Connected Immersion

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Abstract

Immersive VR environments typically cut the user off from the outside world. Such immersion hampers work for most users, as they are unable to attend to external events such as phone calls, emails and alerts. In some situations being cut off from the outside world can be significant safety hazard. We enable access to external events and stimuli in immersive environments so that the user is aware of such events and is able to attend to them without having to disengage from the VR gear. We describe a method and apparatus required to receiving phone calls that arrive on cellular phones in an immersive VR environment.

1 Introduction

Increasingly, immersive VR environments (VREs) are being used for entertainment, training, and command and control applications. While the appeal and benefits of using immersive VREs are clear, there are several major technical issues that must be addressed before their widespread acceptance and use. One of these issues is the effective integration of real world events and stimuli within the VRE experience.

Immersive VREs have two special characteristics:

- They cut the user off from the outside world.
- They require the user to don and hold several different types of equipment and devices.

The first characteristic leads to a disconnected immersion wherein the user is completely immersed in a virtual world and cut-off from his outside world. This type of immersion hampers work for most users, as they are unable to handle external events such as phone calls, emails and alerts. Some of the external events may be of urgent nature and hence require immediate response. Such immersion may also be a significant safety hazard in situations where the user is unable to hear external emergency alarms.

In case the user is made aware of external events and decides to respond to them, the second characteristic of VREs requires that the user disengage from the VRE equipment and devices. This is often a time consuming activity and disrupts work in the VRE. Donning the entire VR gear typically takes a long time and often requires the assistance of others. The time and effort required to disengage from the gear to handle external communication and then reengage to carry on with the VR work presents a significant deterrent to most VR users.

Our project is focused on enabling access to and handling of external communication such as phone calls, SMSs/MMSs, emails and other important alerts and alarms from within an immersive VRE system. By eliminating the need to disengage from the VRE system, this system would remove the safety hazard posed by the current generation of VRE systems as well as increase the overall productivity of the user.

2 Prior Art

We cover prior art in two domains that relate to our current research –VREs and call routing.
The vast majority of VRE researchers have focused on identifying key elements that lead to a sense of immersion and then developing systems that support those elements [Cho et al 2003, Schuemie et al. 2001, Bystrom, Barfield and Hendrix 1999, Witmer & Singer 1998, Slater & Wilbur 1997, Zeltzer 1992, Heeter 1992]. To achieve immersion, several hardware and software components are needed. A key requirement for immersion is to allow the user to look in all directions. Existing technologies to enable this include HMDs, CAVEs(tm) [Cruz-Neira, Sandin, & DeFanti 1993] and other surround displays [Steed, Glencross, & Bierbaum 2003]. To further enhance the feeling of immersion in a VRE, spatial audio is used [Astheimer 1993]. Many different types of I/O devices such as data-gloves and 6-D trackers are used to make the interaction in the immersive VRE natural for the user.

While a significant amount of attention has been focused on improving the sense of immersion in VREs, virtually no research has been reported on effective integration of real world events and stimuli within the VRE experience.

In the domain of call routing, patents cover much of the research and technology. The US Patent Application 20040028208, entitled "System and method for dynamically routing communications", discloses a system and method for routing an incoming call to a subscriber-selected destination number in accordance with dynamic data concerning the subscriber provided by an address book, a calendar and a presence server. A routing system routes the incoming call in accordance with a subscriber-defined routing rule associated with the originating number of the incoming call, as determined from the address book. While call forwarding aspects are common, in this system calls are forwarded to phone numbers rather than a VRE system.

The U.S. Pat. No. 6,125,126, issued to Hallenstal and entitled "METHOD AND APPARATUS FOR SELECTIVE CALL FORWARDING", discloses a method and apparatus for selective call forwarding. However, in the techniques described above, all the calling and called parties of the Web-phone system should be connected to the Internet. Thus, if all the calling and called parties of the Web-phone or Internet phone system are not connected to the Internet, the Web-phone or Internet-phone system cannot receive and transmit the call from and to a public switched telephone network (PSTN) and an integrated services digital network (ISDN).

