Development of an Open Source Urdu Screen Reader for Visually Impaired People

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Abstract

Speech technology has enabled computer accessibility for users with visual impairments but the language barrier poses a great challenge. This project is an effort to overcome the hurdles faced by visually impaired people, in terms of language barrier, by providing them access to digital information through software which can communicate with them in Urdu. A survey was conducted in schools for blind to assess their information and communication needs. The survey helped to deduce the learning abilities, competency level and usability requirements of visually impaired children. An open source screen reader, NVDA was localized and afterwards integrated with Urdu text-to-speech system. The system was deployed in a school of visually impaired children where they participated in training and testing of the system. Results showed that visually impaired children performed equally well and in some cases even better with the localized screen reader as compared to an English screen reader.

Keywords: Localization, assistive technology, visually impaired, screen reader, text-to-speech system, Non-Visual Desktop Access (NVDA)

1. Introduction

Technology has played a dramatic role in improving the lives of visually impaired people by providing them access to sources of information, i.e., newspapers, books etc. that were largely unavailable to them in past. The advancement in information, communication and computer technology has resulted in development of specialized software known as screen readers, which simulate the human voice while reading the computer screen. English is used as communication language in most of the software. Work has started recently in localization area so that local blind community can benefit from the advancement in information and communication technology.

This project focuses on the development of an open source Urdu screen reader for visually impaired people of Pakistan and Urdu speaking community worldwide. An extensive field study was conducted on visually impaired people, specifically targeting school going children and their teachers; to assess their information and communication needs. On the basis of that survey, it was concluded that visually impaired community of Pakistan was in dire need of an Urdu screen reader that should be compatible with word processor so that visually impaired people could read and write Urdu text; secondly it should be compatible with a web browser so that visually impaired people could read web pages in Urdu and search desired information on the internet. To start with, the task of word processor compatibility was taken at first as it was more challenging and exciting. Once a visually impaired person is well versed in reading and writing Urdu text then web browser, email, chat client and other communication tools are easy to learn.

After conducting survey on screen readers in general and studying NVDA, JAWS, Window Eyes, HAL and Thunder Screen in detail; an open-

source screen reader Non-Visual Desktop Access (NVDA) was chosen. NVDA has already been localized into 20 languages. NVDA was localized in Urdu by following the guidelines available at NVDA website.

Urdu text-to-speech system has already been developed by Center for Research in Urdu Language Processing (CRULP). Urdu text-to-speech system was enhanced and improved according to the requirements of the screen reader and afterwards it was integrated with the localized screen reader NVDA.

The system was deployed in a school for visually impaired children for final testing, training and evaluation. Training and evaluation was carried out by defining competency level for word processor i.e. Microsoft Word for visually impaired children of 9^{th} and 10^{th} grade. A test was conducted before training and on the basis of results; strengths and weaknesses of the individuals were identified. Training was planned accordingly and competency level of children was established. Another test was conducted after training and hence the competency level of the children was assessed again after training.

2. Information and communication need assessment

According to Sight Savers International (Sight Savers, 2011), there are 1.4 million visually impaired people in Pakistan. No research has been conducted in the past to assess the ICT needs of visually impaired community. They are not taught computers in schools, except few where measures are being taken to make them computer literate.

The survey was conducted, primarily to understand the psychology of the visually impaired people and identify their information requirements, as these tasks are important for designing the system, training material and training methodology. The research was intended to assess the following areas regarding visually impaired

- Learning capabilities of visually impaired as compared to normal students
- Learning capabilities in computer usage
- Attitude towards learning aids
- Average age, when he/she can start learning computer.
- Comprehension through listening
- Preference regarding the source of information

The survey was conducted in small number of schools, both from public and private sector, for blind children. The target group included visually impaired children from grade 5^{th} to 10^{th}. They were divided in two groups; one group comprised of children who were not taught computer in school and hence they had either no knowledge or very little know how of computers. The other group comprised of children who were taught computer as a subject in the school; so they had basic computer skills and were familiar with the concept of screen reader, text-to-speech system, magnifiers etc.

Apart from conducting the survey on the visually impaired children; we also contacted their teachers, parents and organizations working for visually impaired people, e.g. Special Education Department, Pakistan Association for Blind, Baseerat Foundation, etc. to better understand the behavioral pattern and ICT needs of visually impaired people.

