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Search Engine Module in Voice Recognition Browser to Facilitate the Visually Impaired in Virtual Learning (MGSYS VISI-VL)

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***Abstract*—**Nowadays, web-based technologies influence in people's daily life such as in education, business and others. Therefore, many web developers are too eager to develop their web applications with fully animation graphics and forgetting its accessibility to its users. Their purpose is to make their web applications look impressive. Thus, this paper would highlight on the usability and accessibility of a voice recognition browser as a tool to facilitate the visually impaired and blind learners in accessing virtual learning environment. More specifically, the objectives of the study are (i) to explore the challenges faced by the visually impaired learners in accessing virtual learning environment (ii) to determine the suitable guidelines for developing a voice recognition browser that is accessible to the visually impaired. Furthermore, this study was prepared based on an observation conducted with the Malaysian visually impaired learners. Finally, the result of this study would underline on the development of an accessible voice recognition browser for the visually impaired**.**

***Keywords*—**Accessibility, Usability, Virtual Learning, Visually Impaired, Voice Recognition.

I. Introduction

VIRTUAL learning or online learning is one of the latest technology applied in education nowadays. It evolves with the development of virtual learning environment. Virtual learning environment is a platform in engaging learners with the instructors via online. Online learning environment or virtual learning environment facilitates learners in diversity of categories such as diversity of cultures, range of ages and even physical condition that describes the physical impairment. Relatively, many virtual learning environment applications can be accessed with varieties of design. Many developers are eager in designing and developing their application fully with animation graphics. Their main purpose is only to make their applications look fantastic and impressive [1].

Some developers are not conscious of their users when designing and developing their applications. It is vital that the developers aware with the users' needs when designing and developing web applications. This paper would like to highlight on the topic of "Design for All". The topic of "Design for All" in which this paper focuses on the designing and developing voice recognition browser that is accessible to the persons with disabilities (PWD's), specifically the visually impaired.

Normally, this problem of accessing often relates to the web applications usability and accessibility. The problem of web usability and accessibility will be a crucial ingredient for developers in designing and developing a browser for the visually impaired. A voice oriented browser is one of an assistive technology that is used by the visually impaired. Most of the visually impaired basically depends on sound for easy access to their surroundings. Therefore, process of accessing virtual learning environment is a process of seeking information through the Internet. The sound medium or audio output helps them in accessing information. Due to this fact, there have been many researchers that have developed numerous voice-based browsers for the visually impaired such as [2]-[4], as a tool for assisting in searching information through the Internet. This type of assistive tool is an alternative to assist them in acquiring knowledge via virtual learning environment.

In order to fully understand the needs of usability and accessibility for voice recognition browser facilitates the visually impaired in searching information, the challenges faced by the users when seeking information through the Internet would also be discussed. Besides, this paper would also focus on the methodology of the study that was prepared based on an observation conducted with a group of visually impaired users in Malaysia. Finally, this paper would also include the results of this study that refers to the contribution on the guidelines of developing an accessible voice recognition browser [5].

II. Objectives of the Study

The objective of this paper is to focus on a study of the usability and accessibility topic for developing a voice-based browser as an assistive tool that facilitates the visually impaired in seeking information via Internet. More specifically, the objectives of the study are (i) to explore the

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challenges faced by the visually impaired learners in accessing virtual learning environment (ii) to determine the suitable guidelines in designing and developing voice-based browser that accessible to the visually impaired with no limitation in accessing information. This paper would also focus on the methodology of the study that was prepared based on an observation conducted with a group of visually impaired users and the development of voice recognition browser.

III. BACKGROUND

The research regarding issues of the web accessibility among the visually impaired had been done a few years ago. This can be referred to the research cited by [6], shows that other researchers such as Aaronson and Gabias in 1987, Buning and Hnzlik in 1993, Steele, Goorich, Hennies, and McKinley in 1989, believed that the usability and accessibility of assistive technology is essential to help the visually impaired seeks information. However, such issue is still new among developers in Malaysia and still evolving. Only recently a few campaigns that have been organized by a few blindness organizations in Malaysia in conjunction with the Ministry of Science, Technology and Innovations (MOSTI) on 25 June 2009 and Ministry of Women, Family & Community Development on 3 October 2009 were launched with a purpose to foster awareness among Malaysian researchers related to the information and communication technology (ICT) accessibility for the visually impaired in Malaysia [5]. These programmes were held with the purpose to create awareness among the Malaysian developers on the importance of the usability and accessibility issues when developing applications to facilitate the needs of the society, especially the visually impaired learners. This is to ensure all segments of the society are not left behind in the ICT era. Every learner needs to be given opportunities in acquiring knowledge via virtual learning environment.

