

# Facilitating Information Accessibility for the Print Disabled

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## Abstract

*Information accessibility is becoming a key to personal, professional and national development in this increasingly connected world. While cost of access is still an issue in developing countries such as Sri Lanka, global trends indicate that this barrier will be removed sooner rather than later. Another significant impediment, the Language barrier, is currently being addressed in the region through various Localization initiatives.*

*In this paper however, we focus on a particularly disadvantaged community which is to a large extent shut out from the enormous global information resource made conveniently accessible to the rest of us through the Internet and the World Wide Web: this is the Print Disabled community. With a global percentage of 0.57% and a Sri Lankan estimate of 0.36%, this community forms a significant minority, who are in many other ways well equipped to benefit most from information technology. While the language literacy rate of this community is usually very high in countries like Sri Lanka, their access to information is greatly hampered owing to their relatively low IT literacy. One of the key reasons for this is the mismatch between their physical faculties and the most prevalent user interface in the computer – its screen.*

*Work undertaken at the Language Technology Research Lab (LTRL) at the University of Colombo School of Computing (UCSC) has focused on some of the key assistive technologies for enabling the active participation of this community in the emerging knowledge society. Several of these, such as the development of non-proprietary fonts and input methods, have a broader relevance in facilitating local language support for all. Others, such as Text to Speech, Optical Character Recognition and Talking Book technology, are more specifically supportive of the print disabled community. Still others, such as web accessibility support, are fast becoming global best practice to assist various differently-abled communities.*

*This paper will describe each of the key technologies relating to web content accessibility in*

*local languages with a focus on the Sinhala language support tools currently available through the LTRL. It will also outline preliminary results and findings of testing and deploying such technology in general.*

## 1. Introduction

In today's competitive world, it becomes essential to harness the collective efforts of all citizens towards the task of developing the nation. Past notions of disabilities and disabled communities are giving way instead to the need for solving accessibility issues for empowering the differently-abled. These solutions cannot be ad-hoc, but clearly defined and conforming to commonly held standards.

During the recent past, improvements in Information and Communication Technology (ICT) have contributed to the development of a new set of enabling technologies for facilitating information accessibility to the widest range of the population as possible. Some of these "assistive technologies" built for specific purposes now serve as access solutions. These innovative new assistive technologies have a significant impact on employment and educational opportunities for the disabled.

In this paper, we focus on a particularly disadvantaged community which is to a large extent shut out from the enormous global information resource made conveniently accessible to the rest of us through the Internet and the World Wide Web: this is the Print Disabled community.

The statistical information on visually handicapped in the globe shows that 2% of the world population is affected by visual impairments, with some 0.57% totally blind [1]. The figures for Sri Lanka indicate that some 0.36 % of the population have a disability related to sight [2]. To exacerbate the situation, of the entire disabled community in Sri Lanka, less than 1% has access to computers [3]. While the language literacy rate of this community is usually very high in countries like Sri Lanka, their access to information is greatly hampered owing to their relatively low ICT literacy.

The other key reason for this is the mismatch between their alternative physical abilities and the

most prevalent user interface in the computer – its screen. Primary devices of direct communication between people and computers are Monitor, Keyboard and Mouse. Persons with disabilities, low vision or cerebral palsy, often have difficulty in using such devices [4].

Carl Brown [4] introduces three ways to improve accessibility of computer through non-visual alternatives to visually-handicapped persons:

1. the screen display can be made available in an auditory mode using screen-reading software and sophisticated speech synthesizers
2. in a tactile mode using a refreshable Braille display which echoes the screen display
3. by using a combination of both above methods

Work undertaken at the Language Technology Research Lab (LTRL) of the University of Colombo School of Computing (UCSC) has focused on some of these key assistive technologies for enabling the active participation of this community in the emerging knowledge society. Among the software developed, the Sinhala Text-to-Speech (TTS) system, and the Optical Character Recognition (OCR) system are more specifically supportive of the print disabled community. Another such enabling technology for the print disabled that the UCSC has actively contributed to together with the Daisy Lanka Foundation is the Digital Talking Book (DTB) technology. Several other technologies, such as the development of non-proprietary fonts and input methods, have a broader relevance in facilitating local language support for all. The UCSC also actively promotes the W3C's web accessibility standards which provides accessibility to those with various kinds of disabilities. These assistive technologies will enable the visually impaired community to access computers and the internet in their native language for the first time in Sri Lanka.

