

9 New Technologies for Providing Remote Psychological Treatments

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Abstract. New technologies lead us to a series of new applications that we could not imagine just a few years before.

Many services have appeared for Internet, the global computer network: FTP, e-mail, World Wide Web... Psychological treatments are one of the multiple applications that can be developed using these tools. Dynamic web pages that include information prepared by the therapist for different patients and that receive information from them can be generated. Other tools such as e-mail or chats can be used to provide a direct communication.

Databases can be integrated in web applications for storing data about different patients. Several formats can be used for storing the information, and some of them such as XML provide a promising method of psychological data standardization.

Using different development tools, virtual environments can also be generated and integrated in web pages, so new psychological treatments such as virtual environment exposure are also possible from web applications.

This entire basis provides the structure that allows that new applications can be imagined and developed. In a few years, new trends will appear, probably one of them will be the use of wireless devices to provide psychological treatment and help at any place and any time.

1. Introduction

In recent years, new technologies have shown their utility in different fields: business, learning, medicine and also psychology.

Employees of a company can communicate with others located in different cities, countries or continents only making use of common tools such as e-mail or more sophisticated ones such as videoconference.

Many companies have also developed e-learning strategies, so employees can learn skills required for their work only by connecting to a webpage that will present them the required information in a dynamical way, and also track their responses and possible improvements. These e-learning strategies are not only restricted to internal learning processes, but more and more they are becoming available for the general public. Taking into account new tendencies in education, they will become a common tool for academic purposes, especially in universities.

Medicine is another increasingly important field of application. Doctors and nurses can use telemedicine systems to track physiological data from patients that are located far away from the hospital. This is especially interesting for countries where there are no facilities for people who live in the countryside to move to big cities where hospitals are

usually placed, and also for old people who find difficult going to a hospital away from their home in a regular way.

Finally, the last application we have mentioned in this introduction is psychology. This is a novel field of application of new technologies, but recently many remote applications for psychological treatments have appeared and it seems that the tendency in following years is that new and more sophisticated applications will be used. Telepsychiatry or telepsychology have been defined as “the use of telecommunication technologies to put in contact patients with health professionals in order to accomplish tasks such as medical or psychological diagnoses, education, treatment, consultations, transmission and storage of the patients’ medical stories and data, research and other activities related to the provision of health care” [1]

The purpose of this chapter is to give an overview of the technologies that are available and how they are being used (or can be used in near future) for providing remote psychological treatments.

We will finish this introduction describing some basic concepts about networks and broadband technologies, which are the basis over which we can build applications that communicate remote places.

1.1 Basic concepts about networks

A computer network is a set of systems and services that allows transferring information between user processes that are run in independent computers. The network is composed not only by its physical part (hardware) but also by software layers that are built over this hardware and that control that information is exchanged between processes following some rules that have been defined.

Depending on the geographical extension of the network, we can distinguish between:

- Wide area network (WAN). The extension is higher than 10 Km.
- Local area network (LAN). The extension is less than 10 Km. They are usually destined for private use.
- Metropolitan area network (MAN). They can communicate different industrial nuclei. Their maximum extension is 50 Km.

For WAN, transmission velocities are in the range of kbps. In LAN and MAN, velocities are in the range of Mbps or even higher.

The common case is that a computer on a network will need to communicate with a computer on another network. In order to allow that, those networks will have to be connected either directly or indirectly through another network [2]. Joining different networks, we can have a network of networks, so any computer of a network can communicate with any computer that is located in any of the networks. There is a special network of networks that is the Internet. Internet has become so large that networks all over the world are part of Internet.

In order to allow the communication between networks, some common rules have to be followed. We define a protocol as the special set of rules that end points in a telecommunication connection use when they communicate. On Internet, there is a set of basic communication protocols that are used: TCP/IP (Transmission Control Protocol/Internet Protocol). When one computer connects to the Internet, all the software required to control that TCP/IP rules are followed should be installed in order to be able to send and receive messages.

The higher layer, TCP, controls the division of a message into smaller packets that are transmitted over the network and received by a TCP layer on the other side that reassembles them. The lower layer, IP, controls the address part of each packet to guarantee that it arrives to the right destination. [3]

We can find the origins of the actual Internet in the late 1960s. DARPA (Defense Advanced Research Projects Agency) [4], which is the independent research branch of the U.S. Department of Defense, started a project for interconnecting computers at four university research sites. In 1972, this network (now called ARPAnet) had grown to 37 computers. The evolution of this network and technologies related to it, including TCP/IP protocols, led to the Internet that we use today.

