A Proposed Web Accessibility Framework for the Arab Disabled

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Abstract

E-learning is a useful tool that has contributed in facilitating education for people around the globe. There is a need, however, for making e-learning available to disabled people.
This paper presents a Web accessibility framework which offers the ease of the Web accessing for the Arab disabled users and facilitates their lifelong learning. The basic objective of this framework is the support of the equal rights of Arab disabled people for their access to the education and training.

Key Words : Arabic Moon code, Arabic Sign Language, Deaf, Deaf-blind, E-learning Interactivity, Moon code, Web accessibility , Web framework , Web System, WWW.

1. INTRODUCTION

The Web is providing unprecedented access to information and interaction for people with disabilities.
Web accessibility basically means that people with disabilities can use the Web. More specifically, Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web [1]. However, Web accessibility is not a reality throughout the Web. The problem is that most websites have accessibility barriers that make it difficult or impossible for many people with disabilities to use them. And most Web software tools are not sufficiently accessible to people with disabilities, making it difficult or impossible for them to contribute to the Web. This means that efforts are needed to build a system which makes the Web accessible especially for the disables.
There is a growing, worldwide recognition that users with disabilities have the same right as others to access information technologies [2].
This paper proposes a Web accessibility framework for the main types of the disabilities (deaf-blind/ deaf/ blind) to facilitate the Web accessing for the Arab disabled. The proposed framework enables them to make use of the different websites with low efforts, low time and very low costs. The proposed framework depends on extracting the website content via reading and analyzing the meta-language of any Web page. Then the extracted content is presented in a format that fits the disabled user.
The paper is structured as follows. The next section presents the previous work that has been built for each type of the disabilities. Section 3 presents the proposed Web accessibility

framework. Section 4 presents the proposed Arabic Moon code for the deaf-blindness. Finally Section 5 summarizes the paper, and outlines possible avenue for future improvement.

2. RELATED WORK

Surveyed work done in [3] estimated the number of people with certain disabilities and "access" to the Internet. What "access" means is ambiguous, though, by the researchers' own admission: It could simply mean a computer exists in the home or workplace that can be connected to the Internet or it could refer to active Internet use by the person in question. Even estimated about 43.3% of the world population have some kind of a disability By contrast, in the same survey, 56.7% of non-disabled people have Internet access. The disparity is considerable [4].

The survey is categorized as follows:

- Deafness Related Work: It contains the available accessibility systems that deal with the deaf persons.
- Deaf-Blindness Related Work: It contains the available accessibility systems that deal with the deaf-blind persons.
- Blindness Related Work: It contains the available accessibility systems that deal with the blind persons

2.1 Deafness Related Work

There are four categories of that type of survey based on the use of this system and the user category that interact with it.

•Interactive sign language learning systems: Systems in this category are focused on teaching the deaf students in different countries.

•Content producing systems: Systems in this category is used to provide conversion tools which are used for constructing, storing and maintenance for educational material.

•Text-To-Sign Browsers: A system in this category automatically converts the Web page content to SL. Research at that category is rare and still at the beginning.

•Online Sign Languages Dictionaries: Systems in this category play a very important rule in learning the SL for different languages. All the available SL dictionary systems aren't dedicated for the Arab deaf users' .Moreover; they are video based systems so they have low reliability.

2.1.1 Interactive Sign Language Learning Systems

Khwaldeh et al in [5] proposed a centralized based learning system, which aims to facilitate teaching and learning for both teachers of the deaf and deaf people. This system enables teachers and deaf to interact with each other. But this system is still limited in its use.

In [6] Gennari et al presented LOgic-based e-tool for DEaf children (LODE) that aims at stimulating deaf children to globally reason on narratives written in Italian. Thus LODE presents children with e-stories and apt exercises that stimulate them to analyze the temporal relations between events, and to produce new relations consistent with the story .But this system doesn't support the Arabic language as it supports only the Italian language .

