PRINT-BASED INTERACTION INTERFACES FOR MULTILINGUAL MULTIMEDIA AND SIGN LANGUAGE ELECTRONIC RESOURCE INTEGRATION

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Abstract: In this work we outline previous implementations of multilingual multimedia dictionaries and discuss possibilities for adding new functionalities and expanding their coverage. Independently developed sign language dictionary resources are further explored and considered for inclusion in an integrated multilingual multimedia dictionary with video support. Print based interfaces for direct access to digital content are implemented and a novel concept for dynamic linking to printed documents based on mapping of printed and digital content is proposed. Printed texts in different languages and language independent images are used as interface components for addressing diverse multimedia content including sign language and lip reading multimedia resources.

1 INTRODUCTION

Despite the proliferating electronic information sources, printed media continues to be widely employed. Printed materials, however, do not provide native support for audio, video and interactive multimedia content. On the other hand, multimedia is quite important in language acquisition and could bring to significant improvements, especially when young children are involved. Multimedia content is also indispensable for people with hearing disabilities and other impairments. Although various printed and multimedia materials for young and hearing impaired learners already exist, their integrated use

is rather limited. Instruction could benefit if contents for different learning audiences are brought together in a supportive system for integrated use of printed and multimedia content.

In this work we discuss how multimedia dictionaries with multilingual word definitions, pronunciation samples, and illustrations (Barneva et al., 2009) could be integrated with sign speech and sign language electronic resources (ASLPro, Sign Language Resources, Inc.). An important aspect of our approach is the tangible print-based interface for accessing and interacting with the multimedia content (Kanev and Kimura, 2005; Kanev and Kimura, 2006). Through it, multimedia contents targeting various audiences and controlled separately

could be smoothly integrated into a unified system. Because of the space limit, here we present only the basic features and some possible applications of our extensive theoretical and experimental work. A complete presentation including all technical details will be provided in a full-length journal version of the paper.

2 MULTIMEDIA DICTIONARIES

Nowadays, one can use *talking dictionaries*, *visual* (*picture*) *dictionaries*, and also combined *multimedia* dictionaries. Creating such dictionaries as well as studying and analyzing the issue from theoretical, practical or other points of view, have attracted a lot of interest and resources in recent years. Even a brief review and rough classification of existing electronic dictionaries is a difficult task. There are *monolingual dictionaries* (see, e.g., Houghton Mifflin Interactive; Turrini et al, 2000; Optimus Pascal, 1998; DK Multimedia), *bilingual*, and *multilingual* dictionaries (see, e.g., Chinese-English Multimedia Dictionary; Focus Company; HuiFeng; ILSP).

Figure 1: An audio book tablet with a pen pointer.

For some audiences, and especially for young children, specialized devices for simultaneous presentation and integration of printed and multimedia content are often employed. The audio book tablet shown in Fig.1, for example, would allow a printed picture book and an accompanying sound cartridge to be installed onto it and then used synchronously. If children touch the printed content with the pen, the underlying position sensing device links that to a pre-recorded sound which is played from the installed sound cartridge.

Such audio book tablets, however, can only accommodate printed materials in predetermined sizes that properly fit on the tablet. Flexible scanning

tablets that employ digitally encoded layers embedded into the printed document content and do not require physical scanning tables can also be employed. In this way printed documents could be easily enhanced with digitally encoded positional information that is practically invisible for the naked human eye but is easily perceptible for specialized optical reading devices (Kanev and Kimura, 2005; Kanev et al., 2008).

3 SIGN LANGUAGES AND DICTIONARIES

In contrast to spoken languages that employ sound patterns, sign languages rely on visual patterns to convey meaning. Employed visual patterns are quite complex and manual communication, lip movements, face expressions, and body language are often simultaneously used. It is important to note that due to certain historical developments no one-to-one match of signed and spoken languages currently exists. English speaking countries such as the UK, the USA, and Australia, for example, employ quite different sign language systems (Napier, 2006). Australian sign language is related to the UK sign language but it is also influenced by the American and Irish sign languages. Consequently, hearing impaired persons from those countries could use written English, but not their sign languages, to communicate.