Based on statistic reported by the Social Welfare Department of Malaysia there are 248858 registered disabled people in Malaysia with 22856 are people with visual impairment in year 2008 [7]. Referring to Table I, in year 2008 there are 2817 new registered cases with visual impairment of which 1779 men and 1038 women. Since 2006 to 2008 the number of this population increased from 18258 people in 2006, 20039 people in 2007 and latest in 2008 with 22856 people. This figure shows that it is a necessity to ensure this population also has equal opportunities to access education like others.

In order to develop an accessible voice recognition browser for the visually impaired learners, web accessibility technique should be given high priority. Web accessibility is about making the web contents become accessible and usable by all users. It means that everybody who is either disabled or with no physical limitation can access the web easily and effectively without obstacles. Additionally, a definition given by World Wide Web Consortium (W3C) stated that web accessibility 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, and that they can comprehend the web [8].

TABLE I
STATISTIC OF PERSONS WITH DISABILITIES (PWD'S) IN MALAYSIA FROM 2006 TO 2008

JADUAL 10.3 : PENDAFTARAN ORANG KURANG UPAYA MENGIKUT JENIS KECACATAN, 2006-2008

JENIS KECACATAN	TAHUN		
	2006	2007	2008
Penglihatan	18,258	20,039	22,856
Pendengaran	28,522	31,715	34,580
Fizikal	66,250	73,559	83,070
Masalah Pembelajaran	76,619	85,812	96,246
Cerebral Palsy	887	1,787	2,860
Lain-lain	5,983	7,338	9,216
JUMLAH	197,519	220,250	248,858

JADUAL 10.4 : BILANGAN KES BARU BERDAFTAR MENGIKUT KUMPULAN UMUR, JENIS KECACATAN DAN JANTINA, 2008

KUMPULAN UMUR	PENGLIHATAN		PENDENGARAN		FIZIKAL		BERMASALAH PEMBELAJARAN		CEREBRAL PALSY		LAIN-LAIN		JUMLAH	
	L	P	L	P	L	P	L	P	L	P	L	P	L	P
Kurang dari 6 tahun	102	89	184	115	262	148	1389	649	198	140	156	106	2301	1247
7 - 12 tahun	129	90	149	117	287	171	2241	1045	114	92	119	81	3039	1596
13 - 18 tahun	164	127	146	111	369	233	1174	699	89	56	119	54	2061	1190
Jumlah (a)	395	306	479	343	918	552	4814	2303	401	288	394	241	7401	4033
19 - 21 tahun	106	94	124	87	381	197	434	338	61	32	77	39	1183	787
22 - 35 tahun	344	147	310	266	1311	547	818	558	94	63	281	130	3158	1711
36 - 45 tahun	294	176	205	198	1327	585	427	296	47	41	165	97	2465	1393
46 - 59 tahun	374	196	250	204	1647	741	185	145	35	19	192	115	2693	1420
60 tahun ke atas	266	119	249	150	918	387	61	45	16	6	80	47	1590	754
Jumlah (b)	1384	732	1138	905	5584	2457	1935	1382	253	161	815	428	11109	6065
JUMLAH (a + b)	1779	1038	1617	1248	6502	3009	6749	3685	654	449	1209	669	18510	10098

In order to achieve the objectives of this study, an observation on how the visually impaired access information via Internet has been conducted with a group of visually impaired learners at one of the blindness organizations in Malaysia. In order to access information on the Internet, they use the software known as screen reader that can read the output on the computer screen. Most of the visually impaired learners use a screen reader named JAWS (Job Access with Speech). JAWS is an assistive tool developed by Freedom Scientific, the largest worldwide manufacturer of assistive technology products for those who are blind or have low vision [9]. Although the visually impaired learners can access information on the Internet with the assistance of a few assistive tools such as a screen reader and screen magnifier, still there are a few limitations.