Exemplars of recent efforts related to data transmission and telephone transmission include U.S. Pat. No. 6,259,692 to Shtivelman et al., entitled INTERNET CALL WAITING, issued on Jul. 10, 2001, U.S. Pat. No. 5,467,390 to Brankley et al., entitled DATA TRANSMISSION VIA A PUBLIC SWITCHED TELEPHONE NETWORK, issued on Nov. 14, 1995, U.S. Pat. No. 5,940,598 to Strauss et al., entitled TELECOMMUNICATIONS NETWORK TO INTERNETWORK UNIVERSAL SERVER, issued on Aug. 17, 1999, U.S. Pat. No. 6,014,379 to White et al., entitled TELECOMMUNICATIONS CUSTOM CALLING SERVICES, issued on Jan. 11, 2000, U.S. Pat. No. 6,046,762 to Sonesh et al., entitled MULTIMEDIA TELECOMMUNICATION AUTOMATIC CALL DISTRIBUTION SYSTEM, issued on Apr. 4, 2000, U.S. Pat. No. 6,064,653 to Farris, entitled INTERNETWORK GATEWAY TO GATEWAY ALTERNATIVE COMMUNICATION, issued on May 16, 2000, and U.S. Pat. No. 6,128,379 to Smyk, entitled INTELLIGENT DATA PERIPHERAL SYSTEMS AND METHODS, issued on Oct. 3, 2000.

The US Patent Application 20040013109 by Vaananen, Kai and Ala-Luukko, Sami filed on July 11, 2003 discloses a system comprising at least a terminal from which a connection can be set up to the Internet ; and an exchange for routing calls on the basis of information in a register. The system further comprises an Internet server comprising means for controlling the installation of the software required in the terminal for making and receiving VoIP calls and the activation of the application required for making and receiving VoIP calls as a response to the request transmitted from the terminal ; means for changing call forwarding information in the register; means for converting the data flow transmitted from the exchange to the terminal into a mode suitable for the terminal.

While these recent efforts provide systems for call forwarding in various ways, we note that they do not address the requirements of forwarding calls to VREs.