1.2 Broadband technologies

In order to achieve that different applications such as e-learning, telemedicine or telepsychology become available to the general public it is required that most people have access to Internet, but this is not true for all countries. Moreover, for many applications it is not enough that people have an Internet connection, but it is also required that the user has a high bandwidth connection. “The real possibility of starting telemedicine or telepsychology systems was restricted until recently because of the cost of the equipment and the lack of adequate infrastructures regarding telecommunications” [5].

In this section, we are going to describe some of the broadband technologies that are becoming available to more people in developed countries, so they will allow more diffusion of telepsychology systems.

When we use a modem to connect to Internet, we use analog transmission over copper wires, and this transmission only uses a reduced portion of the maximum bandwidth. However, other technologies [3] have appeared that try to obtain a more optimum use of the bandwidth available with copper wires.

ISDN (Integrated Services Digital Network) is based on the concept of integrating both voice data (analog) with digital data over the same network. There is not analog transmission over copper wire, it is entirely digital. It is widely available in urban areas in the United States and Europe, both for home and business markets. ISDN requires that both the user and the telephonic central install an adapter. It can provide a bandwidth up to 128 Kbps, so it is suitable for transmitting high quality graphics through the network.

There are two possible levels of the service:

- Basic Rate Interface (BRI): it consists of two 64 Kpbs B-channel (data, voice and other services) and one 16 Kbps D-channel (control information).
- Primary Rate Interface (PRI): it consists of 23 B-channels and one 64 Kbps D-channel in the United States or 30 B-channels and 1 D-channel in Europe.

The first kind of service is most suitable for home and small businesses.

DSL (Digital Subscriber Line) includes a set of technologies that are used to deliver high-bandwidth information to final users over ordinary copper telephone lines. When we use DSL, the information is transmitted as digital data, so it is possible to use a higher bandwidth for the transmission. It is possible to transmit simultaneously data and voice signals because a part of the bandwidth is destined to transmit the analog signal (voice) while the rest of the bandwidth is employed for digital transmission (data).

If the final user is close enough to a telephone company central office that offers DSL services, it is possible to receive data at bit rates up to 6.1 Mbps (theoretically, 8.448 Mbps). However, as this is not the general case, guarantee rates oscillate between 1.544 Mbps to 512 Kbps downstream (from the server to the user) and about 128 Kbps upstream

(from the user to the server). ADSL line can carry both data and voice signals, and the data part is continuously connected. DSL installations began in 1998, and given the bandwidth they provide, they are suitable for the transmission of live video, audio or 3D.

Another way of obtaining a high bandwidth for the Internet connection is using a different cable for the connection. Cable TV companies use coaxial cables to communicate between the community antenna and user homes or enterprises. Using a cable modem, final users can connect their PC to a cable TV line and receive data with a bit-rate of about 1.5 Mbps. This rate is about the one available to users of DSL services, and is much better than the 56 Kbps that can be achieved with telephone modems and 128 Kbps of ISDN.

The cable modem has one connection to the coaxial cable wall outlet, and the other to a PC or a set-top box for the TV set. It can be integrated within the computer or the set-top box (for television), but it can also be an external device. If it is an external device, it can usually be connected to the Ethernet card in the computer. The cable modem communicates with a CMTS (Cable Modem Termination System) at the cable TV office. It is not possible for the cable modem to receive and send signals to other cable modems on the network, only to the CMTS.

2. Applications for Internet and intranets

Since the creation of ARPANet at the end of the 60s, many network services have appeared and most of them are widely used at present times. In this point, we are going to comment some of them that can have applicability in the psychological field, especially as tools that can help to provide remote psychological care.

2.1 File transfer protocol (FTP)

The goal of this service is to be able to have access to a file system of a remote computer to check its directory, to transfer a file to the remote computer to ours, or vice versa.

As we cannot access remotely to the Operating System (OS) of a machine, a process acts as an intermediary between the file system of the remote machine and the local machine. The Virtual File System (VFS) offers to the client machine some commands that allow listing the directory, copying a file, deleting a file, writing a file, etc.

2.2 E-mail

This is a file transfer in which the file has a pre-defined structure with some fields that remind the ones from an ordinary letter. E-mail is now widely used for intracompany and intercompany communication. It allows people located at distant places to cooperate on complex projects

It is an asynchronous application, as long as the user creates the e-mail, specifies the addressee and sends it. There is no guarantee that the addressee will read the e-mail (or even respond to it) immediately.

E-mail systems usually consist of two subsystems [6]: the user agent, which allows people to read and send e-mail, and the message transfer agent, which moves the messages from the source to the destination.

User agents are programs (usually called mail readers) that accept a variety of commands for composing, receiving and replying to messages, as well as for manipulating mailboxes.