IV. FINDINGS

Based on the observation, the learners encountered some difficulties in accessing information on the Internet since most of the existing web applications are not accessible. Normally, users with visual impairment, use a computer equipped with screen reader or screen magnifier software to acquire information. Mostly they use JAWS as a tool to read everything appears on the screen. This system reads with a synthesized voice whatever text appears on the screen.

Unfortunately, the user could not understand or grab the idea of information effectively with less information as JAWS has limitation to describe images. This challenge has also been discovered by [10] in his research. According to his research, the user cannot interpret graphics (including photographs, drawing and image maps) unless text alternatives are provided. The researcher suggested that these barriers can be overcome with alternative media such as audiotapes, Braille printouts, electronic text, tactile drawings, and aural descriptions.

Besides, the visually impaired learners feel disappointed when the information accessed is limited due to inaccessibility of the webpage. [11] supported that most of the visually impaired faced problems when accessing information from the web is because of using programs such as generalized screen readers and specialized voice browsers. A basic functionality of these tools is that they serialize a web page into simple text. This serialization often brings uninteresting parts of a web page. This fact disappoints, upsets and disorientates users. The researcher also mentioned that to avoid this noise of useless information, voice browsers and screen readers should provide additional features such as listening to the links or the headings of a web page. These features provide a quicker access to some parts of a web page that are difficult to reach using the simple serialization. However, the misuse of HTML tags sometimes disables their usability and creates additional problems to navigating within a page.

Another example of barriers faced by the visually impaired in accessing information is they did not know where the active window they were looking into. This happened when there are many windows pop up with no alert to the user. As stated by W3C, the visually impaired became disoriented among windows due to the content spawning new windows without warning the user. Lastly, the user closed the window without noticing that it is last in stack and closing the browser instance.

Furthermore, the time taken for the visually impaired learners access the Internet is much longer especially with the unfamiliar webpage. If the webpage is unfamiliar, it took much longer to familiar with structure of the page. With the unfamiliar webpage, the user needs to pay more attention on JAWS voice. He needs to listen carefully on what has been read by JAWS. Therefore, the accessible webpage helps the visually impaired navigates the web and acquires information effectively with no hassle.

V. Guidelines for Developing the Accessible Web Application

These guidelines explain on how to make web content accessible to people with disabilities. The guidelines were developed by the World Wide Web Consortium (W3C) is an international consortium where member organizations, a full time staff, and the public work together to develop web standards. The guidelines are intended for all web developers. The primary goal of these guidelines is to promote accessibility. However, following them will also make web content more available for all users, no matter with whatever user agent they are using. For example, desktop browser, voice browser, mobile phone, automobile-based personal computer or others. Besides, these guidelines will also make the web content available with no matter of the users' constraints on the place they may be operating under. For example, the web content could available with noisy surroundings, in hands-free environment or others.

Concerning the accessibility problem among the visually impaired, the researcher would like to highlight on the guidelines for developing the accessible web for the visually impaired learners, which is developed by W3C. This can be referred to one of the guidelines stated by W3C. In order to make the web application accessible, the developer should provide equivalent alternatives to auditory and visual content. It means that provide content that, when presented to the user, conveys essentially the same function or purpose as auditory or visual content. For the voice-based browser, it should convey the meaning of the content via voice. Thus, the visually impaired users can understand the meaning of the web content.

Following these guidelines will also help the users find information on the web more quickly and effectively. These guidelines also do not discourage the web developers from using images, video or others, but rather explain how to make multimedia content more accessible to a wide audience W3C. Table II depicts the W3C guidelines on how to develop a web application that designed for all. Therefore, these guidelines also can be applied to the development of voice recognition browser that facilitates the visually impaired learners in accessing knowledge via the Internet.

Referring to Table II, it can be concluded that a voice browser with the accessibility elements can enhance the accessibility among the visually impaired for seeking information effectively. The effective voice browser must rely on the accessibility guidelines developed by the World Wide Web Consortium. As stated by [12], by adapting the accessibility technology in the development of web application can give benefits and opportunities not only for the sighted learners, but also the visually impaired learners in accessing information. This is due to provide equal access and equal opportunity to people with disabilities, specifically the visually impaired. An accessible web can also help people with disabilities become more actively participate in society (W3C), especially in acquiring knowledge via virtual learning environment [8].