2.1. Observations

Various observations were made during visits to schools of visually impaired children. Summary is given below

- They are highly motivated.
- Their attitude towards life is very positive.
- They are eager to learn and those students who were not taught computer were desperately looking forward to have that knowledge.
- They share their requirements openly e.g. students who were using screen reader JAWS, complained about its verbosity etc.
- They can easily use mobile phones. They can easily dial a number, write an SMS and send to their friends. They also get updates regarding cricket matches from their mobile phones.
- The attitude of society is overall negative towards them and it results in low confidence level among visually impaired children.
- Hearing is used as the primary source for information gathering in case of visually impaired people. The other extensively used source of data is the sense of touch. Also, it has been observed that through hearing, a properly trained visually impaired person may

understand what is being taught to him/her much more quickly than a normal person.

- The most obvious weakness that is inherent in the visually impaired is the lack of visual input. Most of the interfaces that are encountered in daily life incorporate visual cues. These visual cues are useless for the visually impaired people as these people cannot function normally unless there are some other cues such as audio or something based on the sense of touch is provided.

3. Urdu Screen reader

Over the past few years, the amount of data available digitally has grown rapidly. Internet has become the primary source of information. Unfortunately, the visually impaired community cannot access the information available digitally. There is a limited number of software available to help visually impaired people access the digitally available data; in addition, the language of communication in these software is English. So, the visually impaired people of Pakistan, who do not know English, cannot access the digital data. To provide them this access, a software is required which can communicate with them in Urdu or other local languages.

3.1. Localization of screen reader

Various screen readers were analyzed in this project e.g. NVDA (2009), JAWS (2009), Window Eyes (2009), SuperNova formerly HAL (2009) and Thunder Screen (2009); in order to observe their performance in Microsoft Word, Microsoft Excel and Internet Explorer. Apart from these applications, these screen readers were also observed for how they respond to basic operations performed on computer.

Among these screen readers Non-Visual Desktop Access (NVDA) was chosen for the following reasons

- It is an open-source screen reader.
- It has been localized in 20 languages, which include Brazilian Portuguese, Croatian, Czech, Finnish, French, Galician, German, Hungarian, Italian, Japanese, Portuguese, Russian, Slovak, Spanish, Traditional Chinese, Afrikaans, Polish, Thai, Ukrainian and Vietnamese (NVDA User guide, 2009).
- It is compatible with Microsoft Windows and is compatible with following applications
    - Mozilla Firefox.
    - Mozilla Thunderbird.
    - Early support for Microsoft Internet Explorer
    - Basic support for Microsoft Outlook Express / Windows Mail
    - Basic support for Microsoft Word and Excel
    - Support for accessible Java applications
    - Early support for Adobe Reader
    - Support for Windows Command Prompt and console applications

NVDA was localized in Urdu by following the guidelines available at NVDA website (Translating NVDA, 2009). The interface of NVDA was translated using Poedit (Poedit, 2009). A snapshot of localized NVDA is shown below in Figure 1.

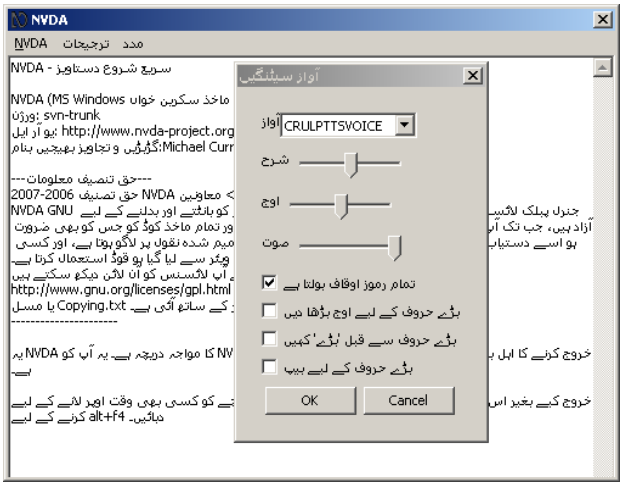

Figure 1: Localized NVDA

3.2. Urdu Text-to-speech system

Urdu text-to-speech system has already been developed by Center for Research in Urdu Language Processing (see Hussain (2004) and Hussain (2005) for details). Its features include

- Natural Language Processor
- Urdu speech synthesizer
- Basic duration model
- Perceptually tested diphone database of over 5000 diphones.

- Basic diacritics prediction
- Web page and email reader applications
- Lexicon of 80,000 words

One of the challenges faced during integration of screen reader and text-to-speech system was that text-to-speech systems are not multilingual; hence Urdu TTS discarded English text which is an integral part of interfaces nowadays. So we developed English to Urdu transliteration system and incorporated it with the Urdu TTS. The architecture of the transliteration system is shown below in Figure 2 (see Ali and Ijaz, 2009 for details).

