

The access of persons with visual disabilities at the scientific content

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Abstract: The access to scientific content, for people with disabilities, involves a number of problems both in reading web documents, which contain the elements as images, with or without alternative text and reading from files, especially if these contain mathematical expressions. From this point of view, the applications' utility for synthesizing artificial language, starting from a written text in Romanian language, is undeniable, given that, the concerns have increased for creation of facilities designed to contribute to a better integration of persons with disabilities in society.

The purpose of this paper is the result of research into education, for the access to science of people with disabilities, by integrating the facilities the audio presentation of information, in Romanian and provides a way to integrate assistive components in an open source learning platform.

Key- Words: Accessibility, Vocal synthesizers, Assistive technologies, Web service, Mathematics, W3C

1 Introduction

Publication and distribution of scientific papers and articles, web sites and e-learning are a way to spread knowledge, promote education and encourage research and development. Language for such communication is often chosen mathematical language because is universal and unambiguous.

However, the problem relates to the accessibility of high quality math resources for each individual, despite the location, cultural differences or learning ability.

Most mathematical concepts are better explained using visual methods, but for persons with disabilities, to convey mathematical content are used other communication channels, namely audio and tactile.

At basis of many tools accessible to blind persons there are speech synthesis systems which produce voice signals starting from a text [1]. When designing a voice-based application is important to understand the limitations of TTS component and we make sure that, these have a minimal impact on the successful use of the application [11]. The synthesis involves various constraints: the vocabulary is virtually unlimited, and the short or long sentences handed, must show a natural character. Moreover, the synthesis must comply with normal intonation possible to ensure good

intelligibility. As you can't save all possible phrases appropriate you must choose a finite and reasonably limited set of basic linguistic units, which, through concatenation to allow synthesis based on some text.

Web services can facilitate communication between different applications. There are many types of integration but most interesting is the composition of Web services. Web services are useful in implementing e-learning systems interoperability. The building of applications is based on reusable components, whose functionality is maintained by Web service providers and easing of communication is given by the fact that Web services communicate through an HTTP channel [7]. At present, the XML-based Web services are the easiest mechanism for integration.

2 Solutions for information accessibility to the blind persons

The content accessibility standards developed by W3C (World Wide Web Consortium) promote the development and interoperability of the Web and especially its universality [18].

The standards created by the W3C to improve accessibility of web sites, can be grouped into three categories:

- *Web Content Accessibility Guidelines* (WCAG) - which contains instructions for making the web content pages accessible to persons with disabilities. Following these guidelines, people will more quickly find what they're looking in web pages and web developers will understand how to make multimedia contents accessible to varied audiences.
- *User Agent Accessibility Guidelines* (UAAG) - document provides guidance for creating user agents that remove barriers to Web accessibility for people with disabilities (visual, auditory, physical, cognitive and neural). These agents include HTML browsers and other softwares, which handling Web content. This document helps both the HTML browsers developers or media players and assistive technology developers, because explains at what types of information and control may expect assistive technology from a user agent.
- *Authoring Tool Accessibility Guidelines* (ATAG) - document that includes instructions for Web developers tools, in that:
 - must assist developers in using creative tools (authoring tools), which to provide an accessible Web content;
 - must assist developers in creating an accessible authoring interface. Authoring tools can help, encourage and assist designers in creating accessible websites with messages warning prompt, verification and correction functions, help files and automated tools.

Websites are often created by linking with other external technologies. By example, Style Sheets allow to control playback (fonts, colors, and other aspects of style) of a Web document without compromising its structure [9].

An application for accessibility of Web pages is usually a client-server application that can provide access to the page, using the synthesized voice. This can be useful blind persons, but is especially appreciated by people with amblyopia (who don't use a screen reader) or for dyslexic people (who even see, but can't read), and by people with cognitive disabilities.

For this category of users designing an application is closely linked to respect accessibility standards and

using of assistive technologies, in this case speech synthesis and voice recognition for the Romanian language, with MBROLA and IVONA voice synthesizers [13].