On the other hand, message transfer agents are usually system daemons that run in the background and move e-mail through the system.

2.3 World Wide Web

This service allows the access and transfer of known documents as web pages, with an independent address system, from a server which is connected to internet, using a client application which is called browser.

The first web application was built in 1989 in the Cern lab (Switzerland) [7]. In 1993, the first commercial browser appeared: MOSAIC [8]. In 1995, the first version of Netscape was distributed [9]. It was followed by the web browser from Microsoft: Internet Explorer[10].

2.3.1 HTTP Introduction

The HTTP (HyperText Transfer Protocol) is the protocol that is used for transferring pages.

The client application is the web browser, and the web server that is used depends on the operating system of the server machine. For example, for UNIX, the most habitual selection is Apache [11], and for Windows NT or 2000, Internet Information Services (IIS) [12] is commonly used.

The way of indicating the page that we want to visualize in our browser is by means of an URL (Uniform Resources Locator). The URL is composed of three components:

- The transfer protocol.
- The domain name. A domain name is a meaningful and easy-to-remember way to refer to an Internet address. This part of the URL indicates a domain name server using the domain name system (DNS) where to forward a request for the web page. The domain name is mapped to an IP address.
- The path.

An example that shows the different parts of the URL is the following:

TRANSFER PROTOCOL	DOMAIN NAME	PATH
http://	www.upv.es	/dir1/dir2/document.html

2.3.2 Markup languages

A markup language is a language for annotating some text with additional information, such as how the text should be displayed. SGML (Standard Generalised Markup Language) [13] provides a standard metalanguage on which a great variety of markup languages is based. In SGML text is marked with start and end tags to label particular elements in the text. For example, we can write:

```
<user>Name Surname</user>
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as a way to introduce the name of one of the users of our system.

SGML defines the way to use this kind of elements (with the initial and final tags), but it does not specify what kind of elements can be used in the format, and in what way they can be nested.

Any language based on SGML should provide a definition of the set of elements that can be used and which ways of nesting are appropriate for a particular application.

HTML (HyperText Markup Language) [14, 15] is a markup language designed to achieve the needs of documents that are prepared for the World Wide Web, which is an application with its own requirements. For example, HTML includes instructions that define how the document will be displayed. And inside an HTML page some references to

other HTML pages can be included (what is called a hyperlink). The browsers are prepared to interpret the information that is codified by means of the tags.

HTML was invented in 1989 by Tim Berners Lee. Initially, it had only a reduced set of tags, but with the use, new purposes were thought, so new tags appeared and were added to the original set. Several versions of HTML appeared: version 2.0, 3.2, 4.0 and 4.1.

HTML 4.1 is now widely supported. All these standards are co-ordinated by the World Wide Web Consortium (W3C). Since HTML 3.2, it was suggested that the best way to define presentation parameters is by means of a stylesheet. This is a set of instructions that specify how the different elements of the HTML document should be displayed: the colour for the different levels of a hierarchical structure, the font, etc.

Cascading Style Sheets (CSS) can be used in an internal or an external way. In the internal way, they are included inside the structure of an HTML file. In the external way, they constitute an independent document (with .css extension) that can be applied to a whole set of web pages.

Using HTML, we may want to use some specialised tags. For example, a session of a therapy can be indicated by a “session” tag. However, it does not exist in HTML. That is one of the reasons that motivated the creation of XML (eXtended Markup Language) [16, 17], a new metalanguage that allows the creation of specialised tags that describe the structure of the document in a more meaningful way.

The idea is to structure the information based on the meaning of each single element. XML does not describe how the information will be presented to the final user.

However, since Internet Explorer 5.0 it is possible to visualize XML documents as a tree structure with different colours depending on the level. This is only a way between multiple alternatives to visualize the structure that is contained in the document. If we want to configure the way of displaying an XML document, we can use a CSS as it can be used in HTML, but it is better to do it using the XSL (eXtensible Stylesheet Language). XSL permits to transform (even altering the order, structures and contents as required) and format XML documents.

2.3.2 CGI, ASP, JSP, PHP

Up to the moment, we have talked about web pages that only structure information and present it to the user. However, this is not the general case.

When HTML was created, web pages were located in a remote server, and the client computer downloaded them. This was the only communication direction: from server to client. However, at the beginning of the 90s it was thought the possibility of sending data also in the other direction, from the client to the server. From HTML 2.0, a tag was defined that allowed the user to include data in an HTML page and send them to the server (with the command POST that is defined in the http protocol). The html form element defines an area in the web page where the user may enter information. Different input elements can be introduced in that area and they permit that the user enters the data in different ways: radio buttons, check boxes, buttons, etc.

But it is not only interesting to send these data, but also to analyze them or do some processing with them. Programs that use these data are called CGI (Command Gateway Interface). A CGI program is physically located and executed in the server and takes as input data the ones that are introduced using the FORM tag.