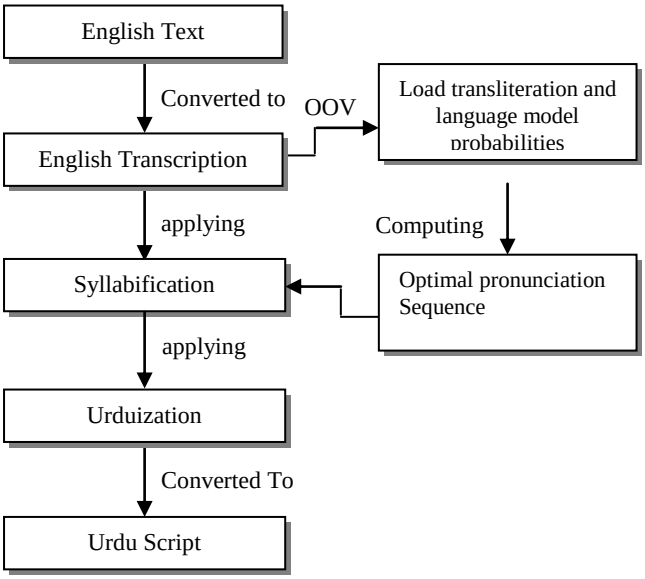

Figure 2: Architecture of English to Urdu transliteration system

Second major challenge was absence of rate control as one could not speed up or slow down the rate of speech. So rate variation control was incorporated and now listener could adjust rate of speech according to his/her preference.

3.3. Integration of text-to-speech with localized screen reader

NVDA has been translated in over 20 languages in which Urdu is not included. It can support any language by integrating that language speech synthesizer with it and by translating the interface and commands. Urdu text-to-speech system, which is an Urdu speech synthesizer application, was integrated with NVDA through Microsoft Speech API (SAPI). SAPI provides standard interfaces for speech synthesis to communicate with TTS. NVDA provides interfaces to control its functionality through SAPI like volume, rate, pitch etc. SAPI query its method to determine which real-time actions to perform; Urdu TTS call this method frequently during rendering process to be as responsive as possible. SAPI method creates two threads to its audio reader and invokes Urdu TTS. First thread read Unicode based Urdu text and buffer it in audio text, the other thread read that speech data and pass it to SAPI. The architecture of the system is shown below in Figure 3.

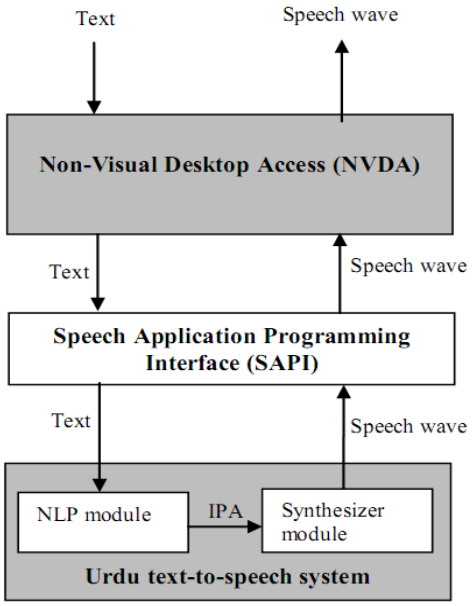

Figure 3: Architecture of the system

4. Training and evaluation

Visually impaired children of 9th and 10th grade of a local school with basic knowledge of computer and word processing, as it was part of their curriculum, were chosen for training. Students were interviewed and data summary of the students is described below in Table 1.

Total no of students	12 (5 completely blind and 7 partially sighted)
Age	12-16 years
Class	9th & 10th grade
Source of information	Braille

Hands on computer experience	3-4 years on average (1-2 hrs per week)
Assistive Technology	Screen reader (JAWS)
Input device	keyboard
Applications used	MS Word

Table 1: Data sunnary of visually impaired students

4.1. Competency level

For evaluation purposes, competency level was defined after consulting teachers who had taught visually impaired children of this age group. These levels are summarized below:

Level 1: Student is aware of the concept of word processing, knows how to open and exit MS Word

Level 2: Student can type text, traverse in the document and navigate menus

Level 3: Student can edit text

Level 4: Student is capable of opening, closing and saving document from/to desired path

Level 5: Student can format text

Level 6: Student can spell check document

Level 7: Student can find/replace text in document

A pre-training and post-training test was designed on basis of competency level. The pre-training test was taken on MS Word (English interface) with help of JAWS. Afterwards students were provided training on MS Word (Urdu Interface) using NVDA. A post-test was conducted after training and results of both tests were compared to see if there was any anomaly in the use of Urdu screen reader.