Kyun Ng et al in [7] proposed an E-Learning framework that creates a common platform for both normal and disabled students which will share the same influential of their academic achievement. The deaf students can communicate with instructor and other students by messaging over the chat-room system .But this system need training on using it and it doesn't support learning the SL in general.

To encourage the deaf children to learn American Sign Language (ASL), Shirali-Shahreza et al [8] proposed a system which is implemented using PHP scripting language [9]. When a deaf person wants to enter a website which is created for deaf persons, a word is shown as a movie using SL. The user should recognize the word and select it from a list. If the user understands the SL and recognizes the word, he/she can enter the website. This system isn't used for e-learning as it could be used for Web browsing.

Another system is proposed in [10] which is an interactive program to teach ASL for K-3 mathematics by 3D animation. But this system is limited for a special type of courses and ages.
Straetz1 et al in [11] proposed a Learning Management System (LMS) which offers German SL videos in correspondence to every text in the learning environment. But it doesn't support Arabic Sign Language (ArSL). And Drigas et al in [12] presented a similar LMS but for Greek SL. The systems are designed notably for deaf adults who want to maintain and improve their mathematical and reading/writing skills. These systems require large bandwidth for downloading videos. So the reliability of these systems is low.
Ohene-Djan et al [13] proposed a system, Kids Sign Online (KSO) system, which is designed to teach British Sign Language (BSL) in tandem with English to deaf children. But this system supports a specific language BSL and doesn't support ArSL.
Stewart et al in [14] proposed a library that is available on the ASL browser website for teaching the ASL. For each word, the "ASL Browser" site has a movie shows a person saying the word using ASL .The movies are in Quicktime [15] format. Although this system supports a small sized movies but its reliability is still low.
There are still limitations in developing e-learning applications which use the ArSL for teaching deaf Arab students, and the already existent rare ones [16, 17] are missing interactivity between the user and the system.

2.1.2 Content Producing System

In [18] Webducation Software Planungs- und EntwicklungsgmbH carry out a project in close cooperation with the Austrian Association for hearing impaired and deaf people (WITAF). The objective of the project is to give possibility for deaf to generate and publish contents by themselves on the learning platform
Efthimiou et al in [19] proposed a platform environment that allows the development of various educational applications accessible by deaf users for Greek Sign Language (GSL).

2.1.3. Text-To-Sign Browsers

In [20] Boldyreff et al proposed a text-to-sign browsers for users of BSL. It is currently limited in their use. One of the major problems is that BSL and ASL do not translate word for word into English or vice-versa, as they have distinct grammars of their own, and therefore it would be difficult to translate a site directly .This type of systems isn't available for ArSL.

2.1.4 Online SL Dictionaries

Dasgupta et al in [21] proposed a cross platform multilingual multimedia Indian Sign Language (ISL) dictionary building tool. However; this system doesn't provide the ArSL .Troelsgård & Kristoffersen in [22] proposed a Danish Sign Language (DaSL) dictionary. For signers who have Danish Sign Language as their first language, the dictionary will provide information about Danish Sign Language such as synonyms and variants. This dictionary is a monolingual dictionary.
Vettori et al in [23] presented Electronic Bilingual Dictionary of Italian Sign Language (ISL) and Italian but it again doesn't support ArSL.
There is also another e-LIS dictionary proposed in [24] which is the Web bidirectional dictionary for Italian sign language-Italian.
Mohandes in [25] proposes a system that translates Arabic text to Arabic sign language. Words that correspond to signs from the Arabic sign language dictionary calls a pre-recorded video clips showing the sign. If the word does not have a corresponding sign in the sign language dictionary, it is finger spelled .But , this system depends on the videos and ,videos need a large bandwidth for downloading.
Suzuki et al in [26] proposed a Japanese and American Sign Language Dictionary System for Japanese and English users. This dictionary again doesn't support ArSL.
The Online Sign Languages Dictionaries [27-37] constitute very important educational tools for the e-learning and training of Sign Languages. To this direction many online dictionaries have been developed for different Sign Languages. The majority includes a large number of signs and targets at signers as well as at students that learn a Sign Language as second language. Each sign is accompanied from the material and includes, on one side one translational

equivalent and the other side synonyms and antonyms in the Sign Language. All that dictionaries don't support the Arabic language.

