

Study-Buddy: Improving the Learning Process through Technology-Augmented Studying Environments

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Abstract. Taking into account the potential of ICT in education and recognizing the need for smart environments and artifacts, this paper presents Study-Buddy, a context aware system aiming to augment the learning process. The system is constituted of an intelligent reading lamp that monitors students' interaction with reading material and provides appropriate information through any near computational device (e.g., tablet, notebook, etc.). Study-Buddy is accompanied by LexiMedia, an educational software targeted to language learning.

Keywords: ambient intelligence, augmented studying, education.

1 Introduction

Ambient Intelligence is an emerging discipline that brings intelligence to everyday environments [1], addressing users' needs in daily activities. While AmI technologies are gradually gaining focus both in the research community and the industry, traditional ICT technologies have already established their usefulness in several everyday life domains, including education.

Taking into account the potential of ICT in assisting the educational process and recognizing the need for smart environments and artifacts, this paper presents Study-Buddy, a system aiming to provide seamless, context-aware support to students, by monitoring their interactions with reading material and presenting related information in a nearby screen. As a result, students can retrieve information supplementary to the reading material in order to better understand specific concepts or terms. In the context of this work, an educational application targeted to language learning has been developed as a proof of concept of the Study-Buddy system.

2 Related Work

The idea of digitally augmenting physical paper has been an exciting one since the early 90's. DigitalDesk [2] and its successor EnhancedDesk [3] were two of the pioneering digital paper augmentation applications that set up the base for further

inspiration for a number of different approaches and extensions in the next decades. The basic idea of these systems was the utilization of computer vision technology, in order to provide its users with more intuitive interfaces, smoothly linking paper documents and digital documents.

Another approach for paper digital augmentation is PaperToolkit [4], an event-based architecture for creating, debugging, and deploying paper and digital applications. The basic concept of PaperToolkit is to facilitate digital pens and paper to capture and organize information, and issue commands to a computer via pen gestures and paper widgets. Visual or audio feedback is presented to the user on a nearby PC or handheld device.

Finally, A-Book [5] tries to address the missing link between paper and online data, using a tablet in order to capture writing on paper and a PDA that acts as an "interaction lens" or window between physical and electronic documents, enabling further user interaction.

In this paper a smart studying environment is presented, named Study-Buddy, which is targeted to foster the readers' learning process. It is constituted by an intelligent reading lamp that monitors the pages of a book placed next to it in order to perceive reader's gestures and provide appropriate information through any near computational device (e.g., tablet, notebook, etc.), to the reader.

3 Study-Buddy

The aim of Study-Buddy is to provide an unobtrusive intelligent environment that implements a context aware system, in order to augment the learning procedure. The system is composed of a smart reading lamp and educational software, called LexiMedia, aiming to provide dictionary information, as well as multimedia information for specific words, assisting thus in language learning.

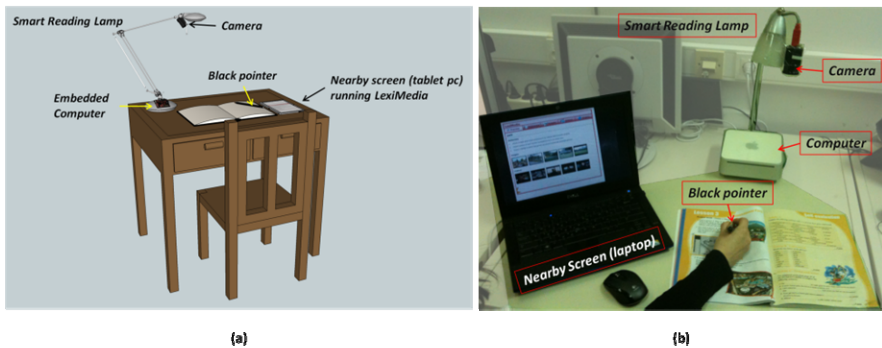


Fig. 1. (a) Study-Buddy setup overview (b) Test-bed setup for the heuristic evaluation

In more detail, the reader's desk is equipped with a smart reading lamp that incorporates a small camera and an embedded computer with WiFi connection, as illustrated in Fig. 1a. The camera of the reading lamp targets to the student's reading area (i.e., the area of the desk where the book is placed). Interaction with the Study-Buddy

system is initiated when a user indicates a word in the book, by using a black pointer (e.g., pen) and carrying out one of the following gestures: pointing at the word, underlining the word or circling the word. From that moment, until the word information is displayed on the user's screen, a number of services are deployed and interoperate, as depicted in Fig. 2.