Programmers can write CGI applications in different languages. The most common are C, C++, Java and PERL (Practical Extraction and Reporting Language) [18].

However, there are alternatives to the use of CGI to process the data. We are going to comment some of them: ASP, JSP and PHP.

An Active Server Page (ASP) [3, 19] is an HTML page that includes one or more scripts that are processed on a Microsoft Web server before the page is sent to the user. Usually, the script uses as input the data received as the result of the user's request for the page and then modifies the appearance of the page before sending it to the client. ASP is part of Microsoft Internet Information Server, but it can be delivered to almost any browser.

Scripts can be written in VBScript or JScript. The file is named with the ".asp" file suffix.

JSP (Java Server Page) [3, 20] is a technology for controlling the appearance of web pages using small programs that are included in the web page (servlets) and run on the web server. It is comparable to Microsoft's ASP, but it was developed by Sun Microsystems. In this case, JSP calls a Java program that is executed by the web server.

Finally, PHP (Personal Home Page Tools) [3, 21] is a script language and interpreter that is freely available and used mainly on Linux Web Servers. It is a cross-platform alternative to ASP technology. The PHP script is embedded in an HTML web page. It usually has the file name suffixes ".php", ".php3" or ".phtml". Before the page is sent to a user that has requested it, the web server interprets and performs the operations described in the PHP script.

All these pages can be defined as dynamic html pages, since content varies depending on the results of executing the scripts or programs.

2.3.3 JAVA

All the programs and scripts that we have discussed in the previous point are executed in the server. However, it was thought that a useful alternative would be to distribute the processing tasks, giving the client the possibility of executing programs. That is the reason why Java language [22] was developed.

Java can generate an intermediate code that is interpreted by the browser, so programs can be executed independently from the platform.

The server compiles the program that is written in Java, and generates the intermediate code called bytecode, which is not executable. This program is introduced in HTML pages. The browser is capable of interpreting both the HTML content and the applets. The applets will be executed in the client interpreted by the web browser when the user references them by means of their URL.

Also, the scripts that are imbedded in web pages (such as Java Script or Visual Basic Script) can be interpreted by the browser (at the client side). It is another possibility for de-centralising the processing tasks from the server.

2.4 Information exchange applications

The previous applications that we have described did not imply a direct and synchronous communication between people. Only the e-mail guaranteed a communication between at least two people, but it was in an asynchronous way.

In this point, we are going to comment other technologies that enable us to communicate directly with other people. Applications can be text-based, so the communication will be by means of texts that will be introduced in the computer by means of the keyboard and sent through the network to a remote computer. We will comment two of these applications: chats and instant messaging.

Applications can also be based on images, so it will not only be possible to send the text that a person has introduced, but also his/her image or voice. We will comment the videoconference application.

2.4.1 Chat

A chat room is a web site, part of a web site, or part of an online service that allows communities of users with common interests to communicate in real time. Most chats do not require that users have any special software, and if they do, such as the IRC (Internet Relay Chat), it is possible to download it from the Internet [23].

When a user wants to enter in a chat room, he/she chooses a user name and a password, and logs into the room of his/her interest. Normally, there is more people online and a signal makes them know that another person just entered in the room. As this is a text-based application, users type the message they want to communicate to the group into a text box, and this message appears in the common area where messages from other users also appear. Then other users can respond to this message. The user is not forced to send messages, so he/she can remain reading messages from other users.

2.4.2 Instant Messaging

Instant messaging (IM) application [3] allow users to know if some chosen people (friends, family, co-workers) are connected to the Internet, and, if they are, to exchange messages with them.

The main difference with the e-mail is that in this case it is a synchronous application: when one user sends a message to another it arrives immediately to the other side, and it is possible to obtain an instantaneous response. The only condition to do instant messaging is that both users should be connected to Internet at the same time. The IM application has a list with the user's selected contacts, and indicates at any moment if they are connected to the Internet, or even their state (for example, the application determines if the user has been away from the computer during a while).

When a message arrives to a user from a different user, a window appears indicating that an IM has arrived, so the user can accept or reject it, or a window appears containing the message. This depends on the concrete application that we are using.

The most commonly used applications for Instant Messaging are AOL Instant Messenger [24], MSN Messenger [25], Yahoo! Messenger [26], ICQ [27], etc. Most of the information that is transmitted using this kind of applications is text-based. However, new versions of different applications allow voice messaging, file sharing, etc.

Moreover, instant messaging systems are beginning to deliver messages to devices different from PCs, such as mobile phones, PDAs (Personal Digital Assistants), etc.

In words from Bill Gates, one "of the most powerful and distinguishing features of the IM protocol is 'presence detection', -i.e., the ability to allow users, subject to their control, to let others know when they are 'online' and available and which Internet-connected devices they are using (...) IM can bring additional capabilities to wireless tools, such as telephones and PDA devices; and, IM can play an important role in interactive TV offerings" [28]