Some sign languages on the other hand may have similarities and even share signs while their corresponding spoken languages are quite distinct and even belong to different language groups. Czech, Slovak, and Hungarian sign languages, for example, are naturally clustered together (Bickford, 2005) despite the fact that spoken Hungarian is quite unique and not related to the languages of the neighbouring countries. Similarly, Bulgarian and Romanian sign languages are also clustered together, although the spoken languages of the two countries belong to different language groups.

Different assistive methods and technologies could help in enhancing and augmenting the instructional process for hearing impared (Adamo-Villani and Beni, 2004; Zamfirov et al., 2007). For illustration we show in Fig.2 the screen interface of a recently developed concise Japanese sign language dictionary for English speakers. Note that the interface and all written words are shown in English while the videos show the signs in Japanese. In the following sections we will discuss how the content of this and other sign language dictionaries could be

integrated with multilingual multimedia electronic resources for better educational support.
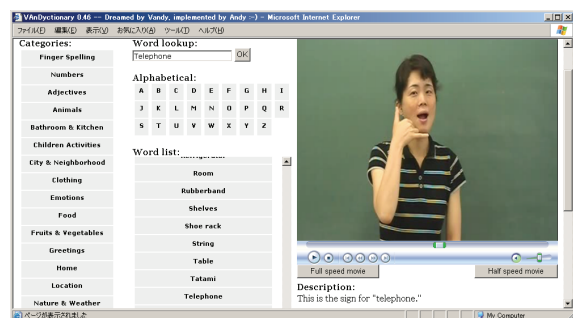

Figure 2: Interface of a Japanese sign language dictionary for English speakers.

4 PRINT BASED INTERFACES FOR ACCESS TO DIGITAL CONTENT

The system that we propose attempts to bring together multiple information sources that can be either online or offline. Technically, any information on the Web can be accessed through a standard www browser. Addressing individual pieces of information, however, is not a trivial task since specific links and corresponding URLs are needed. Maintaining and organizing such links in a convenient, easy to access way is quite time consuming. The form in which links are presented to the user is also very important. Nowadays, there are many specialized magazines and newsletter entirely dedicated to introduction of online resources. Issues of such publications though quickly become obsolete since they only represent snapshots of the Web at the time of publishing and cannot grasp its dynamic nature.

4.1 Dynamic Linking to Printed Content

To address this problem we introduce the concept of dynamic linking to printed materials that allows automated matching of printed and electronic content. When URL addresses are directly printed on paper, dynamic linking is difficult to implemented, since alterations of the URL addresses are not possible. QR-code based URL linking to www pages features similar problems. Printed QR-codes contain directly encoded URL addresses that are extracted and forwarded, for example, to a browser in a mobile phone. This again makes it difficult to change the encoded URL addresses after they are printed on paper.

We address the above mentioned problems by employing paper based point-and-click functionality for implementing direct interactions with the printed content. Through our method, printed objects of different nature, form, and size can be associated with system or user defined actions, such as invoking of specific software and communicating parameters to it. The direct interactions method effectively eliminates the need of printed or QR-code embedded URL links and thus allows more flexibility in adjusting and modifying associated actions and system responses on the fly.

Current printing technologies heavily rely on computerized typesetting and publishers retain digital versions of printed materials for republishing and preparation of new editions, for placement in digital libraries, and others. Such digital versions of printed documents are made more widely available by the publishers as the public demand increases and electronic publishing becomes economically viable. In the rare cases when electronic versions are difficult to obtain and for experimental purposes scans of printed materials could also be employed.

In the following presentation of the idea of dynamic linking to printed materials, we assume that both the printed and the digital versions of the concerned document are available. Once printed, the content of the paper version cannot be altered but its digital version can. By pointing and clicking on different printed objects we can then establish direct mapping with their counterparts in the electronic version of the document. When a word is printed on paper, OCR methods need to be applied to extract the characters comprising it. However, if access to the same word in the corresponding digital document is available, the comprising characters can be directly obtained. By accessing digital versions of printed documents, identification of printed images and their components could also be optimized.