## **2. Assistive technologies for the print-disabled**

### **2.1. Text-to-speech synthesis engine**

Sighted computer users spend a lot of time reading items on-screen to do their regular tasks such as checking email, fill out spreadsheets, gather information from internet, prepare and edit documents, and much more. However visually impaired people cannot perform these tasks without an assistance from other, or without using assistive technologies.

A TTS (text-to-speech) system takes computer text and converts the words into audible speech [5].

With a TTS engine, application, and basic computer hardware, one can listen to computer text instead of reading it. A screen reader is a piece of software that attempts to identify and read-aloud what is being displayed on the screen [6]. The screen reader reads aloud text within a document, and it also reads aloud information within dialog boxes and error messages. Screen Readers also read aloud and menu selections, graphical icons on the desktop. In other words, the primary function of any-screen reading system is to become the “eye” of the visually impaired computer user. These technologies enable blind or visually impaired people to do things that they could not perform before by themselves. As such, text-to-speech synthesizers make information accessible to the print disabled.

Within Sri Lanka, there is a great demand for a TTS system in local languages, particularly a screen reader or web browser for visually impaired people. In the case of the Tamil language, work done in India could be used directly. Until the LTRL of UCSC initiatives were launched in 2004, there was no viable TTS system found developed for Sinhala, the mother tongue of 74 % Sri Lankans [7].

A project was launched to develop a ‘commercial grade’ Sinhala text-to-speech system in UCSC in year 2004. Later, it was extended to develop a Screen Reader which can be used by visually impaired persons for reading Sinhala texts. This effort is a collaborative work with PAN Localization Project<sup>1</sup>, which is providing technical support for Asian languages, aiming to improve the current level of language processing technologies.

The Sinhala TTS system was implemented based on the Festival speech synthesizer [8]. The Festival speech synthesis system is an open-source, stable and portable multilingual speech synthesis system developed at Center for Speech Technology Research (CSTR), University of Edinburgh [8], [9]. TTS systems have been developed using the Festival framework for different languages, including English, Japanese, Welsh, Turkish, Hindi, and Telugu [9]. However, efforts are still continuing to develop a standard Sinhala speech synthesizer in Sri Lanka.

The current Sinhala TTS engine accepts Sinhala Unicode text and converts it into Speech. A male voice has been incorporated. Incorporation of a high accuracy native syllabification routine [10] and implementation of comprehensive text analysis facilities (capable of producing the accurate pronunciation of the elements such as numbers,

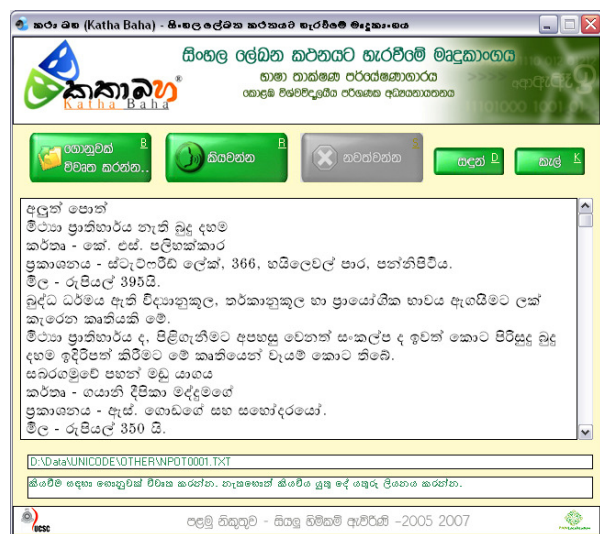
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<sup>1</sup> PAN Localization Project Website: <http://www.panl10n.net/>

currency symbols, ratios, percentages, abbreviations, Roman numerals, time expressions, number ranges, telephone numbers, email addresses, English letters and various other symbols) have been found unique for the language. Moreover, the system has been engineered to be used in deferent platforms/operating systems (i.e. Linux and Windows) and by different software applications.

