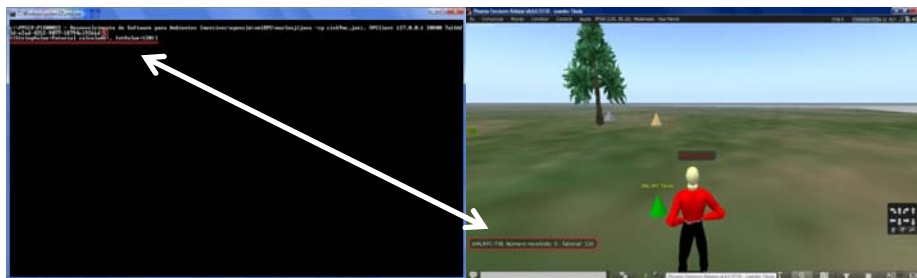


Figure 2: HTTP request from OpenSim object.

Other experience is reverse request, from a client to the OpenSim server. To achieve successful communication is necessary import of the Apache XML-RPC into client at compilation time. We develop a Java client that pass IP server, port, channel and an integer number to OpenSim server. The channel is a link with the object and script that calculate factorial. Figure 3 exhibit client Java execution in the left side. This command connecting the server and open the channel to XML-RPC transfer messages. The white double arrow shows both clients as server execution.



**Fig. 3.** External client accessing OpenSim server by XML-RPC.

All computer systems need database access. Insert, update and search of data are operations that maintain the systems status updated. So, if we want synchronize the real and virtual worlds, we need store and handle data from both worlds. The data access was developed by a research that return the e-mail to user informed. From select operation, other operations can be performed. Figure 4 shows select command result after avatar executes a remote script by a touch in the object.



**Figure 4:** SQL query on the remote server

## 4 Conclusions and Future Works

The virtual worlds is no longer science fiction and movie theme and nowadays take place in the usage everyday of technology. Adults, children, professionals, companies, institutions, and governments take advantage of virtual worlds' benefits. This paper

reported research and experiments related to real and virtual worlds communication, using the Open Simulator server. It was described the internal communication between avatars, objects and scripts in this environment; their communication protocols with external world, detailing the XML-RPC protocol. We presented several experiments involving external world data exchange through remote administration, bidirectional HTTP protocol transfer, bidirectional XML-RPC protocol with Java external client, and we performed database's operations with database information and virtual world data. To future, new experiences are planned using mobile devices, access to other remote environments, and to devices in general (Internet of Things). Data exchange with other information systems, like Learning Management System (LMS) or Enterprise resource planning (ERP) are also areas that need to be researched in more advanced way.