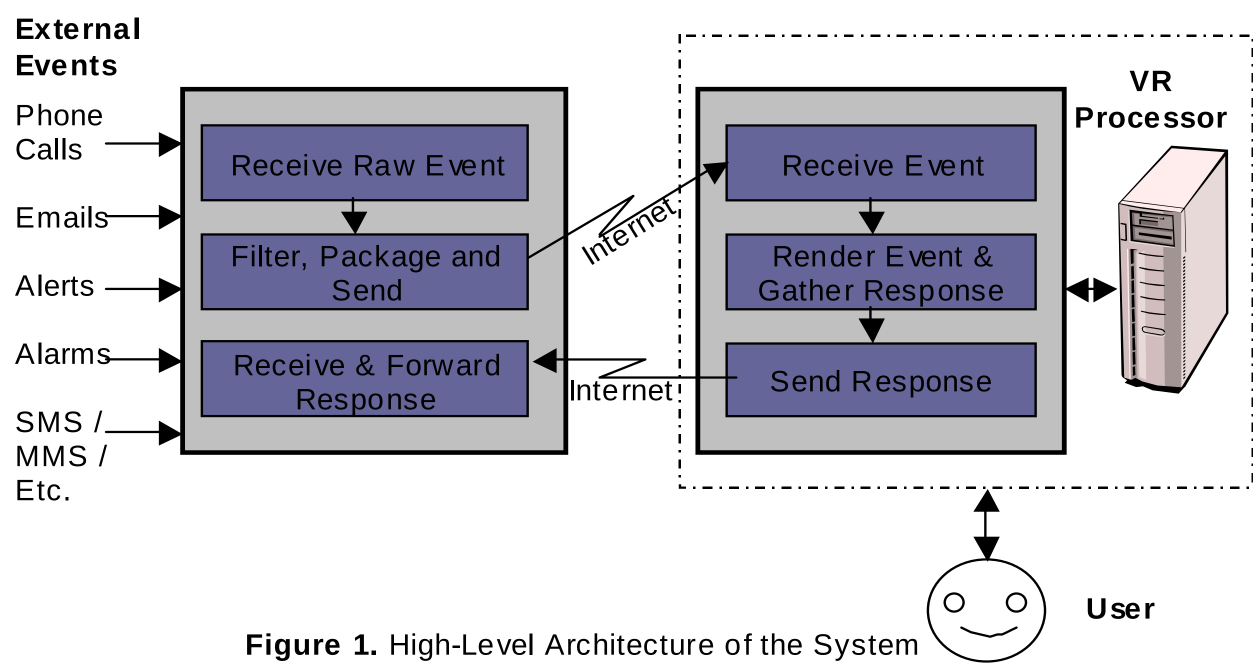

Figure 1. High-Level Architecture of the System

3 System Architecture

Figure 1 shows a high-level architecture of our system. The raw external inputs - phone calls, emails, alerts and alarms etc - are received and filtered, as desired by the user. For example, the user may decide to receive calls from select callers in his VR environment. After filtering, these raw events are packaged for forwarding to the VR system. These packaged inputs are received and rendered in forms that are appropriate for the event type. For example, a phone call event may ring in the VR environment whereas an alert for a meeting may flash.

The initial presentation of the event will elicit a response from the user. In some cases the elicitation is proactive in that the system will prompt the user for responses (for a phone call, for example) while in other cases the system will present the event and wait for the user to respond to it when the user is ready (for an email or a meeting alert, for example).

The VR system forwards user's response to the External Event Handler, which takes appropriate action for the event type. In the case of an accept response for a phone call, the event handler will set-up the call and start a Voice-Over-IP session. In the case of accept event for an email, the event handler will fetch the body of the email and forward it to the VR system.
In our first implementation of the system, we have focused on routing and handling phone calls, in particular phone calls received on cellular phones, to immersive VREs.

4 Call Routing

We have focused on routing telephone calls received on internet-enabled, programmable, cellular phones to immersive VREs. We have emphasized:

- Ease of providing the forwarding information
- Ease of filtering and forwarding select calls
- Ease of handling the call from within an immersive VRE
- Transparency to the call-initiator of the entire process

In its most ideal setting, the key programs run on the cell phone (see Figure 2). Routing calls to a VRE simply requires the user to provide the address of destination VRE system. This is achieved by providing its IP number in a dialog box running on the phone (see Figure 3). Note that our way of routing calls does not involve the telecommunication service provider's infrastructure. This is a significant advantage of our approach.

It is also likely that the user may want to forward calls from select callers only (identified by their caller IDs) to his VRE. As a call arrives at the phone, the Call Event Trapping and Processing module matches the caller ID of the call with the IDs that the user would like to handle in his/her VRE. Only the matched calls are forwarded for the user's action.

Once the user has decided to take the call, the Call Voice / Data Module converts the voice data into VoIP traffic which is transferred. This way the user does not have to disengage/engage any special gear to handle the call. The caller's voice gets transformed into VoIP traffic going to the VRE user, and in the reverse direction, the VRE user's voice is converted into VoIP traffic going towards the

The entire process implemented in our system is totally transparent to the call initiator in that he placed the call he normally would and his conversation with the called party proceeds without any difference to him. We believe that the seamless nature of our system is a critical success factor for our approach. Neither the calling party nor the called party should feel any difference between our process and their normal phone conversation.

Given that the capabilities of cellular phones are evolving at a rapid pace and that many different capabilities currently exit, our system needs to support a variety of configuration. In the following sections, we outline the implementation scenarios for the various configuration/capabilities.

