RoboBraille – Automated Braille Translation by Means of an E-Mail Robot

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Abstract. As society becomes increasingly dependent on literacy, the problems of textual information inaccessible to print-impaired people are likely to grow. This paper discusses the problems of decentralised, user-driven Braille translation and proposes an alternative: The centralised, email-based RoboBraille service capable of translating to and from contracted Braille, including any pre- or post processing steps required to convert between document types, formats and character sets. As such, the RoboBraille service attempts to solve a universal problem as it makes textual information accessible to people who would otherwise find it inaccessible due to disability or reading difficulties. Originally a Danish service, a pan-European consortium is currently validating RoboBraille in six European countries with financial support from the European Commission.

1 Introduction

In Denmark, software to translate to and from contracted Braille in multiple languages has been available since the mid 1980s [1][7]. Although the systems are fairly easy to use, fast, accurate, well-promoted by the support system and available free of charge as downloads from websites, they are not being widely used amongst teachers, Braille readers and others with a need to produce contracted Braille. Why? Traditionally, translating documents into contracted Braille is a time consuming process that requires a wide range of different skills: In addition to mastering the Braille translation software, translators must understand how to handle different document types, character sets and formats. Once translated, the translator must also know details about the Braille device on which the text is to be displayed or rendered. And since Braille translation is a niche with limited resources, software is constantly being updated with software patches. For professional Braille translators, these issues may not pose a problem. However, for the occasional translator – e.g., a primary-school teacher with an integrated blind pupil or a blind Braille reader – they do.

This paper discusses an alternative to the decentralised, user-centric Braille translation systems used widely to produce Braille at varying levels of contraction. Based on experience from developing automated Braille translation solutions during past 20 years, the RoboBraille service is a centralised, e-mail based translation agent that automates the translation process, including any pre- or post processing steps required to convert between document types, formats and character sets. Since

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RoboBraille is based on e-mail, the solution is platform independent and the only skill needed to use the service is the ability to send and receive an email with a document attachment. The RoboBraille architecture is based on standard internet technologies and can be managed centrally. Consequently, the solution is highly scalable, always up to date and can be operated by a minimum of efforts. In addition to translating to and from contracted Braille, RoboBraille is capable of producing audio (mp3) files from submitted documents using integrated text-to-speech synthesisers and audio compression software. The service is being offered free of charge to all non-commercial users.

The RoboBraille service attempts to solve a universal problem: It makes textual information accessible to people who would otherwise find it inaccessible due to disability or reading difficulties. As society becomes increasingly dependent on literacy [3], the problem of textual information inaccessible to print-impaired people is likely to grow. From a conceptual point of view, the RoboBraille is a universal solution to a universal problem. By adapting the service to include the specific Braille translation and text-to-speech capabilities of any given language, the service will be of interest to governments, commercial organisations, interest groups and print impaired people alike irrespective of region or nationality. Using standardised internet technologies to interact with the service supports the notion of a fully pan-European or global service. Originally a Danish service developed by the author in close collaboration with Synscenter Refsnæs, the national Danish Centre for Visual Impairment, Children and Youth (see www.synref.dk), the European Commission has recognised the potential of RoboBraille, and has retained a project aimed at validating the service in five other countries in 2006 and 2007 as part of the eTEN programme. Headed by Synscenter Refsnæs, the eTEN RoboBraille consortium includes seven European organisations.

2 Challenges of De-centralised Braille Translation

Although electronic versions of texts are becoming widely available (or can be scanned and converted to text using OCR software), many documents are kept in older formats or character sets such as the old MS-DOS code pages. Similarly, although certain document formats such as Microsoft Word, Rich Text Format (RTF) or Portable Document Format (PDF) may be suitable for producing visual, printed copies, they may not be supported by the Braille translation software. Finally, since few (or too many) standards exist for how to layout the Braille character set on Braille devices and embossers, few Braille devices and embossers appear to share a character set. Consequently, traditional decentralised Braille translation requires the translator to obtain an electronic copy of a particular text, to convert it into a format and a character set suitable for the Braille translation software, to translate the text into contracted Braille and to convert the resulting text in accordance with the character set of a particular Braille device or embosser. During the process, it may even be necessary to chop up the text into smaller parts in order to fit it into the memory of a Braille device.

Needless to say, the person who only occasionally needs to translate a document into (or from) contracted Braille has a hard time. And should he or she succeed, chances are that the Braille translation software is out of date and the resulting Braille

text flawed. Although we have not conducted a formal survey amongst occasional Braille translators in Denmark, our experience with these users – dating back to the mid 1980s – has confirmed our thesis: Decentralised, user-centric Braille translation is too cumbersome for the occasional user. As a result, teachers of integrated blind-born children in the comprehensive Danish *Folkeskole* abandon contracted Braille in favour of uncontracted Braille or even synthetic speech. Likewise, the blind themselves remain dependent on centralised Braille production sites, who can muster all the required skills, in order to gain access to Braille renditions of textual material.