2.1 The access to educational objects

A learning object is defined as "any entity, digital or non digital, which can be used for learning, education or training" [16].

In the computer-assisted instruction, the access to educational objects must be addressed in terms of developing applications for reading information from different files (Fig.1). Using the sound interface, the user will be guided towards information containers, and by choosing the desired file name and its extension there is a verification of the existence of resources followed by their acquisition and sound rendering, with the possibility of printing in Braille format.

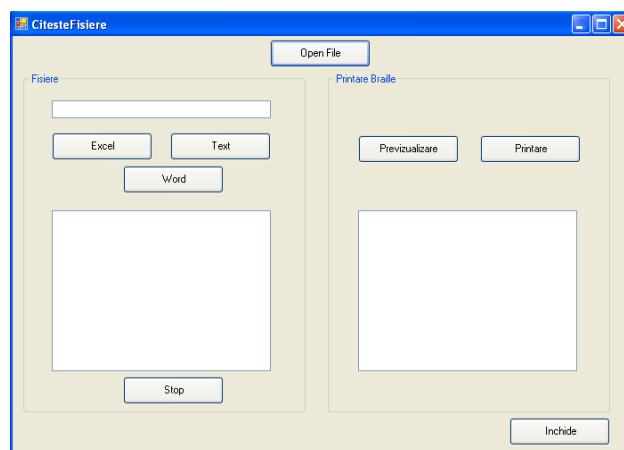


Fig.1 The accessing files

If the blind person wants to enter a filename, he will hear the keys pressed so that finally to hear the full name of the file (possible by using control *Preprocesare_Control*).

The option sound on character typed is possible by implementing a new class called *TextBoxAudio* derived from *TextBox* class.

Using Word and Excel files type in applications requires the addition of references needed moving them. The process is called interoperability, i.e. the ability of the disparate systems to communicate and access to not scattered information. Interoperability is achieved through services provided by Microsoft.NET Framework for interacting with COM components, COM+ services, external libraries. It provides access to existing COM

components, without requiring modification of the original component. Incorporation the *COM components* will be made through specific instruments that can be used immediately after being imported.

The process of transforming text into sound using MBROLA includes the following steps [1]:

a) Connection to database with phonemes and waves, with two steps:

- Connect to the database where phonemes are retrieved from the specific graphemes.
- Call dictionary of Romanian language phonemes "ro1", provided by MBROLA synthesizer and charged in synthesizer with *init_MBR()* function.

b) Preprocessing, is the stage in which takes place the transcript of text with the aid of the phonemes and use the transformation algorithm in transcript numbers in words. Thus, preprocessing may be: simple (text only), preprocessing numbers (integers and real by dialing *preprocesare_numere()* function, preprocessing of complex text (preprocessing of text and figures).

c) Transpose text file in .pho type file by assigning for each of phonemes a series of values which represents the voice fundamental frequency (pitch). The file .pho type will be read by MBROLA.

d) Audio file generated is done by use of the mbrola.dll library. Loading ro1 the dictionary diphones in the synthesizer with *init_MBR()* function. The string of phonemes is then ready to be processed by MBROLA synthesizer using *write_MBR()* function. Reading is done from synthesizer to memory using *read_MBR()* function. By this function is read the processing phonemes result from the buffer of synthesizer. With *reset_MBR()* takes place the synthesizer's resetting.

```
public Preprocesare_Text()
{
    InitializeComponent();
    init();
}
private void init()
{
    if
    (init_MBR(System.Windows.Forms.Application.StartupPath +
    "\\ro1") != 0)
    {
        MessageBox.Show("Error at association with base of
        phonemes.");
        reset_MBR();
    }
}
```

```
void generateRAW()
{
    double writebuf = write_MBR(textBox1.Text);
    if (writebuf == 0)
    {
        MessageBox.Show("Error writing in the
        synthesizer.");
    }
}
```

For application flexibility and portability, are built **controls** (WindowsControl Library):

- *Preprocesare_Control.dll* - encompasses the entire phase of transformation and establishment of sound;
- *TextBox.Audio.dll* - inherited from the TextBox control, this control provides sound reproduction facility of each character typed;
- *Print_Control.dll* - allows preview and print out the text you want in a Braille font, XBraille E. JALLY specific to people with vision problems.