**2.1.1. Applications of TTS synthesis engine:** Sinhala text is made accessible via two interfaces, by the TTS engine. A standalone software named “Katha Baha” primarily reads documents in Sinhala Unicode text format aloud. The same application can also be used to record the synthesized speech.

In this way, local language news papers and text books can be easily transformed into audio materials such as CDs. This software provides a convenient way to disseminate up-to-date news and information for the print disabled. E.g. Newspaper company may pod cast their news paper, enabling access for print disabled and everyone else. Moreover, the same application can be utilized to produce Sinhala digital talking books. To ensure the easy access by print disabled, keyboard short cuts are provided. A screen capture of this desktop application is given in Figure 1.



**Figure 1: Screen capture of Sinhala TTS desktop application**

Owing to the prevalent use of Windows among the visually impaired community in Sri Lanka, it becomes essential that a system is developed within the Windows environment which offers Sinhala speech synthesis to existing applications. The standard speech

synthesis and recognition interface in Microsoft Windows is the Microsoft Speech Application Programming Interface (MS-SAPI) [11]. MS-SAPI enabled applications can make use of any MS-SAPI enabled voice that has been installed in Windows. Therefore, steps were taken to integrate Sinhala voice into MS-SAPI. As a result, the MS-SAPI compliant Sinhala voice is accessible via any speech enabled Windows application. The Sinhala voice is proved to work well with “Thunder”<sup>2</sup> a freely available screen reader for Windows. Furthermore, steps were taken to translate and integrate common words found related to Thunder screen reader (e.g. link=“පැවැත්වීම”, list item =“ලැයිස්තු අයිතම”).

Since most Linux distributions now come with Festival pre-installed, the integration of Sinhala voice in such platforms is very convenient. Furthermore, the Sinhala voice developed here was made accessible to GNOME-Orca<sup>3</sup> and Gnopernicus<sup>4</sup> - powerful assistive screen reader software for people with visual impairments.

It is noteworthy to mention that for the first time in Sri Lankan history, the print disabled community will be able to use computers in their local languages by using the current Sinhala text-to-speech system.

**2.1.2. Accuracy of the text-to-speech synthesis engine:** Text-to-speech systems have been compared and evaluated with respect to intelligibility, naturalness, and suitability for used application [12]. As the Sinhala TTS system is a general-purpose synthesizer, a decision was made to evaluate it under the intelligibility criterion. Specially, the TTS system is intended to be used with screen reader software by visually impaired people. Therefore, intelligibility is a more important feature than the naturalness.

A Modified Rhyme Test (MRT) [12], was designed to test the Sinhala TTS system. The overall intelligibility of the system measured from 20 listeners was found to be 71.5%.

## 2.2. Optical character recognition system

Optical character recognition (OCR) technology is used to convert information available in the printed form into machine editable electronic text form through a process of image capture, processing and recognition [13].

<sup>2</sup> Available from: <http://www.screenreader.net/>

<sup>3</sup> Available from: <http://live.gnome.org/Orca>

<sup>4</sup> Available from: <http://www.baum.ro/gnopernicus.html>

There are three essential elements to OCR technology. Scanning – acquisition of printed documents as optical images using a device such as flatbed scanner. Recognition- involves converting these images to character streams representing letters of recognized words. Accessing or storing the converted text - the visually impaired user can access the scanned text by using adaptive technology software that magnify the computer screen, provide speech, produce Braille output or to store the converted text content in a convenient electronic format.

Many OCR systems have been developed for recognizing Latin characters [14]. Some OCR systems have been reported to have a very high accuracy and most of such systems are commercial products. Leaving a land mark, a Sinhala OCR system has been developed at UCSC [14]. The current OCR system is capable of recognizing printed Sinhala letters typed using widely used fonts in the publishing industry. The recognized content is presented as editable Sinhala Unicode text file [14].

A large volume of information is available in printed form that is currently inaccessible to the print disabled. The Print disabled Sinhala community in Sri Lanka will be widely benefited from both Sinhala TTS and OCR systems. When the TTS system is coupled with OCR, access to printed information will be made easy for the print disabled. The OCR system is essential to the production of digital talking books in Sinhala by saving the time of re-typing.

**2.2.1. Accuracy of the optical character recognition system:** The performance of the Sinhala OCR system has been evaluated using 18000 sample characters for Sinhala. These characters have been extracted from various books and newspapers. Performance of the system has been evaluated with respect to different best supportive fonts. The results have been summarized in the table 1 [14].

