Google Web Toolkit application solution for mild aphasia therapy

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Abstract

Aphasia is a disorder that results from damage to the parts of the brain that contain language. It typically occurs after a stroke, brain tumors, head injuries, infections or degenerative diseases leading to damage in areas of the brain cells. Aphasia causes problems with any or all of the following: speaking, listening, reading, and writing.

Thousands of people of all ages and gender suffer from this disease and the trend is growing with the longevity of population. This article describes the design and development of specific software that can be useful for treatment of mild aphasia. This software is based on a Google Web Toolkit (GWT) application. GWT is an open source framework that allows developing a user friendly interface. The web application can be accessible to speech and language therapists (SLT) professionals and patients at different contexts and learning situations.

Keywords

Aphasia, Mild aphasia, Google Web Toolkit, Therapy, Telerehabilitation, Web application.

I. INTRODUCTION

From the traditional perspective, APHASIA can be defined as a disorder in the ability to comprehend and to use language due to an injury in the central nerve system. As such, it is a multimodal syndrome represented by a variety of disorders in the auditory verbal comprehension, oral production, reading and writing.

From a paradigmatic change, consequently with the World Health Organitation (2001), that moves from a psychobiological classification to a bio-psycho-social model of this disability, then the APHASIA is defined as the loss of the ability to understand and use the language that lead to a reduced ability to communicate, keep and perform interaction and to accomplish all the social roles in life. (Lasker, Garret y Fox, 2007) [1].

In general, when talking about patients that suffer from MILD APHASIA there is a reference to all those persons whose linguistic competence is clearly near to the normal level, but who find some difficulties to name certain words and frequently they need more time than usual to communicate.

The ASHA (American Speech-Language-Hearing Association) [2] defines the person with mild apashia as one who may be able to carry on normal conversations in many settings but who may have trouble understanding language when it is long and/or complex and to find the words (called anomia) to express an idea or to explain himself/herself –this is like having a word “on the tip of your tongue.

The symptoms may go unnoticed for the environment, however, the subject is limited to understand a verbal joke, quickly record a telephone number, retrieve a particular word and / or express an opinion accurately, limiting their social performance

On other hand, mild aphasia is a smoother mode of aphasia but **"Mild Aphasia is still Aphasia” as** say the Aphasia Center of California.

Taking into account the observations led from the clinical practice and supported in all the findings in the current scientific literature [3] [4] [5] [6] [7] that the aphasic patients can also have some other cognitive functions compromised, this cannot avoid consideration when planning a therapy for patients with mild aphasia activities exercising the complex attention function and the working memory so that can give the patient a comprehensive training that is not limited only

to the linguistic disorders and that demonstrate all the difficulties in their daily performance.

There is a correlation between language disorders, attention and memory.
In the current literature it is still under discussion whether mild aphasia problems only occur because of memory and attention disorders coexist or it arises for other reason.

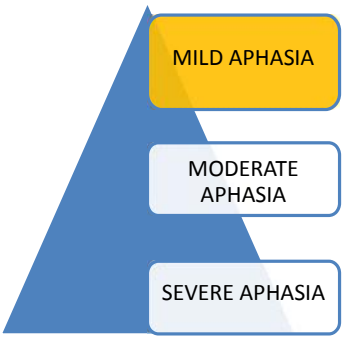

Figure 1. Mild aphasia is still aphasia

Today the use of the WWW has become a standardized infrastructure for giving access to sophisticated telemedicine applications that guarantees accessibility and usability advantages to both customers (patients) and providers (physicians) [8].

II. METHODOLOGY

2.1 Conceptual system design

Taking into account the observations led from the clinical practice and supported in all the findings in the current scientific literature that the aphasic patients can also have some other cognitive functions compromised; this work incorporates elements comprising the overall context of this disease.

There are activities designed to exercise the complex attention function and the working memory so that the patient can have a comprehensive training that is not limited only to the linguistic disorders but it encompasses all the difficulties in their daily performance.

The difficulties encountered in the language of patients with mild aphasia obey a linguistic disorder per se or they are the result of a misallocation of cognitive resources (attention and memory).

For this reason, have worked in the development of "core" modules. The application LEV_APHASIA has three stimulation modules: LANGUAGE, ATTENTION AND MEMORY.

The application LEV_APHASIA addresses the problem of mild aphasia from a global and general perspective.

The project has different goals and aims, but the most important is the possibility of interaction between patient, therapist and web exercises.