VI. System Development

Discussing on the capabilities of the World Wide Web (WWW) to everyone's daily activities especially in online education, there is still some limitation to people with disabilities, especially the visually impaired learners to access information. Therefore, this research would focus on the accessibility related to the development of a voice browser that facilitates the visually impaired in virtual learning. The

visually impaired learners can access the information, but it takes more time, practice, training, knowledge and skill.

TABLE II
GUIDELINES ON DEVELOPING THE ACCESSIBLE VOICE RECOGNITION BROWSER

Guidelines	Descriptions
Text Alternatives	Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, Braille, speech, symbols or simpler language.
Time-based Media	Provide alternatives for time-based media.
Adaptable	Create content that can be presented in different ways (for example simpler layout without losing information or structure).
Distinguishable	Make it easier for users to see and hear content including separating foreground from background.
Keyboard Accessible	Make all functionality available from a keyboard.
Enough Time	Provide users enough time to read and use content.
Seizures	Do not design content in a way that is known to cause seizures.
Navigable	Provide ways to help users navigate, find content and determine where they are.
Readable	Make text content readable and understandable.
Predictable	Make web pages appear and operate in predictable ways.
Input Assistance	Help users avoid and correct mistakes.
Compatible	Maximize compatibility with current and future user agents, including assistive technologies.

Currently, they are able to access information on the Internet with certain assistive tools. For example, they can access the information with the assistance of a screen reader. The screen reader can read aloud everything that appears on the screen. However, some information on the WWW is not accessible to them. This is due to some interfaces that are not optimally formatted for the people with visual impairment. They often spend more time struggling with interfaces that are not fully accessible to them.

Referring to the problems faced by the visually impaired learners in accessing the information on the Internet, this research would ultimately facilitate the visually impaired learners in Web access by providing a tool that fulfills their needs. With these accessible tools, they can spend more time on accessing the actual information than trying to understand the interface. This system will also reveal the capability and the usability of the accessible features. Thus, it is hopeful that this system would contribute for future accessible browser for the visually impaired learners in accessing information for virtual learning.

The objective of this research is to develop a web browser that facilitates the visually impaired learners in accessing information through the Internet as a part of accessing to virtual learning. This research intends to provide a tool that is suitable for the needs of users with visual impairment. This browser is an accessible browser that allows them to navigate the Internet with less complexity by using a medium of speech for alternative input and output. Additionally, this browser will run under the Microsoft Windows operating system.

A. System Development Environment

Web browser activeX is a packaged Component Object Model (COM). Therefore, it is possible to reuse it as a piece of application. In addition, MGSYS VISI-VL reuse the Internet Explorer as it is not necessary to build HTML parser or formatter. Instead, it only needs to intercept a HTML document and rewrite it or add extra information.

MGSYS VISI-VL is a browser that delivers voice as a medium of communication between the visually impaired learners and the system for accessing to the information on the Internet. The browser system delivers voice as the input and the output of the system. Additionally, it is a voice browser that integrates with the accessible tools. For example, it can reorganize information on tables to make them easier to read. Furthermore, it supports speech synthesizers which read text aloud. Specifically, MGSYS VISI-VL extracts, organizes, and controls the presentation of information to the visually impaired learners via voice as a medium of interaction.

B. System Architecture

The architecture of MGSYS VISI-VL is about a web browser system that provides facilities to the visually impaired to easily search information via online technology. It is a system that equipped with the technology of speech recognition and also the tactile of keyboard access. These two features are based on the accessibility that related to the visually impaired needs in a way of seeking information via the Internet technology effectively.

Related to the speech recognition technology, MGSYS VISI-VL receives speech from the learner as the input and gives feedback to the learner also in a form of speech as the output. To receive the speech input from the learner, the learner interacts with MGSYS VISI-VL via a microphone. MGSYS VISI-VL gives speech feedback to the learner via a speaker. The visually impaired may also use the headphone to interact with MGSYS VISI-VL.