2.2 Deaf-Blindness Related Work

It was the advent of the personal computer with Braille or magnified visual output that opened up opportunities for a significant increase in access to information for deafblind people [38]. Software for producing large characters on the monitor is relatively inexpensive, but Braille displays have remained expensive.

Since there is a shortage of skilled transcribers, computer systems are often used to translate text to contracted Braille which is then output on a special embosser [39].

The algorithms for this translation are not simple since the rules governing the use of contractions depend on pronunciation and meaning. For example, there is a contraction for 'mother' which can be used as part of a longer word as long as it does not bridge a syllable boundary as in 'chemotherapy'. [39]

The DOS text-based operating system is easier for many deafblind people than ones, such as Windows, which use a graphical user interface. However keeping to DOS restricts the choice of software in that most new software is written for the Windows environment [39].But it isn't recognizable to use the DOS in the existence of the Web and the Web pages .

Over the years a number of systems have been developed to emulate finger spelling since many deafblind people do not read Braille. Hiroshi & Chikamune in [40] proposed a communication device that could help the deaf-blind communicate with others who do not know the Braille or sign language. Although these devices work well in a laboratory, there have been problems in making them generally available at affordable prices.

Fu & Ho in [41] described a finger language recognition system for handicapped aphasiacs, who are able to express their intents only by using ‘finger language’. Finger language is different from sign language in the sense that it is composed of simple hand gestures, each representing a predefined meaning.

The increasing use of graphics in printed books gives problems. Although many diagrams can be converted to an embossed form, the process of reading by touch means that a diagram has to be tactually scanned and mental image built of the whole diagram [39].This is the opposite process to visual reading where one looks at the overall picture and then reads the detail.

Years ago NASA [39, 42] had a problem with communicating with astronauts during lift-off. The problem was of information overload using visual and auditory communication. Therefore they investigated the use of tactual communication; the project failed, but the research formed the basis of a reading aid for blind and deafblind persons

Systems to recognize printed characters have been developed for inputting text to computers. Such systems have immediate application for deafblind persons since the information can be output in Braille [42].

2.2.1 Moon Code

Moon allows people who are blind or partially sighted to read by touch. It is a code of raised shapes and takes its name from its blind English inventor [46].

There are many advantages for using Moon code [42, 45] which are:

Moon provides an "active" reading method for people who cannot access print - listening to audio books etc is passive

Self study courses in Grade 1 and Grade 2 Moon are available from RNIB, enabling a would-be learner to make a start even if a teacher is not available

Moon is larger and the characters are more "open" than Braille, so easier to feel and decipher

Moon requires a considerably less acute sense of touch than Braille, so can sometimes help readers with diabetes whose finger sensitivity is reduced

Some children and adults with learning and/or physical difficulties in addition to their visual impairments acquire some literacy through Moon, where Braille would be impossible.

Depending on that Moon is not widely known, there are some disadvantages [44-47] of it.

The choice of Moon books available is very limited at present.

There are currently no Moon magazines available, except for deafblind readers.

There is no portable, mechanical device for writing Moon, which there is for Braille.

The number of Moon readers is low and declining.
Whereas a "soft Braille" display can be linked to a computer in order to know what is on the screen, the Moon equivalent is not available, which is a particular disadvantage to those who cannot use a speech package.
All of the available dedicated systems for deaf-blindness have some problems such as high cost and have low reliability. Overall, they can't deal with the Arabic language.