Far worse than the lack of independence is the erosion of basic Braille skills amongst the blind that this situation causes [2]. Over the course of the past 30 years, Braille literacy has shown a dramatic decline. In America [4] and the UK [5], alarming statistics have been published and although less significant, similar trends are reported from other countries (e.g., [6]). Many fail to recognise the importance of Braille: It is difficult to learn as a visually impaired person, difficult to read and understand as a sighted person, it is costly and time-consuming to produce and Braille devices such as Braille printers and Braille displays are expensive. In many cases, speech synthesis appears to be an attractive alternative. However, a symbolic written medium is as important for the blind as it is for the sighted. Braille is a fundamental means of communicating and plays a significant role in the process of intellectual development: It is so much more effective to be an active reader than a passive listener. Furthermore, Braille literacy is an integral part of the personal identity for visually impaired people [5]. In general, lack of Braille skills amongst the blind equals illiteracy – a rather serious issue in the information society.

3 The Process of Resolving the Issues of Complexity

Although the ultimate solution to the issues of complexity in traditional, decentralised and user-centric Braille may be simple – to the degree of seeming obvious – the process of reaching the solution has been long and circuitous. The Danish Braille translation solutions have evolved alongside the general technological development and the adaptation of information technology amongst the visually impaired over the course of the past 20 years. At each stage in this development, barriers have been overcome, only to be replaced with new obstacles. In some case, solutions have been developed to address particular problems. In other cases, solutions have materialised as a result of the general technological development and adaptation.

In the mid-1980s, the main issues facing Braille translation was the availability of translation software on affordable computer systems combined with the lack of electronic versions of textual material. As PCs and scanners became widely available and commercial text editing became electronic, the issues changed and became a matter of distribution, Braille consumption and intellectual property rights. Around 1990, eBooks for the blind became a reality with the establishment of diskette-based distribution and electronic bulletin boards (BBS); these services were eventually replaced by email and the web. Likewise, Braille readers were offered Braille displays or personal Braille printers as alternatives to paper-based Braille. During the past decade, Braille translation software was introduced to the Braille readers and those

preparing ad-hoc material, electronic web-based libraries for blind were established and the Braille-enabled computers improved [7].

Alongside the technology adaptation amongst the visually impaired, information technology was adopted by the general public. From being a rarity 10 years ago, most households today have one or more computers, and the computers are connected to the internet – in many cases through broadband connections. Most people are familiar with emails and electronic documents, and make use of the web for a variety of purposes [8].

20 years ago it would not have been possible. In the current technological climate, however, one solution to the issues of complexity in traditional, decentralised and user-centric Braille translation was obvious: RoboBraille, an email-based translation agent.

4 The Centralised Alternative

Although RoboBraille does not claim to resolve all the challenges of Braille, the service does ease the process of producing high-quality contracted Braille. Braille remains difficult to learn as a visually impaired person, it is difficult to read and write as a sighted person, and Braille devices are costly. However, the actual process of transforming textual documents such as books, articles, bank statements and medical instructions into Braille is significantly simplified. As a positive side-effect, the RoboBraille service can also be used to produce other forms of Braille – e.g., visual Braille for pharmaceutical companies with a need to emboss tactile Braille on pharmaceutical packages and labels – as well as audio files with synthetic speech.

The RoboBraille service is an email-based translation service capable of translating documents to and from contracted Braille and to synthetic speech. Users submit documents (e.g., text files, Word documents, HTML pages) as email attachments. The translated results are returned to the user via email. The user interacts with the RoboBraille service by sending emails to specific email accounts. The main email accounts are listed in Table 1 below:

Table 1. Main RoboBraille translation processes

Email account	Process
`ottepunkt@punktskrift.dk`	Translate document into contracted eight-dot Braille.
`sekspunkt@punktskrift.dk`	Translate document into contracted six-dot Braille.
`fuldtekst@punktskrift.dk`	Translate (presumed contracted) document into standard text.
`filepart@punktskrift.dk`	Partition document into smaller parts.
`converter@punktskrift.dk`	Convert from one document format to another.
`eksport@punktskrift.dk`	Convert to character set of a particular Braille device.
`tale@punktskrift.dk`	Translate document into synthetic speech.
`sb4admin@punktskrift.dk`	Administrative account for status and updates.

The service has been running as a prototype in Denmark since August 2004; in December 2005, the number of processed requests exceeded 12,000.