2.4.3 Videoconference

A videoconference is also a live connection between people in distant locations with communication purposes. In this case, it implies the transference of audio, text and video.

In its simplest version, it only transmits static images and text, being similar then to an instant messaging application. However, sophisticated versions allow the transmission of video images and audio.

The possibility of visualizing the face of the person at the other part of the connection adds non-verbal features to the communication, which can contribute to a stronger sense of familiarity.

Regarding the requirements that are needed for a videoconference, the software is usually free or not very expensive. For example, Microsoft's NetMeeting [29] is included in Windows 2000 and can also be downloaded for free from the NetMeeting homepage.

Regarding hardware, a common PC with Internet connection and a digital camera are enough to allow the user to have a cheap connection with distant family, friends or co-workers, although this quality can be improved with more elaborated configurations.

2.5 Multimedia services

A multimedia application works with different information sources, such as alphanumeric data, fixed images, animated images, voice, video... The main characteristic of these applications, that distinguishes them from other kinds of applications, is that most of the data come from continuous data sources such as voice and video. For example, the videoconference that we have described in the previous point about information exchange applications can also be classified as a multimedia service, as long as we have continuous data sources of video and audio. In this case, they are captured and digitalized and then transferred through the network. In other cases, the original data are already digital.

The other characteristic of these applications is that, as data sources are continuous, they generate a high volume of information, so they require a high bandwidth in the network, with connections such as cable or DSL. And the latency (that is, the time that it takes to transmit a single unit of information from one side to the other) should be delimited.

Besides, special hardware devices or interfaces are required, such as cameras, video and audio digitalizer boards) that generate digital data from analogical inputs.

We can distinguish between two types of multimedia applications:

- Direct applications. They are affected by latency. In real time, digitalization and transmission are made at one side, and reproduction at the other side. An example is videoconference.
- Applications with a previous storage. After digitalizing the information, it is stored in a server, and is recovered in an asynchronous way by the clients. An example of this kind of application is video on demand.

In order to reduce the problem of the high volume of information, techniques of compression are used. There are different kinds of algorithms, with and without losses.

Normally, for Internet application algorithms with losses are used. The most commonly used algorithm to compress data is MPEG [30], used both video and audio.

There are different versions of MPEG.

2.5.1 Quality of service

With the concept of Quality of Service (QoS) we intend to guarantee in advance a minimum transmission rate, error rate and other characteristics that are indicators of the quality of the transmission. It is usually applied to Internet connection, but it is especially interesting for the continuous transmission of high-bandwidth video and multimedia information.

In the strictest sense of the word, quality of service can be defined as the ability to offer guaranteed bandwidth while maintaining specific link quality, delay and jitter

parameters for satisfactory delivery of isochronous applications [31]. These requirements are based on human perceptual studies for voice, video, audio and interactivity.

The most important parameters that are used to define QoS are the following [31]:

- Bit rate. It is measured in bits per second. Depending on the quality of video, bit rates from 300 Kbps (streaming video) to 20Mbps (HDTV) are needed. Technologies chosen for multimedia applications need to provide enough bandwidth to maintain multiple high quality links demanded by users.
- Link quality. It defines to what extent the communication takes place “error free”. The parameter that is usually given is bit-error-rate, which indicates the percentage of bits with error that arrive to the final user. It is not enough to have a high bandwidth, because without low bit-error-rate the transmission will not be correct.
- Delay or latency. It is the time difference between the transmission and reception of packets of information from source to destination. This factor is critical for interactive applications, such as videoconference. A delay of less than 100 ms is required.
- Jitter. It is a variation in arrival of data packets. Jitter can be minimized at the receiver using buffers to control the delay variation. This is usually employed in applications such as streaming video. A typical maximum value for jitter for high quality video is about 10 ms.

Depending on the final application, the restrictions for these parameters will be different.

An application can be restrictive only with one of the parameters, and not so much with the rest of them.

2.5.2 *Video on demand systems*

In video on demand systems [6], the user selects one from a large number of available videos from a remote server using the television set’s remote control, and the video starts immediately. As people are used to the possibility to stop, start, rewind and forward videos, a complete video on demand system should provide the user with these controls. That means that the video provider will transmit a separate copy of the film for each different user.

There are simpler schemes called near video on demand. They offer the advantage of their lower cost. In this case, it is sufficient that each popular film starts every 10 minutes, and run them non-stop. Although the user does not have the possibility of controlling the reproduction (play, stop, rewind...), he/she always has the possibility of changing to another retransmission of the film.