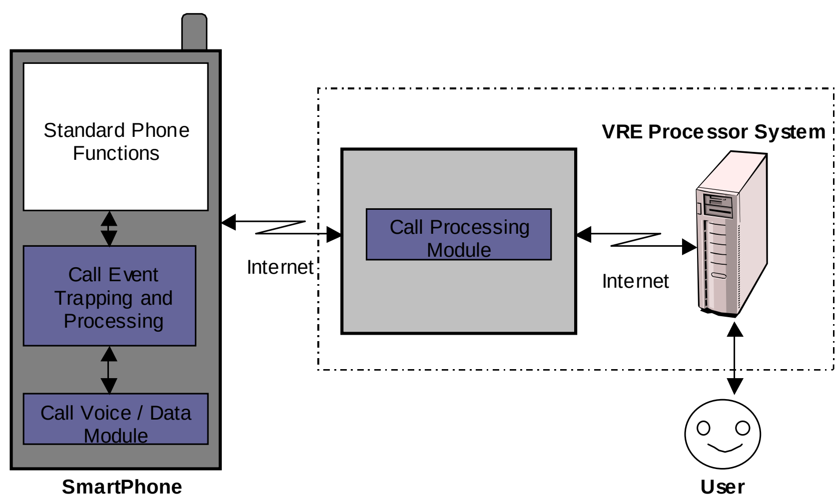

Figure 2. A Class A Smartphone Architecture of the System

Figure 3. Entering the VRE's Address on Siemens XS56

4.1 Class A Smartphones

Class A smartphones can be connected to both GPRS (for data) and GSM (for voice) services simultaneously. While significant developments are underway in the industry, this class of phones is not commercially available yet (in the US). Given that both voice and data connections can be operated simultaneously, this class of smartphones is the best platform for our implementation as both the "Call Event Trapping and Processing" and "Call Voice / Data" modules can be implemented on the smartphone (see figure 2).

4.2 Class B Smartphones

Class B smartphones can be attached to both GPRS (for data) and GSM (for voice) services, using one service at a time. Class B enables making or receiving a voice call, during a GPRS connection. During voice calls, GPRS services are suspended and then resumed automatically after the call has ended. This class of smartphones is commercially available.

Given the restrictions on class B phones, a part of the phone system needs to be run on auxiliary computing systems. As shown in Figure 4, while the "Call Event Trapping and Processing" module can run on the phone, the "Call Voice / Data" module needs to run a separate computer which gets to the phone via a data cable.

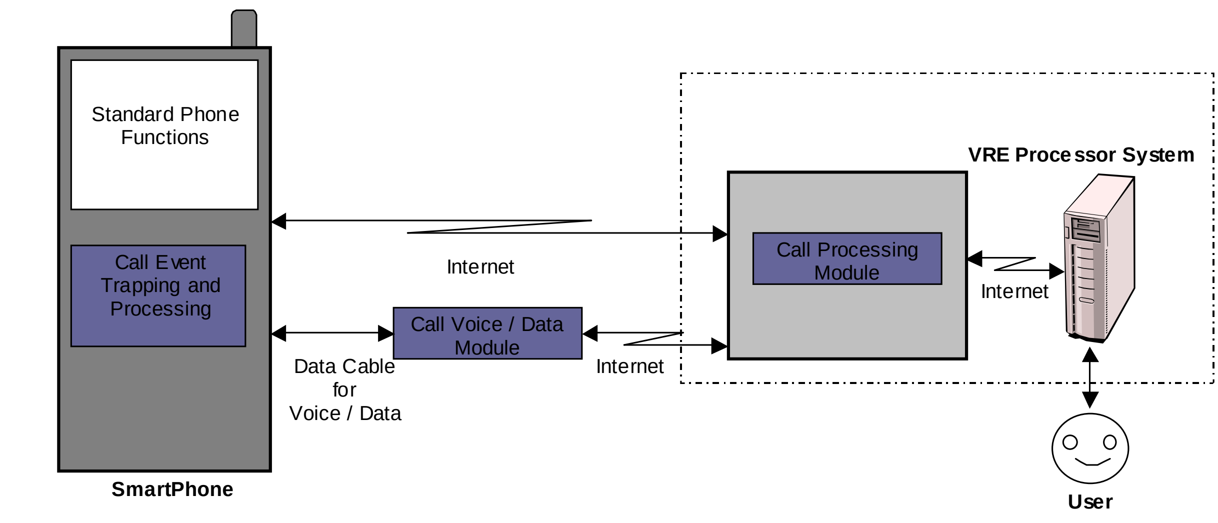

Figure 4. A Class B Smartphone Implementation of the System

4.3 Class C and Normal Desktop Phones

Class C mobile phones are attached to either GPRS or GSM voice service. If we treat them as pure voice devices, they can be treated similar to landline phones. Given that such phones have no compute capability, all of the processing needs to be offloaded onto auxiliary computers, as shown in figure 5.