The current version of the RoboBraille service supports a range of popular document formats, including standard text, HTML, Word and Rich Text Format (RTF). Prior to translation, Word and RTF files are converted into text. Depending on the size of the file, the traffic and server workload, a result is typically returned to the user in a matter of minutes of submitting a request for translation. Figure 1 below illustrates how a user interacts with the system in order to have a document translated into contracted Braille:

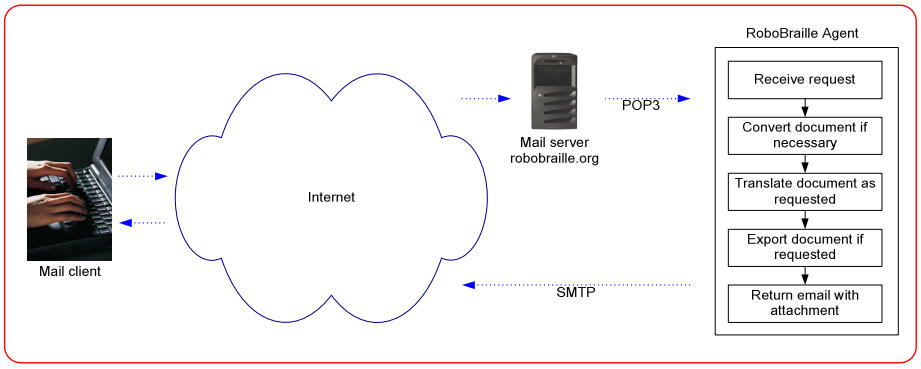

Fig. 1. The RoboBraille Braille translation flow

The translation system assumes that the source document is written in the standard Windows character set for Western Europe (ISO 8859/1). Furthermore, the system supports automatic conversion of older ASCII documents to Windows text files. Once translated, the document is returned in OctoBraille, a Braille adaptation of the standard ISO 8859/1 character. Since few Braille devices share the same character set, the translation system can convert the translated document into a range of different formats to accommodate Braille note takers and embossers.

Likewise, the user may request a document be translated into synthetic speech. The process is similar to that of Braille translation, although some of the steps are different. First, the translation system translates an attached document into a WAVE file. WAVE files are rather large and unsuitable for transmission via the Internet. Therefore, the WAVE file is subsequently encoded and compressed into an MP3 file. The resulting audio file is copied with a unique name to the web server using FTP, and a link to the file is returned to the user.

In order to provide a scalable and high-performance solution, the RoboBraille service is based on a two-tier architecture consisting of a server layer and an agent layer, respectively (see figure 2 below). The server layer includes a mail server for receiving incoming requests and a web server for delivering audio contents. The agent layer consists of a range of identically configured desktop computers running the RoboBraille software package on Microsoft Windows.

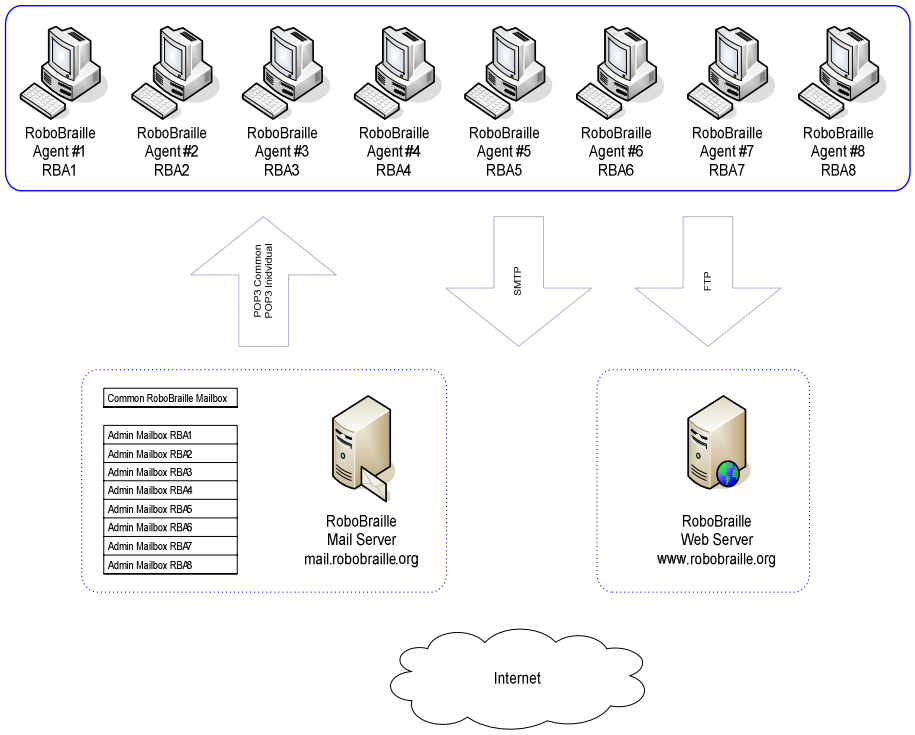

Fig. 2. The Overall RoboBraille Systems Architecture

Incoming requests are received by the mail server and subsequently divided into two different categories:

1. Translation requests: These include all requests for translation of attached documents into either Braille or synthetic speech. All translation requests are placed in the common RoboBraille mailbox, irrespectively of which translation service is requested. All RoboBraille agents read from this mailbox using the POP3 protocol as part of a scheduled poll sequence. The poll interval is typically set to 1-2 minutes. With a poll interval of 1 minute and 8 RoboBraille agents, the RoboBraille service will have a theoretical capacity of servicing 60 * 8 = 480 requests per hour. The common RoboBraille mailbox serves as a first-in-first-out queue. Once a translation request has been read from the common RoboBraille mailbox by a RoboBraille agent, it is deleted from the mailbox. Further processing of the translation request is managed by the individual RoboBraille agent.
2. Administrative requests: These include a number of different request types sent to the RoboBraille service: Request for status, update of data tables, and update of software. As such, these are the requests used to manage the RoboBraille service and ensure that all RoboBraille agents are up-to-date. Rather than delivering these requests to the common RoboBraille mailbox, administrative requests are copies to an individual administrative mailbox for each RoboBraille

agent. All RoboBraille agents read from its administrative mailbox using the POP3 protocol as part of a scheduled poll sequence. Once an administrative request has been read from the individual administrative mailbox, it is deleted from that mailbox. Only selected users can issue administrative requests. These administrative requests allow administrators to check the status and to update the data tables and software modules of all RoboBraille agents simply by sending emails to the RoboBraille service. All RoboBraille agents automatically reboot every night at midnight, loading all updates that may have been mailed as administrative requests during the past 24-hour period.

The RoboBraille software package includes the RoboBraille Automated Mail Responder (AMR) module including software components for graphical manipulation and audio compression, Sensus Braille 4 Braille translation engine, text-to-Speech synthesizers and Microsoft Office Automation components to handle Word and RTF documents.

As the communication between the mail server, web server and the RoboBraille agents are based on standard Internet communication protocols (POP3, SMTP, HTTP and FTP), the individual computers do not need to be located on the same physical location. However, in order to make efficient use of systems administration resources, limit the amount of resources required to keep the systems updated and reduce the risk of unscheduled down-time, all machines are maintained centrally at two separate locations in Denmark.

Each RoboBraille-enabled desktop computer is configured to serve several languages (Braille and text-to-speech translation). Likewise, multiple RoboBraille-enabled desktop computers will be available to serve the same language. As each RoboBraille-enabled desktop computer is running independently of the others, the architecture is truly scalable, and the ability to add new agents will be used to ensure the service level and balance the workload. Experience from the Danish RoboBraille service suggest that deploying identical RoboBraille agents all capable of processing translation requests is a simple means to ensure efficient load balancing and availability.

5 Europe and Beyond

As a universal solution to the problem of inaccessibility to textual information amongst print impaired people, the potential of the RoboBraille solution is substantial. Already, a pan-European market validation project has been retained for funding by the European Commission under the eTEN programme. Once validated in Ireland, the United Kingdom, Italy, Portugal and Cyprus, the RoboBraille consortium expects to maintain the service in the six countries and deploy the service further into other interested countries. Through dialogues with relevant government agencies, NGOs and institutions for the blind, partially sighted, dyslexic and other print-impaired people, and by maintaining a high level of visibility through participation at conferences and press coverage throughout Europe, the RoboBraille consortium will invite other countries to join the service. The aim is to add between two and five new countries/languages per year until all interested EU Member states have joined the service. Several countries outside the EU are also expected to join the service.

Critical to the further expansion of the RoboBraille service is the adoption amongst public and private commercial organization. For this purpose, the RoboBraille service will be developed into a step-stone technology, allowing organisations to communicate electronically with citizens, clients and customers in formats alternative to plain text. The term step stone is used to describe the scenario where a piece of information – e.g., a tax return form, a bank statement, a letter – is mailed to someone via the RoboBraille service. Using the RoboBraille service as an intermediary, the originator of the information may be able to send textual information in a multitude of alternate formats such as Braille, speech and enlarged print. Furthermore, the ability to produce visual Braille for companies who need to emboss tactile Braille on packages, lables, bottles, etc., will be enhanced.

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