The main parts of a video on demand system are: the video servers, the distribution network, and the set-top boxes. The video servers should be capable of storing and transmitting a large number of movies simultaneously. There are different alternatives for the distribution network, but in any case, it is required a wideband networking. Finally, set-top boxes are the final point where movies arrive. They have to decode and allow the visualization of the movies; in fact, they are powerful, specialized personal computers.

2.5.3 *Development tools*

Depending on the multimedia system that we plan to design, we can use different tools. For example, for a video on demand system we will need to configure a video server that is able to store and output a large number of movies simultaneously. That configuration includes both the hardware and the software part. Several applications for providing streaming video are available. Between others, we can mention: Helix Universal Server

from RealNetworks [32], Windows Media Services from Microsoft [33] and QuickTime Streaming Server from Apple [34]. The advantages of these server software packages are that they add some functionality related to load balancing, automatic bandwidth negotiation and the ability of users to fast-forward through the videos in the server.

However, videoconference and video on demand systems are not the only alternatives if want to add multimedia content to the Internet. We can use some authoring tools such as Macromedia Flash [35] to include interactive streaming video, animations, audio, vector and bitmap graphics into web pages. That is a way to create very impacting user interfaces for different kind of final applications.

2.5.4 Sample applications

Several sample applications can be thought with these kinds of multimedia tools. Besides the ones that we have previously described (videoconference and video on demand), many other multimedia applications are being used in web pages for different final applications.

Of particular interest are dynamic presentations for enterprises, games for entertainment purposes, educational programs for children, etc. In the following points we will describe how this kind of tools can be useful for the psychological field.

3. Data storage and standardization

Technology can help us to provide remote psychological assistance to users. In the previous point we have described the technologies that support that kind of applications.

One of the possibilities that web technologies offer us is to collect data from the user (using forms in html pages). This data can be processed at the server, but usually we will be interested in storing it so the psychologist can consult it later in case it is needed. That is why we will need some kind of technology that supports that data storage: databases.

But we do not need only to store that data; it will be interesting to store that data in a standard way. There is still not a standardised way to store psychological data, but some approaches have been made, and we will comment one of them later [5]: the use of XML as a possible way to structure and organize data about the evolution of users of a telepsychology application.

3.1 Introduction to databases

A database is a collection of data that is organized so that its contents can easily be accessed, managed and updated [3].

In relational databases data is stored in a tabular structure so that it can be organized and accessed in different ways depending on the purposes. Relational databases were invented by E.F. Codd at IBM in 1970 [36].

The structure of a relational database is a set of tables that contain data classified into different categories that are structured in columns. For example, if we are collecting data about the responses of a user inside a psychological application, we can have different columns for data such as user identification, age, sex, responses to questions about anxiety, responses to psychological questionnaires, etc.

There exists a standard interface to access to the data stored in relational databases.

It is the structured query language (SQL) [37]. Depending on the information in which we are interested, we can extract it from the database using the appropriate database commands. SQL is a language for making interactive queries from and updating a database

such as IBM's DB2, Microsoft's Access, and database products from Oracle, Sybase, and Computer Associates.

The main advantages of relational databases are that they are relatively easy to create and modify.

Once a database structure has been created, it is easy to add new data categories, without modifying applications that work with previous data categories.

3.2 XML

We have described previously the XML format as a way to structure information that can be visualized in browsers using style sheets (XSL). However, we can also use XML as a way to organize data collected from the user, without worrying about the presentation. This can be especially interesting for medical and psychological applications.

This technology allows modelling the patient status, the actions carried out during the treatment and all complementary data that is needed in a patient file. This file can be transmitted from the patient's computer to the control system (a remote server), so it is possible to use it as a way to de-centralise and standardise the data for communication between the different elements composing the system. Data can be processed locally without requiring a centralised server that provides all the system intelligence, and be sent to the control system at the end of the session.

Data stored in XML can easily be adapted to other formats, so that compatibility with other systems is provided. And it allows for remote data access, for example to the clinic story of a patient.

Besides, XML allows the inclusion of "metadata", for example, the description of the structure and format of the data goes along with the data itself, and it includes mechanisms for validating the structure of the data records.

All these characteristics suit perfectly the transmission of highly structured medical/psychological information through Internet / intranet.

4. Virtual environments in web pages

A tool that has been commonly used in recent years for phobia treatment is 3D virtual environments. Besides, the development of 3D interactive graphics has become one of the major sources of impulse for the IT sector in the latest years. Spectacular advances have been achieved by the parallel evolution of hardware (by means of graphic accelerators) and software (with the evolution of OpenGL or DirectX).