The first step in manipulating Word documents in .Net is adding a COM reference Microsoft Word 11.0 Object Library. Is added: *using Microsoft.Office.Interop.Word;* After instantiation word processing (*Word.ApplicationClass oWordApp = new Word.ApplicationClass ();*) can be called specific methods and properties of Microsoft Word. Adding a COM reference is made to handle Excel files in .Net.

```
public Microsoft.Office.Interop.Excel.Application ExcelObj=
    new Microsoft.Office.Interop.Excel.Application();
```

The files of .txt type don't require reference or adding any instantiation of the application in basic application.

Text synthesized by MBROLA can be listened also with IVONA, considered one of the best synthesizers in the field for Romanian language. To use synthesizer IVONA, is necessary to add the option that facilitates user access to files, so that in passing the mouse over an element of the list, the user will hear the file name and can have access to it via sound rendering.

2.2 The access to general information available on different sites

The accessibility information to sites requires the development of APIs (Application Programming Interface) to intercept information from a Web

browser control and facilities for audio presentation of information.

To intercept the information in the browser and their translation into audible language are used web services, which can facilitate communication between different applications. Also they permit their reuse and create new opportunities in many areas as they provide an easy way to distribute information to a large number of consumers.

The request (message) is sent to server on which there is the web service. The server will process this request, will forward it to the web service, which will execute the method called and will return the response to server, which in turn will send it toward the application. Calling web service within an application built in C # is done by adding a Web reference to webservice.net service. It then declares objects of predefined classes in service (for example, an object of type Global Weather), then you can call the associated methods:

```
AplicatieTTS.net.websvcex.www.GlobalWeather vreme =
new AplicatieTTS.net.websvcex.www.GlobalWeather();
XmlDocument xml = new XmlDocument();
string xmlBody = vreme.GetWeather(oras,tara);
xmlBody = xmlBody.Replace("<?xml version='1.0'
encoding='utf-16'?>", "");
xml.LoadXml(xmlBody);
XmlNodeList temperatura =
xml.GetElementsByTagName("Temperature");
```

Using other web services (exchange rate, search, e-mail) is performed similarly, by adding the reference, the declaration of variables and calling functions provided by tools accessed in order to return the desired result.

For the synthesized speech control are used control tags which check the *volume* control, *frequency* or *breaks* that might occur in synthesized language. Thus, after entering text in the textbox, the user can choose to render synthesized speech including pauses between words or the rendering to be faster.

Other options can be: for e-mail, where the opening of window and adding the necessary elements is assisted by audio messages released when the user passes the mouse over a particular field, option which allows the simulation Google search engine, with web service provided by it.

Google API services have the following classes:

- *GoogleSearchService*,
- *ResultElement*,
- *DirectoryCategory*
- *GoogleSearchResult*.

When the mouse passes over the textbox in which follow to be entered keywords for search, the user will hear a message to indicate this and to induce him to perform a mouse click to reach that area. After entering keywords, the user can select the search option and the content of the first link to load the page using a web browser. Persons with visual disabilities can listen to the content of the first page found, the search is accomplished pages only in Romanian.

The application as **web browser** is useful for people with severe visual disabilities, impaired lower view, but also people with motor or learning disabilities.

Application accessibility consists in the possibility of taking over the voice commands, and auditory rendering of the content of web pages.

The **composing of services** provides the access to information services for blind persons (weather, exchange rate, media), documentation service (web browser adapted) or communication (reading email, chat, so).

Using the web browser by the persons who can't see is now possible because they are "announced" at any time on which option in browser is located the mouse.

Some actions can be triggered with voice commands, such as navigation: *back*, *forward*, *stop*, *refresh*. The user receives auditory feedback when takes place the onset of action (the command is carried out) and to the finish of actions: loading web page, sending an email.