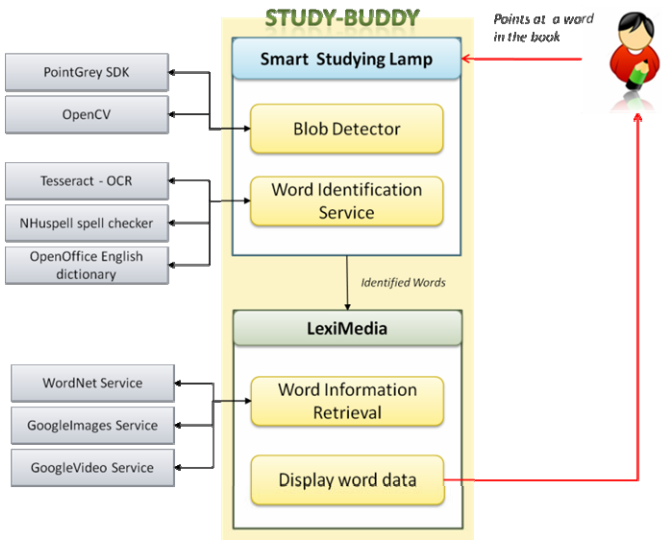


Fig. 2. Architectural Overview of Study-Buddy

Whenever the smart reading lamp observes that the reader needs help about a word or a phrase, it scans the area trying to recognize the indicated words, using OCR software. Then, it collects useful information about the recognized words, such as related images and words' definition. Finally, it transmits the aforementioned information to a near the reader computational device (e.g., tablet, smart phone, etc.) which runs LexiMedia.

LexiMedia¹ can be used in the context of learning a foreign language, or while learning one's mother language as a young student. As soon as the user indicates the word of interest, a preview of the word information is displayed including up to three definitions for the given word, five representative images and five related videos (Fig. 3a). Additionally, dictionary data can be viewed, including all the definitions available for the word, as well as synonyms and examples for each definition (Fig. 3b). Furthermore, users can view a number of images (Fig. 3c) and videos for the specified word, which are retrieved by Google. Additional facilities include viewing enlarged images, playing videos, and viewing the visited words history.

¹ LexiMedia is a composite word consisting of Lexi (which is the Greek term for "word") and Media.

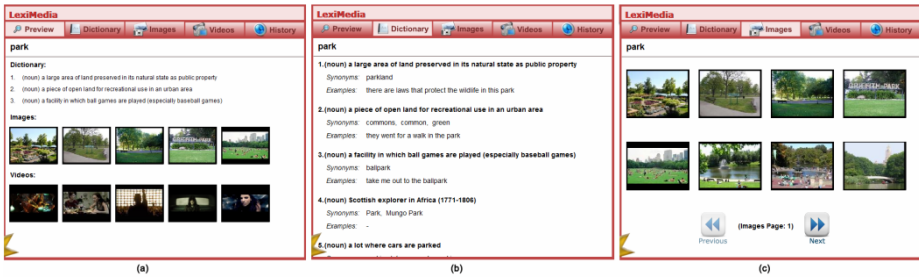


Fig. 3. LexiMedia screens: (a) Preview word information (b) Dictionary data and (c) Images related to the current word

4 Evaluation Results

A heuristic evaluation [6] of the Study-Buddy system was carried out by four usability experts, as soon as a functional prototype was completed. The evaluation process aimed at identifying usability problems regarding the LexiMedia software, as well as the overall Study-Buddy system, examining the supported gestures. For the purposes of the evaluation, a test-bed setup was used (see Fig. 1b), comprised of a PointGrey Flea2 camera, an Apple Macintosh and a Notebook.

The evaluation resulted in identifying fourteen usability improvements and problems that should be eliminated before actual users would evaluate the system. Findings were rated by each evaluator individually on a scale from 0 (not a usability problem) to 4 (usability catastrophe). The most important issues that were identified as major usability problems (average rate > 3) include the following:

- Additional gestures should be supported for indicating whole phrases, such as for example pointing at the first and the last word of the phrase.
- The feedback provided through sound for indicating that the system received the user input (i.e., word to look for) could be further improved with more distinctive and intuitive sounds.
- When a video is playing in LexiMedia and the user indicates another word, the video should be stopped and the new word information should be presented.

The response time from the moment the user points at a word until the related information is presented in the nearby screen varies from 2 to 3 seconds. The overall user experience would be further improved if this time could be reduced.

- The most preferred gesture in terms of usability was that of pointing at a word, followed by the underlining gesture. However, the gesture of circling a word turned out to be the most accurate one, given the blob detector service that was used in the context of the prototype.

5 Conclusions

This paper has presented Study-Buddy, a smart studying artifact which monitors (through a smart reading lamp) students' interaction with reading material, and

provides context-related information in a nearby screen. The LexiMedia educational application that has been implemented in the context of this work provides dictionary and multimedia information related to the word that interests the user.

In order to assess the usability of the proposed system a heuristic evaluation was carried out as soon as a final prototype was available. The evaluation results suggested several improvements, mainly focusing on users' gestures and timely system feedback.

Future plans include addressing the issues that were raised during the heuristic evaluation, carrying out tests with end users, improving the physical construction of the smart reading lamp, and embedding additional educational applications in the Study-Buddy system.

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