For psychological treatment purposes, virtual reality can be seen as an intermediate step between the therapist's consulting room (a totally protected environment) and the real world [5]. A good approach to provide remote psychological treatment is based in the use of virtual environments inside web pages. In this point, we are going to describe some technical alternatives.

4.1 Requirements

If we plan to use a virtual environment imbedded in a web page, several technical configurations should be taken into account. When we design a virtual environment, we can give importance to the realism, which in technical language implies the use of more complex geometries for the modelling of the environment, more realistic textures, radiosity algorithms, etc These factors make that the size of the virtual environment file grows. This

is acceptable as long as we are going to run the environment in a local machine. If we plan to run the virtual environment from a web page, two alternatives can be taken:

- Design the virtual environment in a way to reduce the size of the final file. That will imply a reduction on the realism of the environment, which can be acceptable depending on the final application.
- Send the virtual environment to the user in a CD (or allow the user to download it from the internet before using it and copy it in the local hard disk of his/her computer). That way, the user will have a local copy of the virtual environment, and the web page can access to it when it is required. One requirement in this case can be to guarantee that the environment is only run from the web page. In order to do that, several strategies can be thought that depend on the technology that we have used to develop the virtual environment. For example, if the technology allows that parameters are passed from the web page to the virtual environment, some initialization password can be sent to the environment at the beginning of the session. If the user runs the environment locally, this password will not be sent, so the virtual environment will not work.

4.2 Development tools

Currently, two approaches coexist in the use of 3D graphics inside the web browser:

- A proprietary software. For example, we can mention the Virtools software [38]. This software must be installed as a plug-in (automatically or specifically).
- VRML (Virtual Reality Modelling Language) [39]. It is a file format and run-time description for 3D graphic elements for use on the World Wide Web. It includes interaction and animation elements as well as interfaces to scripting languages to provide more general simulation behaviours to network services. Currently, VRML worlds can be scripted with Java and JavaScript, both of which are familiar to most web programmers.

5. Telepsychology applications design

The adaptation to Internet of psychopathology involves the application of a range of available technologies. In the previous points we have described several services that are available for the Internet.

FTP provides a way for transferring files between the therapist and the patient: documentation that the patient should read, writings of the patient that are important for the therapist in order to make a diagnosis or treatment, virtual environments that the user has to install in his/her computer to follow the treatment, etc.

Other tools such as e-mail, chats, instant messaging or even videoconference provide ways of establishing a direct communication between the therapist and the patient, which allows the user to ask for the therapist's help when it is required, or even to have online sessions in which both the therapist and the user take part.

Of course, the World Wide Web offers a much wider field of actuation. Web pages can be designed that control a structured treatment that the patient should follow, and store the answers and evolution of the patient in a database, perhaps in an standardised format that can be shared between different applications, such as XML.

Virtual environments can also be integrated in web pages and be used as a part of the treatment. Or a video server can be prepared with different videos that the therapist considers useful for the therapy, and the patient can download them following the

psychologist's instructions, or navigating from a web page that controls which is the order in which videos should be visualized.

Telepsychology is a wide field. A quite frequent strategy is to provide information on particular disorders and the existing therapeutic possibilities. An example of it can be found in the TAPIR ("The Anxiety Panic Internet Resource") frame [40]. But in recent years, other approaches have appeared, such as self-help remote applications that follow a structured treatment protocol so it is possible to ensure that the user does not skip any step in the treatment, gaining more control of the process such as Talk to me, a system for public speaking fear treatment on the Internet [5]. In the following points, we pretend to describe the points that should be taken into account when designing a remote psychological treatment application.

5.1 Psychological considerations

The first step to design a remote psychological treatment application will be to describe in an exhaustive way its goals and in the kind of treatment that is required.

Between other aspects, it should be clarified which kind of treatment it will be: a full self-help treatment or a therapist-guided treatment. It has to be selected the kind of psychological disorder that it should address and the psychological protocol that should be followed.

5.2 User requirements analysis

Taking into account that we are designing an Internet application, we cannot presuppose that the patient has any special hardware or software at his/her home.

For most applications, the only hardware requirements for the user will be to have an Internet connection and a standard PC, with a graphics card in the case we plan to use virtual environments for the treatment.

Regarding software, it is possible that the user has to download some software before starting the treatment. It has to be clarified during the design phase and clearly specified in the final application so a normal user can easily install everything that is needed for a correct operation of the application.