For options in the browser are determined voice commands, as predefined key combinations, that can be called by the user. When loading a Web page the browser will not read the entire contents of the web page, but will read the title page loaded followed by the number of existing images, the number of links, the buttons and paragraphs. Then can be read to select specific elements on the page (links, images, buttons, the paragraph with a number, the selected text or all text).

New Microsoft technologies make it possible the applications development easier using speech recognition and voice synthesis when using SAPI interface.

Also, Windows Vista has additional features compared to Windows XP, namely the speech recognition engine installed with the operating system and an enhanced SAPI interface (version 5.3).

Despite the emergence of a performance synthetic voice for Romanian, currently there isn't speech recognition engine for the Romanian language,

therefore the commands in the Romanian language are hard to recognize.

2.3 Mathematics accessibility

The access of persons with disabilities to scientific material relates to scientific texts, which include tables, equations, diagrams or pictures.

Most of web documents containing specific elements of mathematics use images (jpg, gif, png), created by TeX software or Microsoft Word to display mathematical formulas. Some documents are distributed in PDF, TeX, PostScript, Word or RTF file type. It is also common to use Java applets or plug-ins. This led to problems of accessibility to read documents containing mathematical expressions for the visually impaired persons, and especially for the blind.

Mathematical information has as graphically form different formats, which requires specialized software for information acquisition, storage and its retrieval.

2.3.1 Aspects regarding the reading mathematical expressions and symbols in Romanian

Reading in mathematics is different from reading a simple text, primarily because mathematical expressions are written in bidimensional form. For a blind person understanding a mathematical formula requires repeated scanning and jump over some secondary parts in the formula.

Moreover, mathematical symbols used in mathematics, which are read differently in each language, emphasize the difficulty of addressing this area. For example, the symbol " f " has a *graphic equation representation*, a *textual representation*, used by the editors, and a *textual form*, which underlies the "reading" mathematical expression.

The specific elements of mathematical expressions are:

a) The **symbols** used in the construction and vocal rendering of mathematical expressions, have also specific names in Romanian language (Table 1):

Graphics sign	Equivalent in LaTeX	Pronunciation in Romanian
\sum	<code>\sum</code>	sumă
$\sqrt{\quad}$	<code>\sqrt{\quad}</code>	radical
\neq	<code>\neq</code>	diferit (nu este egal cu)
\leq	<code>\leq</code>	mai mic sau egal cu

∇	<code>\nabla</code>	gradient
∞	<code>\infty</code>	infinit
\int	<code>\int</code>	integrală
\exists	<code>\exists</code>	există
\forall	<code>\forall</code>	oricare ar fi

Table 1 Pronunciation of mathematical symbols in Romanian

b) The names of **mathematical functions** that have common short name (Table 2)

Graphics sign	Equivalent in LaTeX	Pronunciation in Romanian
\cos	<code>\cos</code>	cosinus
\arcsin	<code>\arcsin</code>	arcsinus
\sin	<code>\sin</code>	sinus
\ln	<code>\ln</code>	logaritm natural
$\sum_{i=1}^n$	<code>\sum\limits_{i=1}^n</code>	sumă de i egal cu 1 la n
\lim	<code>\lim</code>	limită
\log	<code>\log</code>	logaritm
\exp	<code>\exp</code>	exponențială

Table 2 Name pronunciation for usual mathematical functions in Romanian

c) The **order of pronunciation**, controlled by the brackets, which allows control regarding expressions' evaluation (Table 3)