2.3 Blindness Related Work

There are many screen readers and screen magnifiers to help the visual impaired as in [48; 49]. But all the available dedicated systems for blind users are very weak with the Arabic language and they aren't specified for the Arabic Web users. Consequently; researcher tried to solve this problem in a simple way in the proposed Web accessibility framework as an analysis and design stages.

3. THE PROPOSED WEB ACCESSIBILITY FRAMEWORK FOR THE ARAB DEAF-BLIND

The proposed system and all of its components cooperate to produce the educational material for deaf-blind in an interactive way .The proposed system is a 3-tier [50] system architecture which means Database retrieval & updating , Application Logic and GUI presentation as shown in Figure 1.

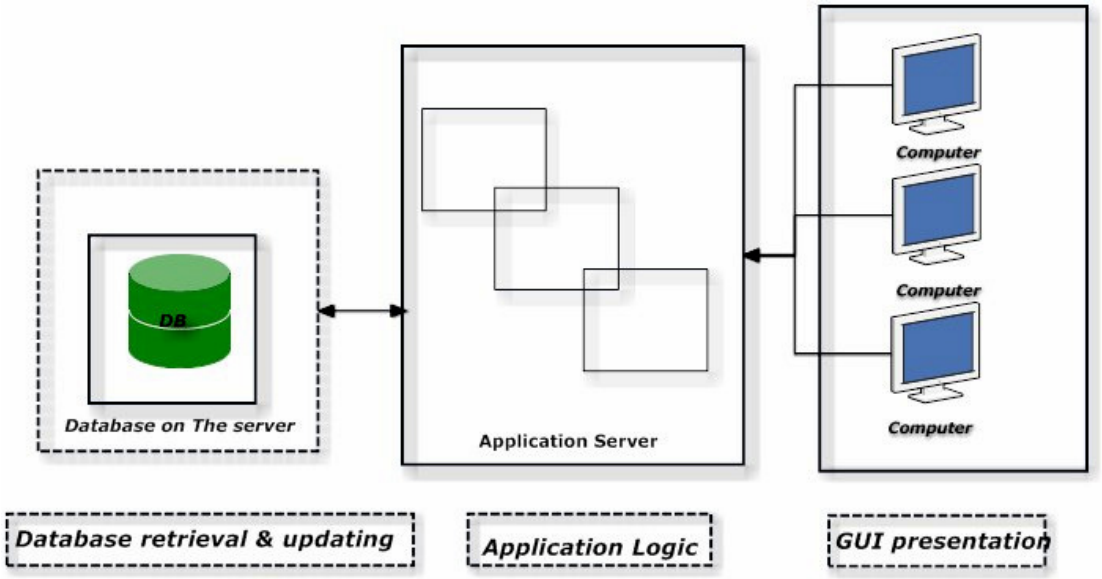

FIGURE 1: The 3-tier architecture of the proposed framework

Following are the proposed components of the proposed framework as shown in Figure 2.