In some concrete applications, it is possible that the user has to use some specialized hardware or software. These will probably be applications for specific users, and they will have to provide some kind of technical assistance to help the user to configure the system.

5.3 Tasks analysis

During the evolution of the treatment, several stimuli will be presented to the user. In the design phase, it has to be selected which kind of stimuli: images, texts, animations, virtual environments, etc. And once it has been done, the most appropriate alternative from the technical point of view has to be chosen. For example, images can be presented integrated in web pages, and the user can access to them following a predefined order that the navigation through html pages forces. The same can happen with the text. Animations and virtual environments have to be developed using some of the development tools that have been analyzed in previous points. And after that, they can also be integrated in web pages.

Depending on the estimated size of the virtual environment files, the user can download them before starting the treatment or they can be used directly from the web.

A second point that has to be considered is the control of the patient activity. The normal case is that the patient should follow a controlled flow decided and supervised by the system. To assess the evolution of the patient, different tools such as questionnaires can

be used. User responses can be analyzed by the system to determine if he/she can continue with the treatment. During the design phase, it has to be decided if these responses should be stored by the system, so the psychologist can consult them afterwards. If it is the case, it has to be designed a database system to store the data, and select the format in which it has to be stored.

Finally, another point is the connection between the patient and the psychologist. It has to be decided which kind of tools will be used, ranging from e-mail to videoconference.

5.4 User interface design

Although this is the last point we are describing, this is not the least important. The design of the psychological and technical aspects that support the application are the basis, but it is decisive that the application is attractive from an aesthetic point of view. Web page designers have experience in this kind of tasks and will make that the final application has a good appearance.

6. Future trends: wireless devices

With this chapter, we expect to have given a general overview of the techniques that can be used for the design of telepsychology applications. However, we do not want to finalize it without describing a new set of technologies that can be the basis of many future psychological treatments: wireless devices.

6.1 Wireless devices characteristics

Wireless devices include a variety of different hardware terminals such as PDAs (Personal Digital Assistants), cellular phones, etc. Divisions between cellular phones and palm-top computers are expected to become increasingly indistinct [41] and many products appear in market that combines the functionality of both types of devices.

Some common characteristics of these devices are the following:

- They have a reduced size and can usually be held inside the hand. That is why they also receive the name of handheld devices.
- They have a reduced computing power when compared with a PC.
- The display has small dimensions, so the content has to be adapted to the characteristics of the screen before being displayed.
- The way to introduce text is different that the one used in PCs. It can be a virtual keyboard that appears in the screen, the device can do writing recognition or it can be included a small keyboard in the terminal.

6.2 Internet applications

There are versions of browsers that have been designed specifically for handheld devices.

Contents of web pages have to be adapted in the server to the characteristics of these devices, especially display size.

Regarding the way to connect to Internet from these terminals, it has to be a wireless connection, because the use of cables will impede that they are used any time at any place. Many alternatives are available currently.

The GSM network completed with the WAP protocol is one of them, although it has the inconvenient that it is circuit-switched [3], with a single connection between two end-

points in the network for the duration of the connection, so the billing method is based on this duration.

GPRS is gradually spreading and it provides packetized data transmission at bit rates of 100 Kbps and over [41].

In the near future, the implantation of third generation of mobile systems (UMTS – Universal Mobile Telecommunication System) [3], also packet-based, will offer a bandwidth of 2 Mbps, so more applications can be easily integrated in wireless devices.

On the other hand, Wi-Fi technology (802.11b) [3] is also rapidly growing and it can be an alternative to wired LANs. It allows bit rates up to 11 Mbps, so if the terminal allows Wi-Fi connectivity, this can be an appropriate alternative for having an Internet connection in places where a wireless LAN is available.

6.3 Multimedia

Bandwidth is the most important limitation that we have at present to develop multimedia applications for wireless devices.

However, software applications have been developed for wireless devices that allow the visualization of video-streaming in PDAs or cellular phones, such as Windows Media Player for Pocket PCs [42].

Versions of Flash MX for handheld devices have also been developed [43]. They allow the visualization of interactive content and animations.

6.4 3D environments

Regarding the possibility of using 3D environments in wireless devices, the main limitation is in their graphics processors. Their capability for 3D hardware acceleration is reduced or null.

However, we expect that in the near future more powerful graphic processors will be integrated. And meanwhile, several software alternatives for visualizing 3D content are available.

There are VRML browsers for wireless devices (such as Pocket Cortona from Parallel Graphics [44]).

Other alternatives include the Swerve3D viewer that has been developed by Superscape [45]. The interactive content is independent from the hardware and only requires that the Java Virtual Machine is present in the device.

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