4.2 Mapping of Printed and Digital Content

Our method establishes one to one mapping of a printed and a corresponding digital document based on their presentation layout and not on their content. In this way adjustments in the content of the digital version of the document could be made at any time as long as its layout does not change. This allows updating of hyperlinks and references to online information sources and thus keeping the document synchronised with the dynamic content available on the web.
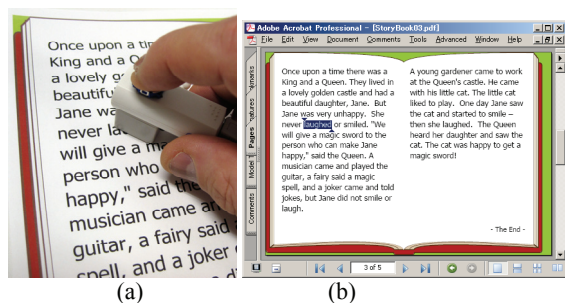
Figure 3: Mapping of printed and digital content.

If a user points and clicks on the printed word "laughed" by a specialized CLUSPI reader as shown in Fig.3a, a Unique Document Identifier (UDI), Publisher Sheet and Page (PSP) positioning information, and the CLUSPI reader rotation in respect to the printed page could be instantly obtained. The UDI is converted to a PDF file name containing the digital version of the printed document that can be opened with PDF reader software and displayed as shown in Fig.3b The PSP data identifies a publisher sheet of size up to A0+ along with a horizontal and a vertical offsets from its top left corner. Based on this data we derive the corresponding printed page number and the position of the CLUSPI pointer on that page. Obtained data can be used for instructing the PDF reader to show the page on the screen and then the cursor can be moved to the derived position. At that point, if a double click with the left mouse button is effectuated, the word under the cursor would be automatically selected and highlighted as shown in Fig.3b.

With this we have demonstrated how clicking on a word in a printed document could be used for automated extraction of its character string from a corresponding digital document. In practice, to avoid interference with other running applications, one or more virtual screens may need to be used.

5 PRINT BASED ACCESS TO MULTIMEDIA CONTENT

The PDF approach discussed so far is suitable for printed and digital documents containing mainly text, pictures and hyperlinks. When sound and video are also involved, using a standard www browser would be more convenient. In the following sections we discuss how a print-based point-and-click interface is employed for integration of multilingual

multimedia and sign language electronic resources through a www browser.

5.1 Text based Printed Interfaces

Printed materials for foreign language education may be either entirely prepared in the target foreign language or they can also use the mother tongue for translation and explanations. In Fig.4 we show some typical CLUSPI enhanced content of an English language textbook for Japanese students that we will use as an example in our further discussion.
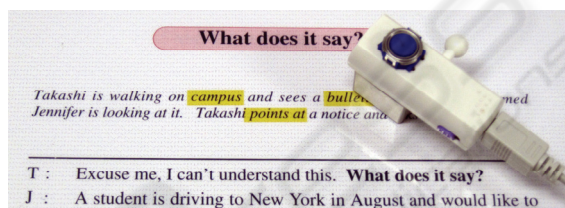

Figure 4: Sample CLUSPI enhanced content for Japanese learners of English.

Students are expected to read the text, to learn the highlighted new words and to make sure that they fully comprehend the entire dialog. A native speaker recording of the dialog is available on an accompanying CD, so students can use it for listening and pronunciation training. We have employed the above CLUSPI enhanced content for conducting experiments with the print based point-and-click functionality that we have discussed earlier. The following links between the printed content and the audio have been established:

- English pronunciation of highlighted words
- Japanese translation of highlighted words
- Reading of sentences in English
- Translation of sentences in Japanese

Playback of voice recordings associated with the highlighted words is initiated by pointing and clicking on them with the CLUSPI reader as shown in Fig.4. The CLUSPI reader orientation in respect to the printed document is used to discriminate between the English pronunciation and the Japanese translation of the highlighted words. With this interface, students can instantly access voice recordings for new words in any order and can easily replay them for training, as many times as needed.

Playback of recording of the dialog sentences is initiated by pointing and clicking in the white margin in front of each sentence. Recorded voice readings of sentences in English are helpful for hearing practice and for natural English intonation training. Japanese translations, on the other hand, are instrumental for the verification of understanding.

5.2 Image based Printed Interfaces

Pictorial illustrations or pictograms are generally considered as language neutral because they could convey certain meaning without resorting to writing or pronunciation. Printed illustrative materials would therefore be suitable for building interfaces and accessing dictionary content in multiple languages. In Japan, for example, comics books or "manga" are very popular and could be used as natural print-based picture interfaces for language learning. The comics characters could speak in different languages, depending on the learners' mother tongue and the target foreign language.