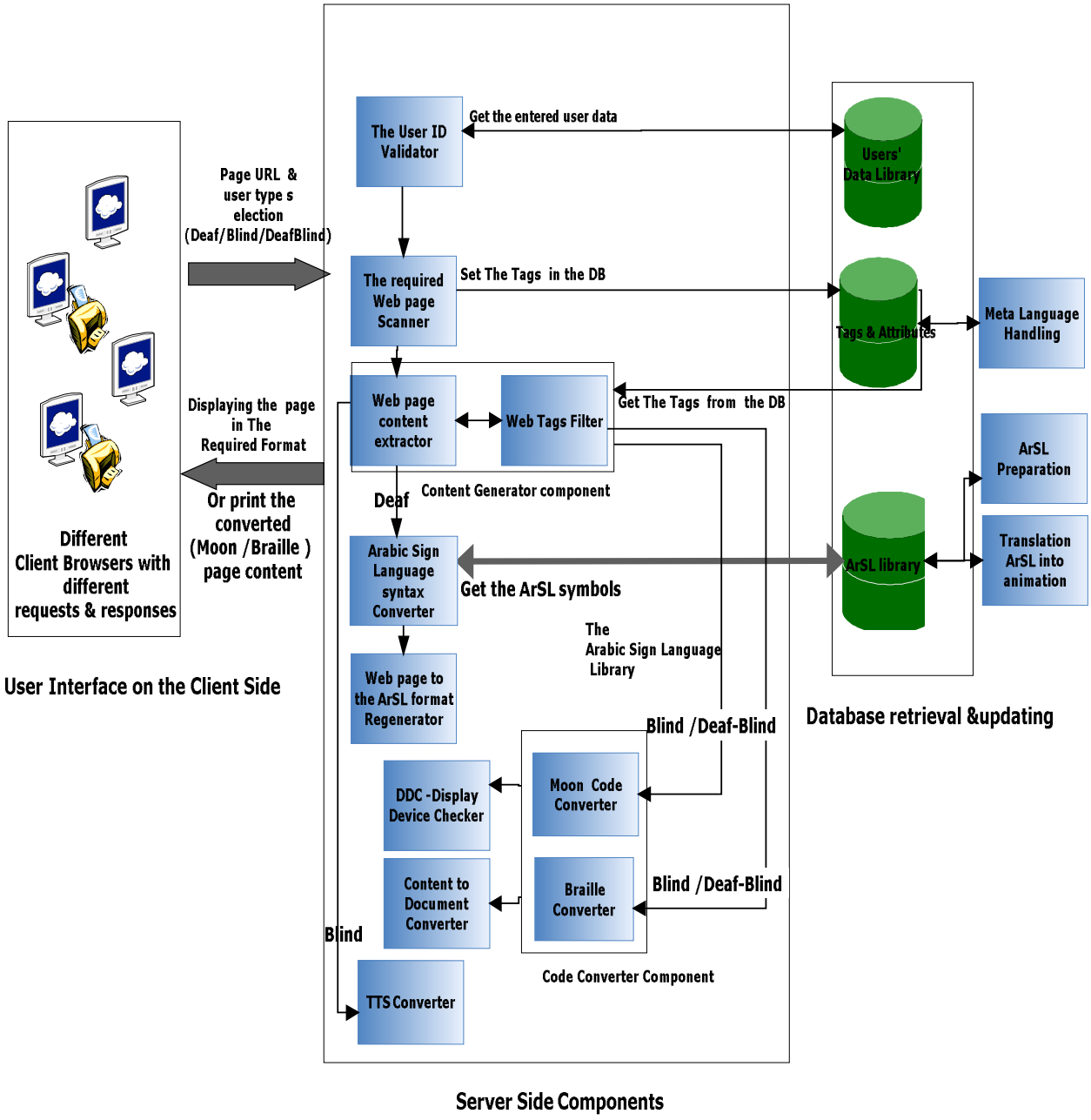

FIGURE 2: The block diagram architecture of the proposed framework

3.1 The Client Side Component

- The User Interface: Through which the user access the system first he/she enters the required URL then he/she choose the type of the disability (Deafness /Blindness /Deaf-Blindness). Then the request is processed though the server side components and the response are sent back to the user.

3.2 The Server Side Components

- The User ID Validator : Checks the user's login information and identify the user's disability type
- Users' Data Library :Contains all the user's information ;Name , password ,e-mail address

, disability type ,and ; if the user is blind ;blindness language (Braille /Moon) .

•The required Web page Scanner: It's the first component in the server side of the application. It Opens the required Web page and scans the full content of it, and then the scanned content is passed to the suitable component.

•Meta Language Handling: This module is a summarization for the steps that researcher followed to be able to handle the meta-language of any Web page.

•The Tags Library : All the scanned tags from the Web page are inserted in a database to be processed later in the content generator component

•The Page Content Generator: It has two subcomponents 1-Web page content extractor & 2-Web Tags Filter.