**Table 1: Experimental results of classification**

%	<i>FM- Abhaya</i>	<i>DL- Manel bold</i>	<i>Lakbima</i>	<i>Letter Press</i>
Recognized	97.17	96.26	89.89	95.81

From this evaluation it can be concluded that the current Sinhala OCR has average accuracy of 95%.

### 2.3. Localized version of AMIS: The adaptive multimedia information system

DAISY (Digital Accessible Information System) is an open international standard for accessible multimedia. The DAISY Consortium is set up in Switzerland by leading not-for-profit organizations from around the world serving blind and dyslexic people in order to develop and maintain the standard [15].

Having defined the Consortium's vision as [15]: all published information is available to people with print disabilities, at the same time and at no greater cost, in an accessible, feature-rich, navigable format; The DAISY Consortium actively promotes the DAISY standard for Digital Talking Books (DTB) [16]. DTBs facilitates the reading experience for people who have reading disabilities.

A DTB produced conforming to the DAISY standard can be played back via special hardware devices as well as using software [16].

AMIS<sup>5</sup> is a free of charge, open source DAISY book playback software. Highlights of AMIS include its self-voicing interface, plug-in support, bookmarking, variable playback speed, full text searching ability, and support for skipping and “escape” facility. AMIS supports Unicode and is available in several languages, including Hindi, Thai, Malay, and Sinhala.

The UCSC, together with DAISY Lanka Foundation developed the Sinhala language packs for AMIS. This work includes the complete translation of the user interface and all dialog boxes, message boxes etc, production of AMIS help, a fully synchronized DTB in Sinhala, and recording of prompts needed for self-voicing. All recordings were carried out in the professional studio attached to the UCSC, guaranteeing the best possible quality of the recorded material. The AMIS Sinhala language pack can be downloaded from: <http://downloads.sourceforge.net/amis/>. A screen capture of localized AMIS is given in Figure 2.

<sup>5</sup> Available from: <http://amis.sourceforge.net/>

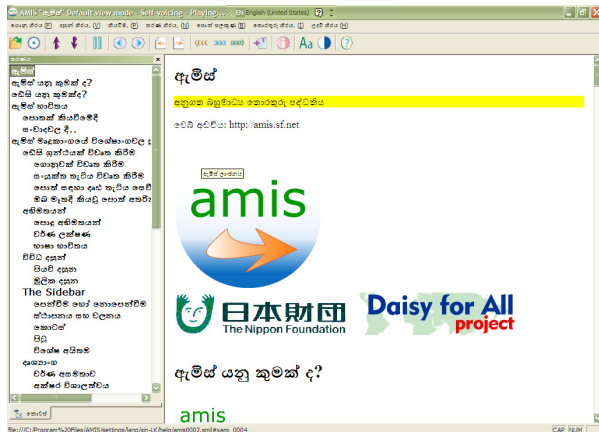


Figure 2: A screen capture of localized AMIS

## 2.4. Font encoding conversion utility

The TTS system needs Unicode text as input. However most of the previously produced material is in proprietary encodings. Thus prior to synthesizing, the text should be converted to Unicode. This can be achieved by another tool developed for this purpose. The latest desktop version of the font encoding conversion utility supports more than 14 common font encodings. An accessible online version capable of real time conversion to Unicode and vice versa is available at: <http://www.ucsc.cmb.ac.lk/ltrl/services>.

This is not an application which can be directly used by the print disabled community. It is a preparatory tool which can be used by the facilitators.

## 3. Web accessibility for the print-disabled

The world wide web provides a wealth of information, and the user population of the web is diverse, including users of all ages, educational levels, and levels of computing experience. It is important to note that many users of the web have various types of disabilities. Many non-disabled people increasingly use limited user interfaces such as mobile phones to access web content. The majority of web developers are not taking these facts into consideration when developing websites; i.e. web sites need to be accessible to all users, including those with disabilities and those who use devices with limited capabilities. Moreover, development requirements of the web sites differ according to the type of the disability. Forms of disability includes sensory (e.g. hearing and vision), motor (e.g. limited use of hands) and cognitive (e.g. learning disabilities) [17]. A web site that is effectively accessible by majority of the disabled community can

be known as an “accessible website” [17]. Unfortunately, most websites are not currently accessible. Recent studies point out that large percentages 70–98%, depending on the category of site of web sites are not accessible [17], and over time, web sites are getting more inaccessible, as accessibility violations get added to sites. These problems can be alleviated by constructing websites, keeping this group of users in mind. In addition, this effort will have positive implications for all the other users as well. In this paper, we mainly focus on the web design considerations for the visually impaired community.