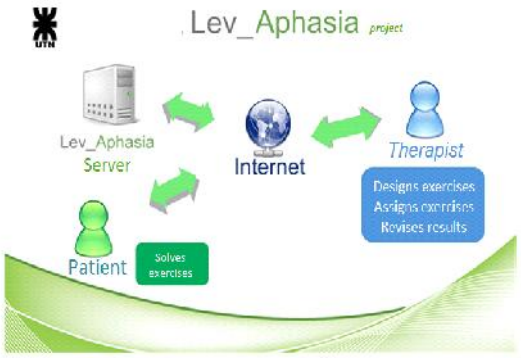

Figure 2. LEV_APHASIA system lay-out.

2.2 Software design

2.2.1 Development process and directives

The development process is based in the Agile Unified Process (AUP), which is a simplified version of the Rational Unified Process (RUP). It describes a simple and easy-to-understand approach to developing business application software using agile techniques and concepts yet still remaining true to the RUP [9]. It is focused on the development of an evolutive and increasing design.

It applies agile techniques including agile modeling (AM), test-driven design (TDD), agile change management, and database refactoring to improve productivity. AM is the basis for agile model-driven development and is a key concept introduced in AUP to effectively model and document software systems. Simply put, AM is

a collection of values, principles, and practices for modeling software in a lightweight manner. 9–10 It values communication, simplicity, courage, feedback, and humility. Its principles include:

- assuming simplicity, which is the equivalent of Occam's razor in software engineering;
- embracing change, in that requirements will inevitably change during the project lifecycle;
- incremental change of a system over time to accommodate requirement changes; and
- rapid feedback from project stakeholders after every software release. [10]

These principles are vital for the nature of this project since the evidence of usage by the SLT along with the activities done by the patients present much more information than the initial requirements.

The guidelines have been to adopt open sources technologies and a frameworks widely used in the software industry. This allows us to count on a great information community and to use efficiently the available infrastructure.

2.2.2 System architecture

According to this guideline, Java Enterprise Edition platform has been chosen since it is a solid platform, widely used by academic institutions and companies, and which bears a great amount of libraries.

It is a web application designed in three layers that allows not only the therapists but also the patients, researchers, or government officers to access to all its functionalities through any modern web browser without setting up additional software.
For the persistence of data it has been selected a model of relational data, which gathers all the information of the patients, exercises and their treatment.

The server of the selected database is MySQL since *"It is a true multi-user, multithreaded SQL, database server. MySQL is fast and flexible enough to allow storage of logs and pictures in it. The main features of MySQL are speed, robustness and ease of use. MySQL has filed called BLOB (binary large object) that can be used to store large video files."* [11].
The structure of the three layers software consists of:
Domain Layer: it is the layer that resolves the object-relational mapping problem; it uses the specification Enterprise JavaBeans version 3 and Java Persistence API for the manipulation of objects. The implementation is carried out by Hibernate, the *de facto* standard.
Service Layer: it is the layer that contains the logic of the business and exposes it as service in the View Layer.
View Layer: It is very crucial for projects of this nature since it is really important to implement interactive exercises for the patients, focusing on the usability and user-friendly interface for the patient.

The view layer is implemented in the Google Web Toolkit framework, the GWT is a model-view-controller framework abstracting the process of writing HTML, JavaScript, and associated Asynchronous JavaScript and XML (Ajax) messaging into code written in Java, and then processed by the GWT for deployment in Web application server. It eliminates the complexity of hand coding HTML, JavaScript, and other elements that bind the JavaScript actions triggered in an HTML page (client-side code run within the browser) to the controlling layer executing within the Web application server (server-side, where the database resides)[12].

It enables the development of the Rich Internet Applications from the server-side Java language into client-side JavaScript language.
This framework enables to develop interactive exercises for the patients, making it easier the implementation for the developer, since they only have to focus on the functionality of the exercise and not in the technical complexity of usage of HTML and JavaScript and their

appropriate running through different browsers (Microsoft Internet Explorer, Mozilla Firefox, Google Chrome, etc).

On the contrary to some other technologies different from open source technologies or that they require to install some applications in the computers, the use of Google Web Toolkit just require a modern web browser and a good internet connection. The technology used enables the patient to perform their interactive exercises from any computer or appliance that comply the aforesaid requirements.