Graphics sign	Equivalent in LaTeX	Reading order by using parentheses
$f(n) = \begin{cases} n/2 & \text{dacă } n \text{ este par} \\ -(n+1)/2 & \text{dacă } n \text{ este impar} \end{cases}$	<code>\f(n) = \left\{ \begin{array}{l} n/2 \\ -(n+1)/2 \end{array} \right. \quad \text{\texttt{\textbackslash if \$n\$ is even}} \\ \text{\texttt{\textbackslash if \$n\$ is odd}} \end{array}</code>	F de n egal cu acoladă, n supra 2, dacă n este par și minus paranteză rotundă deschisă n plus 1 paranteză închisă total supra 2, dacă n este impar
$\lim_{x \rightarrow -\infty} \exp(-x) = 0$	<code>\lim_{x \rightarrow -\infty} \exp(-x) = 0</code>	Limită când x tinde la infinit din exponențială de minus x, egal zero
$\sum_{0 \leq i < m, 0 \leq j < n} P(i, j)$	<code>\sum_{\substack{0 \leq i < m \\ 0 \leq j < n}} P(i, j)</code>	Sumă când i este cuprins între 0 și m, și j între 0 și n, din P de i, j
$\left(\frac{x^2}{y^3} \right)$	<code>\left(\frac{x^2}{y^3} \right)</code>	Paranteză deschisă, x pătrat, supra y la a treia, paranteză închisă
$A_{m,n} = \begin{pmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,n} \\ a_{2,1} & a_{2,2} & \dots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \dots & a_{m,n} \end{pmatrix}$	<code>A_{m,n} = \begin{pmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,n} \\ a_{2,1} & a_{2,2} & \dots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \dots & a_{m,n} \end{pmatrix}</code>	Matricea A de n linii și m coloane egală cu, pe linia întâi, a11, până la aln, pe linia a doua, a21, până la a2n, puncte puncte, ultima linie, aml, până la amn,

Table 3 Order controlled by brackets in reading mathematical expressions

d) The **constants**, which require functions for reading numbers.

The problems arising in reading the equations are solved by **prosodic**, for example, raising the voice when compositions are several successive positions, or pause (delay), to suggest the end of a mathematical subexpression. They have a great importance thus eliminating the ambiguity in the understanding of mathematical expressions.

To achieve the appropriate natural speech is necessary to define a set of **rules prosodics**.

When we read mathematical expressions we tend to simplify, don't include parentheses and/ or lexical indicators (eg "start square root" and "end fraction") because if are omitted them, these appear more natural and thus we save time and effort.

However, if such expression must be read to a person blind or visually impaired, these indices should be included so that the expression isn't ambiguous.

Prosodics information that pitch - and time breaks - can be used to distinguish between similar forms.

Handling mathematics involves well defined tasks, beyond simple understanding of a mathematical formula, requires the ability to segmentation the formula, copying and transformation it and maintaining referential access to different parts of the formula.

2.3.2 Navigating through maths formulas

All mathematical expressions - even the most complex, can be only represented as a tree structure, that matches the grammar of context. An example of tree structure, necessary in mathematical expression analysis (1) is (Fig. 2):

$$\sqrt{y-3x} \quad (1)$$

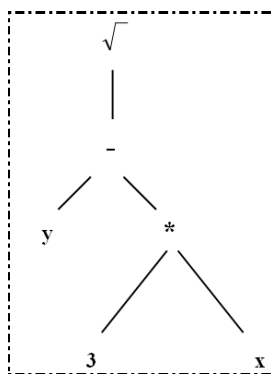


Fig.2 Tree structure of mathematical expressions

Designing an application which allows reading of mathematical expressions in Romanian language for persons with visual disabilities, starts from the premise that:

- the mathematical expressions can be edited using LaTeX, MathML and then converted into specific formats;
- is necessary setting the rules of conversion from MathML content (or LaTeX) to vocal representation in Romanian;
- creating the dictionary which contains the mathematical vocabulary and additional terms, which help to describe formulas;
- to develop algorithm, which creates internal structures of mathematical expressions (based on analysis of content MathML), these structures are necessary for voice interactive browsing and it concerns hierarchical representation of mathematical formulas, subformulas and operators;
- rendering sound mathematical expressions in Romanian language is made by using synthesizers for Romanian

Equation is expressed usually in graphic form, because of its bidimensional form and special symbols used.

For this purpose have been developed equation editors (Word Equation, MathType, so on).