People with visual impairments often experience following browsing difficulties [20]:

- inability or difficulty to obtain a bird’s-eye-view of the screen
- understanding the layout of items on the screen
- observing the dynamically changing visual content

Some of these difficulties are caused by the improper usage of Hyper Text Markup Language (HTML) codes. Commonly found poor HTML design practices [18] leading to inaccessible websites include the use of images that do not have alternate tag/text, use of complex images (such as graphs or charts) with poor description, videos without sufficient descriptions either in text or audio, tables that do not make sense when read serially (in a cell-by-cell or "linearized" mode), usage of frames without "NOFRAME" alternatives or without meaningful names, forms that cannot be tabbed through in a logical sequence or that are poorly labeled. Font sizes of some web pages are fixed and cannot be changed. Web pages with inconsistent layouts cause navigation difficulties (especially when the font sizes of such websites are increased as required by disabled user).

It is important to cater for the color blind users when choosing a color scheme for a website. It is noteworthy to mention that color should not be used to convey information that is not conveyed by other means. Similarly, a color that is used as a unique marker to emphasize text on a web site, text that inadequately contrasts with background color or patterns, browsers that do not support user override of authors' style-sheets are barriers that people with color blindness may encounter on the web.

Other difficulties of accessibility arise from the poorly designed applications. Some software applications [20], including browsers and authoring tools, are found to be lacking keyboard support for all commands, and some of these applications do not comply with standard application programmer

interfaces (APIs) the operating system they are based in. Also the use of non-standard document formats makes web inaccessible for the disabled users. Particularly, the above-mentioned problems will cause screen readers to fail reading the items found on the screen, making the applications inaccessible by the print-disabled community.

The World Wide Web Consortium (W3C) develops and maintains the protocols used on the web to ensure interoperability in order to promote universal access. The Web Accessibility Initiative [18] provides guidelines, known as the Web Content Accessibility Guidelines (WCAG), to help developers make their websites accessible [19]. These guidelines are extremely useful to identify and fix the common web-design mistakes stated above. Furthermore, the latest versions of web development tools offer new functionality to analyze and resolve accessibility-related issues of websites. Important accessible web content development guidelines [18], [19] are summarized in the Appendix.

Nowadays, there is a trend of catering the disabled users by providing a text-only or high-contrast version of the website, but that is entirely inappropriate, and in some cases may actually make matters worse; e.g. graphics can often provide an important visual aid for partially-sighted users. From the early stages of developing a website, accessibility related issues should be considered and hence, the websites should be designed with keeping the disabled community in mind, so that it can cater all.

#### 4. Future work

Future work on the Sinhala TTS engine will mainly focus on improving the naturalness. Improving the prosody aspects of the system (naturalness) will eventually increase the intelligibility as well. It is also expected to develop a female voice in near future. The steps have been identified to incorporate lacking functionalities of MS-SAPI interface. The above steps will enable the Sinhala TTS voice to be accessed by a range of screen reader software, specially the screen readers widely used by the visually impaired community (e.g. HAL, Jaws). This will also enable the easy integration of the Sinhala TTS with DAISY DTB producing software such as Sigtuna DAR, hence the DTB production process can be accelerated and automated.

Possibilities of localizing AMIS into Tamil language is being studied as well.

The current Sinhala OCR system is font dependent. Work is in progress to make the OCR

system font independent and to improve the accuracy. Sinhala OCR and the TTS systems, which are currently two separate applications, will be integrated enabling the user friendliness to the print disabled.

Based on the developed knowledge, the improvement of cutting edge assistive technologies such as the development of mobile device screen reader software, Sinhala Unicode to Braille (vice versa) converters etc can be accelerated.