- The Web page content extractor extracts the Arabic Web page content.
- The Web Tags Filter component eliminates each tag in the extracted content and returns with only the pure page content .Then it passes the extracted content to the suitable next components.

•Arabic SL syntax Converter : Translates the required Web page to the ArSL getting the synonymous SL words from the ArSL library

•Arabic SL Library Preparation Module: The ArSL isn't like the Arabic language [25] neither in its vocabulary nor its grammar. The first requirement to build the dictionary system was collecting the knowledge required to deal with the ArSL experts, specialists and reading different ArSl references. The second step is getting an article in a specific field and applying the ArSL knowledge on it. To get the words that can be translated into ArSL from any page, all the words must be converted to their roots.Then the whole synonymous words must be declared . Then check for ArSL synonymous existence.

The Translation of the ArSL Words into Animations Module: After collecting the words that can be represented in ArSL .The gestures of each word must be declared and stored in a database with the corresponding word. Then the animation for each word is designed from the word gestures .Finally the animations are restored in the database.

•ArSL library: This library contains of about 3500 Arabic gestures corresponding to the most common Arabic words [51] .Then the output of the ArSL syntax converter is passed to the suitable component.

•Web page to the ArSL format Regenerator: This component converts the signs to an adequate format for the Web, by regenerating the Web page content with its tags again.

•Text To Speech (TTS) converter: TTS is an external service that is used within the framework. (If the user is a blind) he/she can select whether the page is spoken loudly It converts the page content to speech. (Note: There still some problems in converting the text to some languages such as Arabic and Farsi [38, 51] or not.

• Code Converter It takes the user selected blind-language (Braille or Moon) as an input and gets the appropriate one as an output.

- Moon Code Converter: It converts the Web page content to Moon code.
- Braille Converter : :It converts the Web page content to Moon code

•Display Device Checker (DDC): If the Display Device (DD) is selected to display the output on an adequate device; the DDC checks if the suitable display device (Braille display device or Moon display device) is plugged to the computer or not .If it's plugged, the output will be transferred to it .If there is no device plugged; a special error message will appear It may be a spoken error message for the blind user and can be sensed as vibrates for the Deaf-Blind one.

•Content to Document Converter : :It takes its input from the (Moon code /Braille) converter module and build a text file on the fly that contains the Web site content in a descriptive form.

If the user either a blind or deaf-blind, he/she can select one of the two selections –if the speaking the page loudly wasn't selected-the type of the output language, Braille or Moon code, (But there is still a problem, there is no special display device for moon characters) And select whether the output will be on a Braille /Moon display device or in a document to be printed with a special embossers later.

3.3 Interaction Description between the Proposed Framework Components

Flowchart shown in Figure 3 shows the interaction between the framework components.