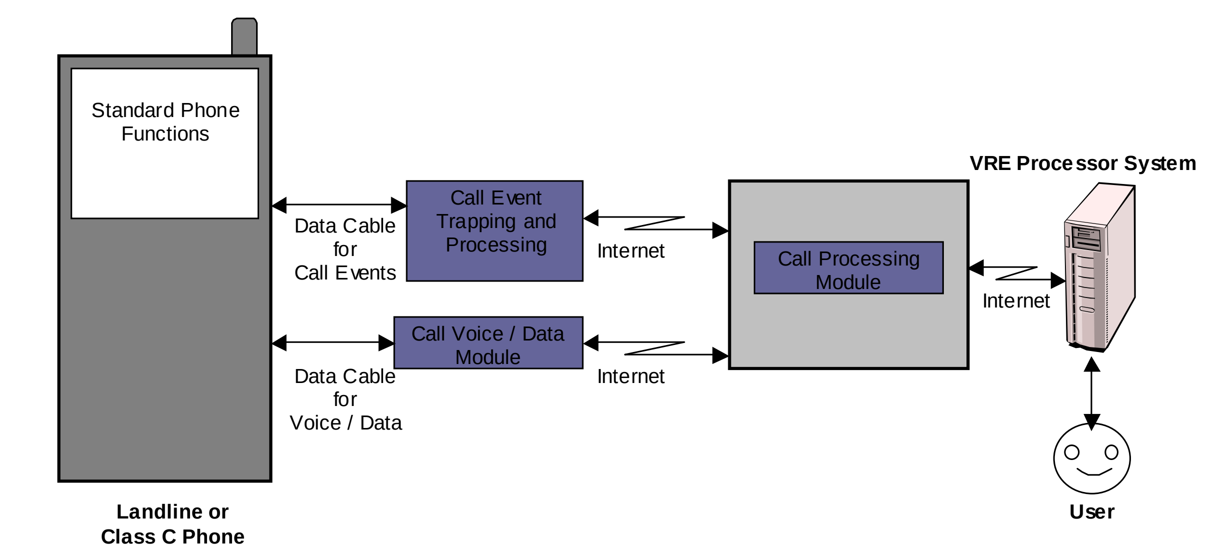

Figure 5. A Class C or Landline Phone-based IImplementation

5 Implementation

The current version of our system is implemented on a Siemens XS56 PocketPC/phone hybrid (see Figures 3 and 4). Being a class B GPRS device, this phone can make/receive calls as well as provide access to Internet but not simultaneously. In order to trap incoming calls, we run the "Call Even Trapping and Processing" module on the phone. This program is able to receive calls and convey the information about the call to the VRE system by using a Bluetooth connection (With a Class A phone, the Bluetooth connectivity can be replaced by a GPRS / WCDMA / CDMA2000 connectivity). Upon receiving notification that the user wants to accept the call, this system establishes the phone connection. At this time, the voice I/O happens through data cables that connect the phone to a PC that forms a VoIP connection to the "Call Processing" module of the VRE system. This PC runs the "Call Voice / Data Module" – takes analog voice from the phone and converts it into VoIP.

The "Call-Processing Module" of the VRE system performs two main tasks – exchange and handling of call events with the cell phone and providing the VoIP functionality for the system.

6 Conclusions and Future Work

To be successful, immersive VREs need to support the needs of their users who will spend long hours in the environment. Instead of being isolated applications, immersive VREs need to integrate all of the support functionality that users need for extended work. Given the time and effort it takes to engage and disengage VR gear, the requirement that the user be able to handle external communication from within the VRE is even more critical than in a non-immersive environment. Our approach to integrating real world communication within the VRE experience is a first step towards providing this integration. We have implemented a system that connects smartphones to VREs. We plan to integrate other modalities of human communications in VREs.

7 References

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