#### 5. Acknowledgements

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## **Appendix A: Web accessibility guidelines**

### **A.1. Web accessibility is a marketplace issue**

At least 10% of the population in most countries has disabilities under visual, auditory, physical, speech, cognitive, and neurological disabilities. These can all affect access to the Web.

### **A.2. Manual user agent testing**

Following methods can be used to test the web content accessibility. They are namely check global Navigation whether it is user friendly and easy to understand? and Navigate *without using the mouse* then see the effectiveness? Turn images off. What happens to usability? Check how screen reader software (*Jaws/Hal*) conveys the page to users. Is the information conveyed equally well in graphic- as well as text-based user agents?

### **A.3. Validity and conformance testing**

Validity and conformance has been carried for DTD used XHTML, conveyed natural language and character set usage.

### **A.4. Images: the alt, title longdesc and D-link attribute**

There are several ways to provide a *text equivalent* to images. In HTML version 4 and XHTML, the `alt` attribute must be specified for the `<img>` and `<area>` elements. The `alt` attribute contains a shorter description of the graphic, normally containing minimal and essential information only. The `title` attribute on the image element is not a text equivalent; it is a general information extension (Compare the `caption` element in table). Still, it can be used to expand the information provided in the `alt` attribute. Some user agents use this information, others don't. The `longdesc` attribute points to an external XHTML document containing information that is more extensive than that in the `alt` attribute.

The "`D-link`" is an alternative to the `longdesc` attribute. The need for an alternative is based on the fact that few user agents support `longdesc`. The `D-link` is a visible, explicit link to the long description of the image.

## A.5. Associating a label to a control

The label element associates the label for the input. This attribute takes a name of the control which the label is to be associated to. The names of each control are given by the `id` attribute of the associated controls. For an example, `<label for="email">Enter your Email address here:</label> <input id="email" name="email" type="text" size="30" />`

## A.6. Complex tables

Use the `headers` attribute to identify which table header (`<th>`) is associated with the current table cell (`<td>`). The `headers` attribute should contain the same value as the `id` attribute on the table header (`<th>`).

## A.7. Character entities

There are two main cases when certain characters can not be typed as-is in text nodes or attribute values: Their presence would be misinterpreted as markup and they are not available on the used system/keyboard. To handle this problem, XML uses a construct called character entity references. This is a "virtual" reference to a certain character. A character entity reference always begin with the ampersand sign (&) and always end with the semicolon (;). To cover for the first case above (misinterpretation as markup), XML predefines five character entity references. Some of them are: `&lt;` for the less-than sign - the opening angle bracket (`<`) and `&amp;`; The ampersand (&).

## A.8. Access keys

By adding the `accesskey` attribute to an element, it is in some user agents possible to directly give focus to, or activate, the element. With this functionality, the keyboard will work just like a mouse regarding *direct access to a certain point of the page*.  
`<a href="#top" accesskey="t"> Go to top of page </a>`

These are reserved keys in some common browsers. Note that they vary in other language versions.

## A.9. Skippable navigation

A link to skip the navigation bars and go directly to the main (body) content of the page is normally placed close to, or at the top of the page.

## A.10. Abbreviation and acronym

Expand abbreviations and acronyms with the `title` attribute, at least the first time they occur.

## A.11. Alternative style sheets (CSS)

A document can have multiple style sheets associated with it. The user is given an option to choose. Not all browsers support this feature. To include extra style sheets, add more `<link>` elements in `<head>`, with the `rel` and `title` attributes.

## A.12. CSS validation

Always make sure the created CSS is valid and also compatibility-check using browsers or dedicated compatibility-checking tools.

## A.13. What is document validation?

It is the only way to ensure that the user agent will understand the information contained within the document and therefore the only way to ensure that the receiver has a chance to understand what you want to say. It is required to ensure that the document can be treated by machines (parsers, servers) without errors. Make sure the document from the previous practice has a correct prolog, including an XHTML transitional DOCTYPE.

Document Validity in XML means that the document is tested against its Document Type Definition (DTD) to ensure that the markup corresponds to the rules of the grammar. A non-valid document contains *errors*. Errors should always be corrected. A Validity test

## A.14. Conveys natural language usage

The `lang` and `xml:lang` attributes are used to convey the natural language of the presentation. If the whole document uses the same language, the language attribute can be put on the root element.