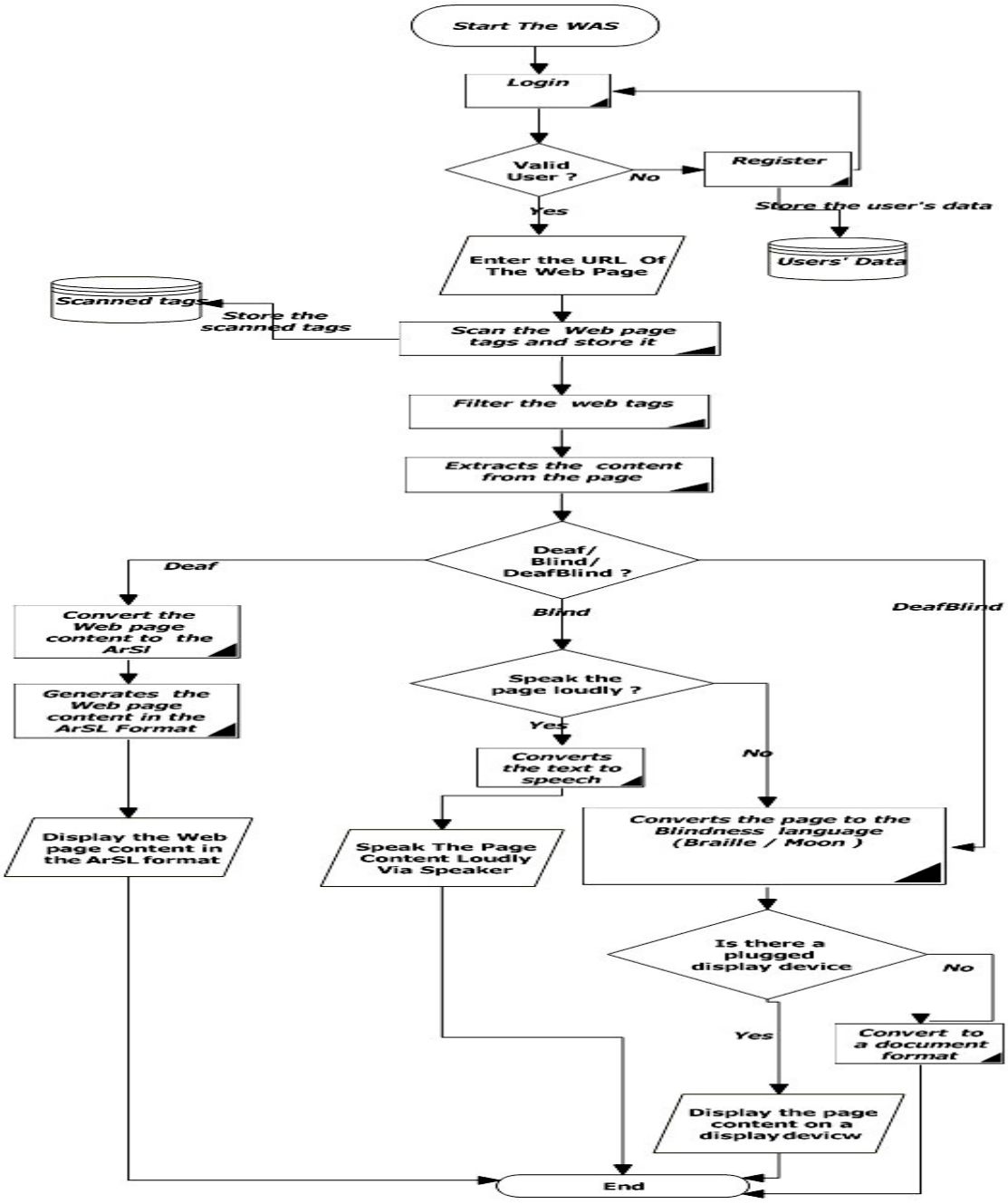

FIGURE 3: The system flowchart of the proposed Deaf/Blind framework

As shown in Figure.3; the user logs into the application the he/she enters the URL of the required page and selects then the page is scanned in the system to extract the page content of it .If the user is deaf, the content is converted to the SL syntax using the ArSL library The deaf user gets the page in his own language; SL. If the user is blind the content is spoken loudly using the TTS module. If the user is blind/deafblind the descriptive content is converted to either the Moon code or Braille then it's displayed on a special display device (If there is someone plugged) .If there is no device plugged, the descriptive content is converted to a document with to be printed in the client side with a special embossers.

4. THE PROPOSED ARABIC MOON CODE

Authors faced the problem with how can they make the Arabic websites accessible for the Arabic deaf-blind persons. They studied all the available communication methods for the deafblind people.
Depending on that study and studying the advantages of the Moon language that was mentioned in the subsection 2.2.1, authors built a new Moon code font for Arabic alphabets **TimesMoon**. They built **TimesMoon** depending on the formation of the Times new Roman font. **TimesMoon** is the first version for this new font and need many updates for the Arabic language. The reading method for this code will be from the right to the left as Arabic ,so that the Arabic deafblind user won't face problems with reading his/her mother language. Then authors used the **TimesMoon** font in the proposed framework for Arabic Deaf-Blind to facilitate the Web accessing for them. Authors used the Fontlab application to implement the design of the proposed Arabic Moon code .
Tables 1, 2 show the **TimesMoon** alphabet and its Unicode that corresponds to each Arabic letter