The tactile keyboard access functions together with the speech recognition process. The visually impaired would be asked to press certain keyboard keystroke to run certain commands. The tactile keyboard access equipped together the speech recognition functions in order to accomplish the accessibility features needed by the visually impaired when accessing computer. Using keyboard keystroke is an integral component among the visually impaired users to perform their tasks. The visually impaired learner may speak or type a keyword to be searched.

MGSYS VISI-VL has three modules to run the search engine function that are Speech to Text (STT), Text to Speech (TTS) and HTML Parsing which is related to the accessibility features covered in MGSYS VISI-VL. The Speech to Text (STT) Module is a module that allows the visually impaired learner to provide speech input. The learner speaks a keyword or phrase to the MGSYS VISI-VL. Then, this system will recognize the phrase spoken by the learner and try to analyze it with the STT system setup. MGSYS VISI-VL response to every single interaction with the visually impaired learner

through this module by converting the learner's spoken keyword into typed text.

The Text to Speech (TTS) Module is a module that converts text document to spoken words. MGSYS VISI-VL reads all content of a page that has been loaded to the learner. MGSYS VISI-VL converts all text loaded on a page into speech. Thus, the visually impaired learner can understand all the content on the loaded page. The HTML Parsing Module is about to recognize the style of HTML coding on MGSYS VISI-VL. Its function is to match the pattern of the HTML coding on MGSYS VISI-VL. The type of HTML parsing for MGSYS VISI-VL is Regular Expression. The HTML parsing on MGSYS VISI-VL will rely on the accessibility features that suits to the needs of the visually impaired learner. The complete architecture of the system is illustrated in Fig. 1.

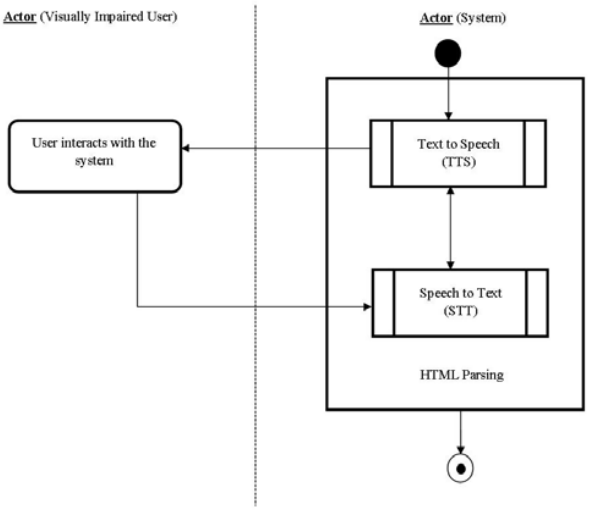

Fig. 1 Model of MGSYS VISI-VL

VII. Conclusion

This research can contribute on creating awareness of accessibility issues in designing and developing the speech browser as a tool for seeking information effectively. The findings from this research support the idea on enhancing the development of speech browser in a form that is accessible to everybody. This can be referred to the accessibility implications for the websites' developers. First, it is necessary for the websites' developer to concentrate their design comply with the accessibility guidelines developed by W3C. Second, the website developers must rely on the visually impaired learners' requirements when designing and developing the voice browser in order to help them effectively seek information. Finally, the speech synthesizer developed by the developers must consider the accuracy of the synthetic pronunciation in order to bring the correct information that is meaningful to the visually impaired.

Accessibility issues need to be addressed by all web developers to enhance the accessibility and usability among the visually impaired learners to enable them in seeking information via Internet. Adapting the accessibility technology in web development can also give benefits and opportunities for the sighted learners in accessing information. Those without access or without the effective assistive technologies can fall behind or indeed may even never get started [13].

In conclusion, based on the interviews done with the visually impaired learners, they perceived that a computer-based technology such as voice browser can assist the visually impaired persons in acquiring knowledge much easier and effectively. This is because of their dependability on sound for recognizing their surroundings. Therefore, an accessible voice browser is an essential technology that greatly benefits the disabled especially the visually impaired in seeking information. Finally, it is hopeful that all web developers are aware on the accessibility matter when developing their web applications in order to give equal access and opportunity to people with disabilities, specifically the visually impaired. This can help them to be more active in their participation in the society.

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