The graphic format is not efficient in terms of storage, requiring large memory and time for drawing; therefore, the performance equation editors use an alternative textual of equations (eg LaTeX, MathML) based upon some conventions for rendering of spacing and symbols used in mathematics.

In our application we use both formats (graphical and textual) and the reading expressions starts from any of formats mentioned (Fig. 3).

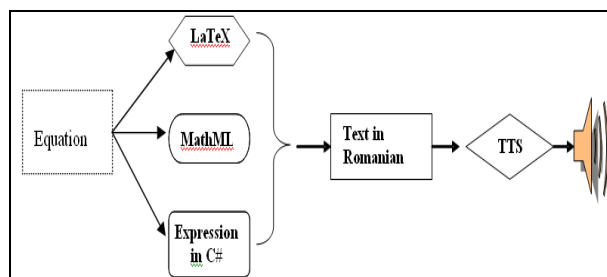


Fig. 3 Scheme for reading mathematical expressions

A component named *Equation* allows handling of graphical symbols and in the same time composes equivalent textual form using the conventions of

language from LaTeX [17]. Then, the textual form from LaTeX is "translated" into a text in Romanian language, including pronunciation of symbols in Romanian language and taking into account the order of their reading in compound phrases. The Romanian text is "decorated" with punctuation which control prosodic when is reading text. The text resulting represents the input for voice synthesizer.

2.3.3 Availability as components

The approach is based on components, the assumption that a component "equation editor" allows building the equation image offering alternative textual description in a language like LaTeX and other component builds the text for the pronunciation in Romanian and forward it to voice synthesizer (Fig. 4).

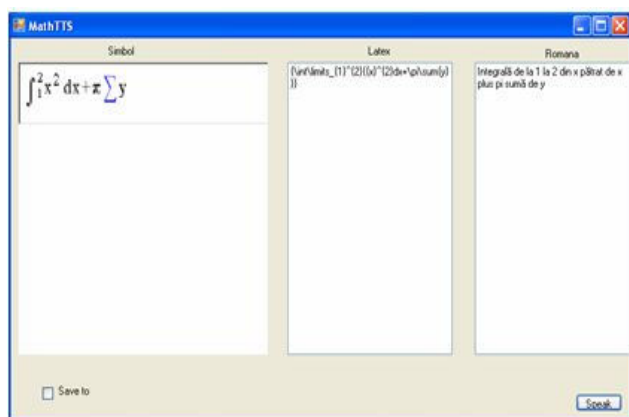


Fig. 4 MathTTS component

The objects for mathematics learning are made available as components.

Using component technology allows the definition, management and interconnecting specific objects to mathematical in which is realized the training [14].

These components are designed (in terms of the granularity and composability) to be coupled in an environment of interconnected components and have thus, properties for linking components, generally by reference [15].

Properties can be accessed to achieve interconnection through "drag and drop" operation or even at runtime by right clicking the mouse, from contextual menu.

An example of this can be component "function" which is superimposed on *MathTTS* component (Fig. 4), using the "drag and drop" operation.

Such analytical expression of function takes place and sending it to synthesizer.

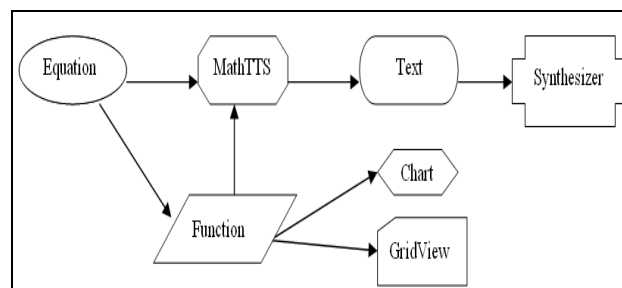


Fig. 5 Interconnect components

Learning is more effective when visual memory is correlated with auditory memory and *MathTTS* component contributes significantly to the learning process performance.

2.3.4 Interoperability through Web services

Educational objects as educational components are stored and accessed independently, and using reassembly, are created new courses or sequences of individual learning.

Web services' aim is to provide components that can communicate with each other, whatever language they were written and regardless of operating system.