Unicode	الحرف بلغه مون (ا ب ت ث ج ح خ د ذ ر ز س ش ص ض ط ظ ع غ ف ق ك ل م ن ه و ي ى)	الحرف بالعربيه
0627	ا	أ,ا
0628	ب	ب
062A	ت	ت
062B	ث	ث
062C	ج	ج
062D	ح	ح
062E	خ	خ
062F	د	د
0630	ذ	ذ
0631	ر	ر
0632	ز	ز
0633	س	س
0634	ش	ش
0635	ص	ص
0636	ض	ض
0637	ط	ط
0638	ظ	ظ
0639	ع	ع
063A	غ	غ
0641	ف	ف
0642	ق	ق
0643	ك	ك
0644	ل	ل
0645	م	م
0646	ن	ن
0647	ه	ه
0648	و	و
0649	ي	ي
064A	ى	ى

TABLE 1: The alphabet in Arabic Moon (**TimesMoon**)

Unicode	الارقام بلغه مون (الارقام بلغه مون)	الارقام بالعربيه
0023	⠼	(Start)#
0061	⠁	١
0062	⠃	٢
0063	⠉	٣
0064	⠙	٤
0065	⠑	٥
0066	⠋	٦
0067	⠛	٧
0068	⠓	٨
0069	⠊	٩

TABLE 2: The numbers in Arabic Moon (**TimesMoon**)

5. CONCLUSION AND THE FUTURE WORK

This paper has been presented a We-based accessibility framework for the disabled Arab students. The proposed framework deals with three types of the disabilities: deafness, blindness and deaf-blindness. It depends on extracting the website content via reading and analyzing the meta-language of the Web page, then the extracted content is presented in a format that fits the current disabled user; printed Moon code for the deaf-blind users, ArSL animations for the deaf users or speech for the blind users.

Also a proposed e-learning system for the deaf Arab students has been presented. This system depends on the ArSL animated library. This library consists of each Arabic word and the corresponding ArSL designed animation. The animations designed for this purpose are very reliable; as they are very light animated gifs. Although the other existing BSL or ASL libraries depending on videos. So this library has many more advantages than any other existing one.

Also this paper has been presented proposed design for the Arabic Moon code for the deaf-blind Arabs.

Moreover, it presented a survey on the Web accessibility concept and definitions, goals and the current applied Web accessibility systems with the pros and cons of them.

5.1 Future Work

As always, there is a room for additional improvement. Further areas of research that have been identified warranting future investigation are:

- This work is intended to be included in a Quality Assurance program dedicated for the disabled Arab students. To give them their rights a the other students in good education.
- Implementing the proposed framework as a complete system and publish it online for all the Arab disabled because the proposed framework is a prototype level.
- Improving the system to read any material published on the web.
- Improving the ArSL animated library so that the deaf user can choose the preferred avatar.
- Expanding the framework to fit the other types of the significant disabilities including the cognitive disability .
- Expanding the framework to deal with AJAX-based sites and web3 sites.
- Building a complete e-learning system for the disabled persons
- Expanding the proposed dictionary for the other languages so that the deaf Arab persons can learn more than two languages .
- Designing and building the ArSL library with an icon maker for more reliability.
- Building an Arabic chat room dedicated for Arabic deaf persons.
- Building a web-based Arabic TTS library to improve the Blind module performance.
- Expanding the e-learning system for deaf Arab students with building an exam management system dedicated for them.

- Building an Arabic Moon display device to facilitate the interaction for the Arabic deaf-blinds.
- Test and validate all of the systems on their specified users.
- Including the Web common language in The proposed framework .

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