## References

1. Wii | Assistência | Nintendo, <http://www.nintendo.pt/Assistencia/Wii/Wii-301698.html>
2. Firsts Steps with Kinect - Xbox.com, <http://www.xbox.com/pt-BR/Kinect/GetStarted/>
3. How to market your products - Second Life, <http://community.secondlife.com/t5/English-Knowledge-Base/How-to-market-your-products/ta-p/700181>
4. Adjei, M. T., Noble, S. M., Noble, C. H.: The influence of C2C communications in online brand communities on customer purchase behavior, *Journal of the Academy of Marketing Science*, Volume 38, Issue 5, pp 634-653 (2010)
5. Hodge, E., Collins, S., Giordano T.: The virtual worlds handbook: how to use second life and other 3D virtual environments, Jones and Bartlett Publishers, Sudbury (2011)
6. Rico, M., Martínez-Muñoz, G., Alaman, X., Camacho, D., Pulido, E.: A Programming Experience of High School Students in a Virtual World Platform, [http://aida.ii.uam.es:8080/vleaf/es/manuales/VLEAF\\_IJEE.pdf](http://aida.ii.uam.es:8080/vleaf/es/manuales/VLEAF_IJEE.pdf) (2011)
7. Kim, S.-K., Joo, Y. S., Shin, M., Han, S., Han, J.J.: Virtual world control system using sensed information and adaptation engine, In: *Signal Processing: Image Communication* 28, pp. 87-96 (2013)
8. Campi, A., Gottlob, G., Hoyer, B.: Wormholes of Communication: Interfacing Virtual Worlds and the Real World, In: *International Conference on Advanced Information Networking and Applications*, pp. 2-9 (2009)
9. Guo, J., Chow, A., Gong, Z.: Virtual Wealth Realization in Virtual and Real Worlds, In: *IEEE International Conference on e-Business Engineering*, pp. 85-94 (2009)
10. Eno, J. D., Thompson, C.W.: Virtual and Real-World Ontology Services, In: *IEEE Internet Computing*, vol. 15, no. 5, pp. 46-52 (2011)
11. Chen, B., Huang, F., Lin, H., Hu, M.: VCUHK: Integrating the Real into a 3D Campus in Networked Virtual Worlds, In: *International Conference on Cyberworlds*, pp. 302-308 (2010)
12. Szabo, G., Veres, A., Molnar, S.: Towards Understanding the Evolution of Wars in Virtual and Real Worlds, In: *Fourth International Conference on Systems and Networks Communications*, pp. 153-158 (2009)
13. Back, M., Kimber, D., Rieffel, E., Dunnigan, A., Liew, B., Gattepally, S., Foote, J., Shingu, J., Vaughan, J.: The virtual chocolate factory: mixed reality industrial collaboration and control, In: *International Conference on Multimedia*, pp. 1505-1506 (2010)
14. Xiao-lin, W., Qiang, Y., Qi, L.: The Influence of Real World on Virtual World: An Investigation of Virtual Land Price in Second Life, In: *International Conference on Management Science & Engineering*, pp. 625-630 (2010)



15. Rahman, A.S.M., El Saddik, A.: HKiss: Real world based haptic interaction with virtual 3D avatars, In: International Conference on Multimedia and Expo, pp. 1-6 (2011)
16. Mishra, S., Agarwal, A., Khemka, V., Sharma, G.: Enhancing Enterprise Virtual Worlds with Real-World Event Information, In: International Conference on Computer Communications and Networks (ICCCN), pp. 1-4 (2011)
- [17] Shaikh, M. Al M., Prendinger, H., Hirose, K., Mitsuru, I.: Easy Living in the Virtual World: A Noble Approach to Integrate Real World Activities to Virtual Worlds, In: International Conference on Web Intelligence and Intelligent Agent Technology, pp. 466-473 (2009)
18. Rahman, A. S. M., Hossain, S. K. A., El Saddik, A.: Bridging the Gap between Virtual and Real World by Bringing an Interpersonal Haptic Communication System in Second Life, International Symposium on Multimedia, pp. 228-235 (2010)
19. Laaki, H., Kaurila, K., Ots, K., Nuckchady, V., Belimpasakis, P.: Augmenting virtual worlds with real-life data from mobile devices, In: Virtual Reality Conference (VR), pp. 281-282 (2010)
20. Gutierrez, J.M., Oton, S., Jimenez, L., Barchino, R.: M-learning Enhancement Using 3D Worlds, International Journal of Engineering Education, Vol. 24, Issue 1, pp. 56-61 (2008)
21. Eguchi, A., Nguyen, H., Thompson, C. W.: Everything is alive: towards the future wisdom Web of things, In: World Wide Web, Vol 16, Issue 4, pp. 357-378 (2013)
22. OpenSimulator Main Page, [http://opensimulator.org/wiki/Main\\_Page](http://opensimulator.org/wiki/Main_Page)
23. Second Life Official Site - Virtual Worlds, Avatars, Free 3D Chat, <http://secondlife.com/>
24. Communication Protocols - OpenSim, [http://opensimulator.org/wiki/Communication\\_Protocols](http://opensimulator.org/wiki/Communication_Protocols)
25. Second Life Wiki, [http://wiki.secondlife.com/wiki/Main\\_Page](http://wiki.secondlife.com/wiki/Main_Page)
26. LSL Wiki HomePage, <http://lslwiki.net/lslwiki/wakka.php>
27. XML-RPC Home, <http://xmlrpc.scripting.com/default.html>