4.2. Pre-training test

A pre-training test was conducted in order to assess the competency level of the students with JAWS. They were asked to perform operations in MS Word (interface in English), e.g. type text, cut, copy, paste, spell check, save document and find/replace. Results are shown in Table 2. Total score was 16 and time was recorded (in minutes) for typing a 75 word English paragraph.

4.3. Training

Training was conducted for 5 days (30 minute session daily) in which 12 students participated. Students were trained on Urdu screen reader, i.e., NVDA and MS Word localized in Urdu. They were taught Urdu keyboard and were asked to type Urdu text in MS Word. Most of the key mappings were same for English to Urdu Braille so according to them it was easy to memorize the Urdu keyboard. Afterwards, they were taught how to edit text; open, close, save, find/replace dialog box and spell checker.

4.4. Post-training test

A post-training test was conducted in order to assess the competency level of the students with NVDA. They were asked to perform operations in MS Word (interface in Urdu) e.g. type text, cut, copy, paste, spell check, save document and find/replace to see if they can perform them with equal proficiency as with JAWS and MS Word (interface in English). Results have been shown in Table 2. Total score was 16 and time was recorded (in minutes) for typing a 75 word Urdu paragraph.

5. Results

The pre-test and post-test results have been summarized in Table 2.

	Pre-test		Post-test	
	Overall Score	Time taken	Score	Time
Student #1	14	9	14	9
Student #2	10	18	12	20
Student #3	14	7	14	8
Student #4	14	12	14	9
Student #5	12	10	14	8
Student #6	10	20	11	22
Student #7	8	10	10	8
Student #8	12	10	14	8
Student #9	13	13	14	12
Student #10	12	10	14	7
Student #11	10	16	11	18
Student #12	12	12	13	10

Table 2: Pre-training and post-training test results

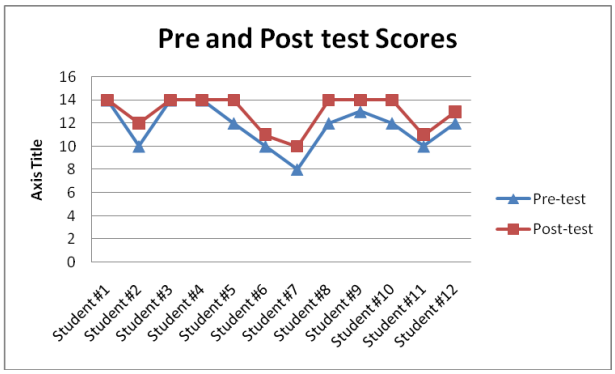

Figure 4: Pre and post-training test scores compared

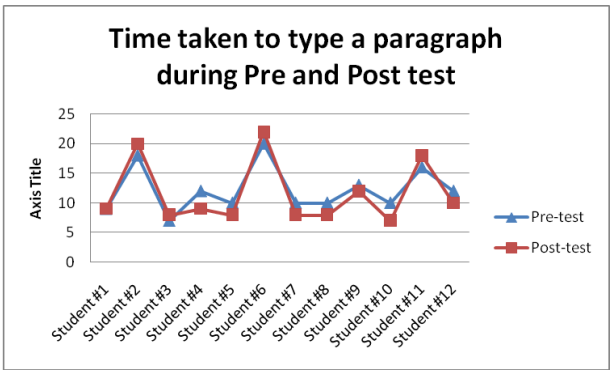

Figure 5: Pre and post-training test time compared for typing a 75 word paragraph

6. Conclusion

As it is shown in Table 2 and Figure 4, the post-training test scores of all the students are either same or have been improved as compared to the pre-training test, which shows that students were able to perform equally well with Urdu screen reader i.e. NVDA and MS Word localized in Urdu. Similarly, the time taken to type an English paragraph in pre-test and the time taken to type an Urdu paragraph in post-test show similar trend except for the few individuals whose typing skills were not good as shown in Figure 5.

Overall, the students were motivated and quite excited about learning how to read/write Urdu text. They even asked us to switch to localized Window XP i.e. Window XP with Urdu support. They were comfortable with the voice of the Urdu text-to-speech system although they sometimes complained regarding the verbose Urdu words used in interface of Microsoft Word.

7. Future Work

We intend to enhance the screen reader for web browsing, email and chat client. Afterwards we intend to develop training material and training methodology for visually impaired children in order to train them on these tools and then evaluate them in order to investigate the sustainability and scalability of this model.

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