A multilingual multimedia dictionary for children containing graphical illustrations of all dictionary entries along with pronunciation recordings and translations in Japanese, English, Turkish, French, and Swahili has already been presented in (Barneva et al., 2002). We have expanded its functionality and have developed a print based interface (Barneva et al., 2008) for direct interaction support. The dictionary includes various options like grouping of words in different categories and preview of typical sentences, spelling, related images, and others.

There are also video clips for helping children understand difficult notions and expressions. Word puzzles and multilevel games further support language learning in a natural way and contribute to the relaxing atmosphere during the study. Quizzes for evaluation and self-evaluation of the current knowledge are also available.

5.3 Printed Interfaces for Sign Languages

Entries in traditional printed sign language dictionaries usually contain one or more pictures or drawings of the signer accompanied with a textual explanation. This may be good as a reminder to help recall some signs already familiar to the signer but it is definitely not sufficient for new signs and for self study. Sign language dictionaries and materials for lip reading training could obviously benefit if access to video content is provided. We will continue, therefore, with discussing how the multimedia base of our dictionary could be extended to include sign language video and what influence that might have on the print based interface to the dictionary content.

Some typical entries of a printed American Sign Language (ASL) dictionary describing how to sign the numbers 16, 17, 18, and 19 are shown in Fig.5. Both, the textual part and the illustrative parts of the

entries, could be linked to instructional videos. In this case linking of multiple videos introducing the sign from different perspectives and by different persons may be helpful for improving understanding and retention. To introduce the number signs in different sign languages, however, new printed content would be needed, since the one in Fig.5 is bound to ASL.

Illustrative drawings for signing the numbers from 16 to 19

Numbers 16, 17, 18, and 19 are made by combining the number 10 with 6, 7, 8, and 9. Hold the number 10 handshape inward, and as you move your wrist outward add the second number. Think of these numbers as 10 and 6, 10 and 7, 10 and 8, 10 and 9.

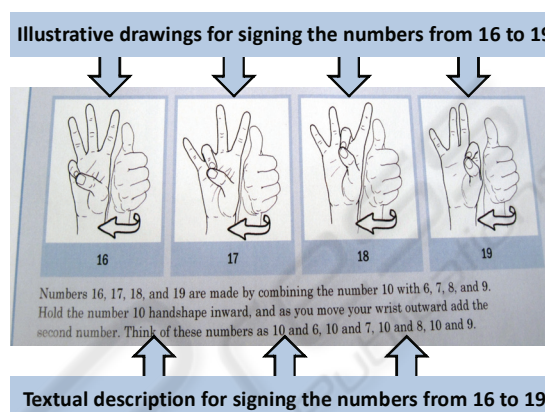**Textual description for signing the numbers from 16 to 19**

Figure 5: Sample number entries in a printed sign language dictionary.

For a successful integration of video support in a multilingual sign language dictionary, therefore, the printed contents need to be carefully redesigned. Instead of illustrating how to sign a word in a specific sign language, the printed contents should include drawings or pictograms capturing and conveying the meaning of the word. This is exactly what we have attempted to achieve with the printed iconic interface to our previously developed multilingual multimedia dictionary for children. We take this idea one step further and consider introducing the word signs not individually, but in the context of short sentences and popular stories (Fig.6). In this way, meanings of target individual words become clearer and easier to grasp by the sign language learners.

We are currently using the Aesop's fable "The Fox and the Grapes" for experimenting with screen based and print based interfaces. The screen interface shown in Fig.6 is accessed through a standard browser where clicking on the pictures invokes the multimedia dictionary entry presentations in a separate window. The page content shown in the browser can be printed on CLUSPI encoded paper and then used as interface control component as explained earlier.

Figure 6: Aesop's fable "The Fox and the Grapes" employed as multilingual multimedia dictionary interface.

6 CONCLUSIONS

In this work we have introduced our approach for providing support for children and hearing impaired persons through multilingual multimedia dictionaries employing video, and screen- and print-based interfaces. We are planning to continue with adding more sign language and lip reading resources from different languages, expanding the story coverage, and providing support for different educational games and other activities.

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