2.2.3 Code sample

The follow code sample briefly show us how the application typifies the patient response.

```
public void registrarRespuesta(Long idEjercicioAsignado, int intento,
String respuesta) {
          EntidadManager em = EntidadManager.getEntidadManager();
          try {
               // Se obtiene el ejercicio asignado
               EjercicioAsignado ejercicioAsignadoEJB = (EjercicioAsignado)
em.findById(EjercicioAsignado.class, idEjercicioAsignado);
               // Se asocia la respuesta con el ejercicio asignado

                    // Se genera el objeto respuesta
                    RespuestaEJB respuestaEJB = new
RespuestaEJB(ejercicioAsignadoEJB, intento, respuesta);

                    // Metodo 1: A partir del ejercicio asignado, se
obtiene el ejercicio
                    List<String> nombreParametros = new
ArrayList<String>(1);
                  List valorParametros = new ArrayList(1);
                  nombreParametros.add("idEjercicio");

valorParametros.add(ejercicioAsignadoEJB.getIdEjercicio());
                    EjercicioBase ejercicioEJB = (EjercicioBase)
em.findByNamedQuery(ejercicioAsignadoEJB.getEjercicio().getClase()+".findB
yId", nombreParametros, valorParametros).get(0);
                    // Se consulta al ejercicio que tipo de respuesta es
                    TipoRespuestaEnum tipoRespuesta =
ejercicioEJB.obtenerTipoRespuesta(respuesta);
                    if(tipoRespuesta == null){
                         // Metodo 2: a partir de una respuesta igual para
el mismo ejercicio, se obtiene el tipo de respuesta (si tiene asociado)
                         nombreParametros.add("ejercicio");

     valorParametros.add(ejercicioAsignadoEJB.getEjercicio());
                         nombreParametros.add("respuesta");
                         valorParametros.add(respuesta);
                         List<TipoRespuestaEnum> tiposRespuestas =
(List<TipoRespuestaEnum>)
em.findByNamedQuery("RespuestaEJB.findTipoRespuesta",
nombreParametros, valorParametros);
                         if(!tiposRespuestas.isEmpty()){
                              tipoRespuesta = tiposRespuestas.get(0);
                         }
                    }
                    respuestaEJB.setTipoRespuesta(tipoRespuesta);
                    // Se persiste la respuesta
                    em.crear(respuestaEJB);
```

In this code there can be seen the logic to persist a word as the response entered in an input text by the patient for an exercise. Before persisting, you get the exercise and there is any consult if the answer entered is correct according to the definition of the exercise (Method 1). If the word entered is not the correct answer and it is not in the definition of the exercise, then there is a search in the saved answers from other patients since a SLT would have checked and decided if that was the correct answer having someone answered the very same exercise (because it is a synonym, for instance), or if it is some kind of distraction (Method 2).

III. RESULTS

Up to now, LEV-APHASIA has been tested in the laboratory with very few cases but it has proved to work in full capacity.

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Fig. 5. LEV_APHASIA therapist interface (example).

Fig. 6, LEV_APHASIA patient interface (example).

As you can see in the figures 5 and 6, the interface is very user-friendly.

Single-subject multiple-baseline design:

Have been used alternative treatments when there are several behaviors which require different treatment.

Instead of applying all treatments at a time on the patient, have alternated each one of them. Then, have compared results seen and evaluated the effects on the patient.

For example, X program is applied on a deficient activity. At the same time, the other deficient activities are at rest. Then the therapy is applied on the second activity and put at rest the first one. In the case these therapies were effective, improvements can be seen on each phase of the treatment and stagnations would be present when the treatment was suspended. In all cases, prior baseline references are taken into account.

Briefly, the methodological sequence with the procedure of LEV_APHASIA is:

1) Obtain a baseline in all three modules
2) Apply the Language module only
3)Measure baseline Language
4) Apply the Attention module only
5) Measure baseline Language
6) Apply the Memory module only
7) Get a new baseline.

IV. DISCUSION

LEV_APHASIA is a very important software whose principal aim is the treatment of mild aphasia. Computer and telecommunication tools account for the fast growth of home health care via telemedicine in recent years [13].

The few results achieved with this software are very promising and encouraging but further work is needed in the design of protocols for massive trials and tests of this software.

At the present LEV_APHASIA is to be tested in a larger sample of cases and for this reason is necessary to work on improving the clinical trial protocols with professional teams from some hospitals at Argentina.

Also, speech-language therapists have been trained for the use of LEV _APHASIA.

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In this phase of the work, the expectations are to obtain a solid core of results and from these outcomes, several and different analyses will be initiated. Then, there will be some work on the re-design of procedures to improve the current protocols

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