In service-oriented systems, operational entities, which are distributed network, are services.

The service provides access to functionality system, such that the entire system can be seen as a set of interactions between constituent services.

For access to existing scientific articles on the web, can be used web controls, which serves as a browser, intercepting user interaction and rendering audio with the reading possibility : only a selected text, all texts of that page, internal links or external webpage, the texts included in the present controls on the page and only when moving the mouse over them (*MouseEnter*, *MouseLeave*) or some descriptions of images and tables on the associated titles of them, respectively of column names from the table.

2.4 The access to printed information

Another application of access technologies is an optical character recognition software (Optical Character Recognizer, OCR), which converts the scanned images of pages from a book in text files

that can be read using the voice synthesizer or a Braille display (Fig. 6).

This application allows the blind persons to read a book, a magazine or a newspaper.

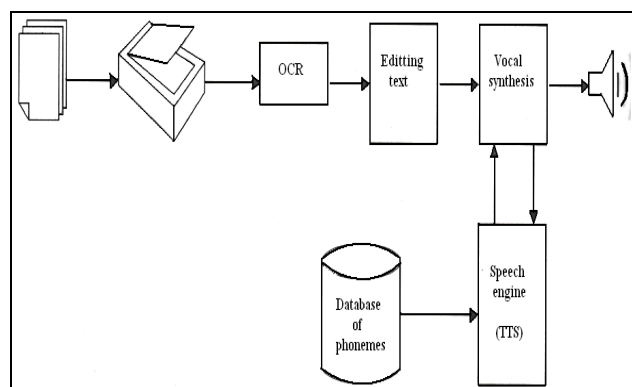


Fig.6 A system architecture for Vocal Rendering of Printed Documents [4]

To implement a system for rendering of documents emphasis should be on the development of capable interfaces to connect specialized components developed by software firms [12].

3 Proposal for integrating assistive modules in an open source learning platform

E-learning platforms need to provide audio software of educational content as a service. This allows quick writing distributed applications which running on different computers and integrates TTS (Text To Speech) components.

Learning objects are closely related to e-learning standards, therefore to be transported, the object must meet certain standards and to be reused must have a specific instructional design.

Educational objects as educational components are stored and accessed independently, and using the reassembly are created new courses or individual learning sequences.

Each learning object is characterized by a set of attributes that enable tracking, the management and its evaluation. The descriptors collections that uniquely identify and complete an educational object represent metadata, which are based standards. Metadata allow obtaining information from another computer on the structure, content and use of educational material [2].

The existence of a consensus on metadata schemes for learning objects shouldn't be an obstacle for digital content developers.

In Web context there are two possibilities for implementation of metadata: XML (Extensible Markup Language) as data modeling language and RDF format (Resource Description Framework) metadata modeling language [3].

Scheme for access to a learning platform with facilities for the blind persons may be (Fig. 7):

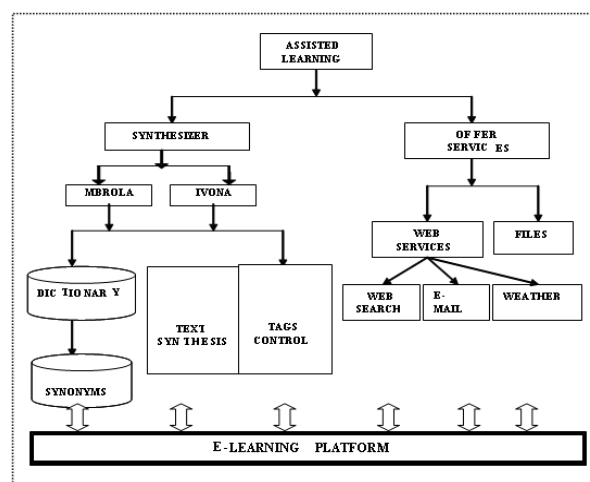


Fig.7 Scheme for access to a learning platform with facilities for the blind persons

Such a platform can integrate mechanisms for acquiring of more complex knowledge, like mathematical expressions compound, which requiring using previously a software module for textual transposition of equations.

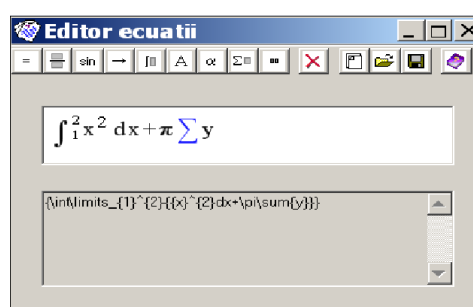


Fig.8 Equation component

The *Equation* component (Fig. 8) allows editing graphics of equations while generates script code for easy storage and compression, respectively for conversion into common formats used on various platforms editing.

Among the editors used in textual transposition of equation form, LaTeX is considered best suited for writing mathematical text and mathematical symbols [10].

The access to learning platform can be done using:

- Microsoft. NET Framework Version 3.5, which provides facilities for stability, ease of development and use, availability of long-term support for a wide range of applications, rapid result, modernity and interoperability.

To memorize encodings SAMPA (Speech Assessment Methods Phonetic Alphabet) characters associated text, but also to retain the dictionary of synonyms, is used a database.

- The database, can be created with Microsoft Office Access 2007 or MySQL, and the connection to it can use MyODBC specific objects.

For speech synthesis systems which are based on selection and acoustic unit concatenation is needed large database [8].

- Additional packages such as the function libraries (DLL), the sounds, the images or fonts used by applications which are included in the kit installation or in application.
- Audio programs running on Microsoft Windows XP SP2 Professional or Vista to create the .wav and .txt files.
- Programs for printing and post-processing.

The synthesizer, built on MBROLA library basis, generates an artificial language using concatenation diphones from Romanian dictionary language, and imposes integrity restrictions, while the synthesizer IVONA is based on unit selection technique.

The comparison made by using MBROLA synthesizers and IVONA highlights the advantages and disadvantages of the two synthetic methods used. Thus, Carmen voice is naturally much higher, because its intonation, but MBROLA is more understandable because reads with diacritics.

From economic point of view, the technology proposed allows to make efficient and flexible e-learning platforms, by enabling fast integration of components already created or existing in other open source sites.

Web-based learning is one of the educational options most commonly used today.

However, these platforms suitable for a wide variety of courses, have some limitations on the mathematics [10].

On the other hand, to create assistive software we must take in account their design principles, among which most important are:

- Flexibility, which involves creating a user interface, flexible, adaptable, able to meet different requirements and preferences of users;
- User interaction with application, must be done through the keyboard for all application options, and major options should be accessed using the mouse;
- Rendering the results should be in different formats: video, text, graphics, audio or combinations thereof;
- Consistency, which allows interaction with other applications and standardized systems, in a manner consistent and predictable;
- Compatibility with assistive services - is recommended for applications built using standard interface elements, compatible with assistive tools.

4 Conclusions

The scientific concerns of building IT systems for people with visual impairments are encouraged by existing law and numerous treaties signed in the European Union, treaties whose aim is to increase accessibility of IT applications.

To enable equal access to education delivered electronically, persons with disabilities should be able to take advantage of electronic format, in the same way as people without disabilities.

New technologies offer a perspective to create educational content and its transmission and access.

For the computer-assisted learning the designing of web sites and web applications must be centered on user.

The researching, in this case, is based on the synthetic rendering of information displayed on the current web site and taking voice commands to direct navigation.

Learning objects are seen as Web services on a platform of e-learning, can be used as stand-alone components or integrated into other services, what promote their reuse.

Web services are useful in implementing interoperability e-learning systems [7].

The development of online educational modules dedicated and integrated externally and use of quality educational content, which provide to students the development their individual capacity, are important factors in achieving e-learning sessions [6].

The need to create accessible websites that integrate Web applications with educational content is an option for the computer-assisted learning based on the Web.

Such is provided the access to information, as well as the training of persons with visual disabilities.

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