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Smart Education Environment System

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Abstract

This paper proposes a Smart Education Environment System (SEES) framework that upgrades the traditional, book-based library to meet the interests of an emerging IT-aware generation. The library will remain as the information center of the university but will also become the base for knowledge exchange using cutting-edge technology. As described in the paper, high-bandwidth wireless technology, social networks, and integrated databases can all facilitate the role of the library, which is to act as a centralized resource in support of research and learning. The framework consists of three sub-systems: electronic bookshelves (for ease of access and management of the book stock); virtual white space (for discussion of information found within the library and, by extension to the whole of the academic environment); and a social network with an integrated innovation database (to disseminate new ideas). The paper shows how these sub-systems can be arranged to support the SEES.

Keywords*: electronic bookshelf; interactive whiteboard; RFID; 60 GHz WLAN; social network*

1. Introduction

Technology integration is usually sparred in the presence of two major ingredients, competition and standard of competency of the technology (1). The real pressure for integration normally will be exerted by the validating or accrediting authorities. If institutions of higher and further education intend to remain competitive, they must ensure effective integration of technology in the classroom environment and within their campuses. A rethink therefore is needed of the teaching methodologies standard to engage with the digitally oriented students in our classrooms. Technology/smart education opens the door to richer learning tools and encourages engagement of innovative teaching techniques

Teaching Integration and Impact throughout engaging students in activities outside a traditional curriculum encourages them to become critical thinkers and problem-solvers. Research-integrated teaching approaches are problem-based, project-led and rely on teamwork, shadowing the way commercial companies undertake a task, and attracting students with a passion for research and innovation. The SEES will generate motivated students who will take their project-oriented and information-intensive approach into regional business enterprises. Creating an innovative learning environment will act as a beacon in the wider world, particularly when dissemination of the beneficial impacts of the system takes place at conferences and in journals.

The traditional library service is faced with a wide variety of demands from current users, especially from researchers and students, and the emerging generation in general, which is more at home with information technology than it is to the world of printed books. At the same time, librarians are highly motivated to meet these on-going changes through the employment of novel technologies and IT methods.

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This paper proposes a framework for an Smart Education Environment System (SEES), which will provide a library with an integrated database incorporating three core sub-systems: 'Electronic Bookshelves', for automating access to the bookshelves; 'Virtual White Space', for the discussion of information found in the library; and 'Innovation and Social Network Database (ISNB)', for disseminating and storing new ideas and concepts, each of which is described in Section II. The benefits of the SEES arise from utilising: the knowledge that exists within a library, the usage patterns (e.g. from exploiting patterns that emerge from library users accessing the books); and the application of advanced wireless technology within the library. Some of the proposed functionality could be achieved by existing wireless LAN systems such as IEEE 802.11n. However, by employing the emerging IEEE 802.11ad standard for indoor 60 GHz wireless [1] [2], ILS hopes to future-proof its development by enabling the low-latency transfer of high-bandwidth multimedia, such as from digital document archives, and high-definition (HD) video. It also intends to exploit such technologies because in themselves they can act as engines for innovation and growth.

The Smart Education Environment System (SEES) research-integrated teaching project focuses upon the development and application of information technologies - a key scientific and technological development priority of these days. Students will benefit directly from using SEES and participating in its research and development. SEES will provide the university environment with smart education services through three core sub-systems.

2. SEES Sub-Systems

The ILS framework, as mentioned in Section I, incorporates three core sub-systems, as illustrated in Fig. 1. The following Sections delineate the main features of the sub-systems.

2.1 Electronic Bookshelves

Will integrate students' familiarity with mobile devices with the latest technology to develop a much-improved educational environment (e.g. virtual browsing of books on the library website). This is a novel idea based at the edge of wireless technology, which uses a 60 GHz wireless network and RFID (Radio Frequency IDentification).

It is first sub-system, which is called 'Electronic Bookshelves', a challenging task to go through the library shelves looking for a book, which might just contain the knowledge for which we are looking for, even if we have the options of previewing the books on the library's website. In addition, the heavy daily tasks of managing the borrowing and return of books, as well as subsequently shelving those books, demands a considerable effort from library staff, an effort that could be directed to better use. As far as the authors are aware, Electronic Bookshelves is a novel idea based upon cutting-edge wireless technology, namely the combination of a high-speed 60 GHz wireless network [2] with RFID [3]. In this way, support is given to a wide range of new library applications. When combined with search algorithms employing semantic and matching techniques, this sub-system will make possible: virtual browsing of the bookshelves; access to book content; and give additional information about books related to the topic in which the user (e.g. student or researcher) is interested. Thus, ambient wireless applications will power the Electronic Bookshelves and register common interests with other users of the library, enabling group working and project collaboration.

In constructing "knowledge sources" from "data", the challenge is to turn data collections into usable knowledge. Meeting this challenge results in an 'Electronic Bookshelves' knowledge base. This knowledge base will not be static but evolve over time in a continuous learning cycle. Furthermore, there is a need to provide methods and technologies to tap into these knowledge sources to navigate, search or access them in various ways. It should also be possible to update the knowledge accordingly instead of simply accessing it.

For the librarians this system will, of course, give a better overview of the current state of the library and provide easier management.

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2.2 Virtual White Space

The White Space is the second sub-system as identified in Fig. 1will be a virtual space where user(s) can use Interactive Whiteboards (IWBs) to create and save novel ideas. IWBs are becoming increasingly important, particularly when they provide the ability for participants to be represented as avatars interacting in a 3D virtual space [4]. They provide a powerful solution for discussion meetings and educational applications, but can also be highly useful for developing ideas. IWBs have been used recently as educational tools to deliver a wide range of computer applications to the classroom or across the internet, where they help to enhance learning systems[5–6] (such as the Smart Classroom proposed by Samsung and Huawei).

According to the authors in [7], IWBs have been used in collaborative modelling as part of a visualization and logic approach. A prompt visualization of a problem can be very helpful in supporting explanations of a complex subject. These types of visualization can be provided for by a digital whiteboard. Furthermore, this interactive learning tool allows users (students or researchers) to "play" with keywords and provide a more enjoyable way to explore complex problems, and produce innovative solutions. Within the White Space the In the White Space the IWB will be supported by a 60 GHz radio for multimedia wireless communication and use of semantic and matching algorithms.

2.3 Innovative Social Network Database

A Social Network and Innovation Database (SNIB) will provide coverage of major innovations in technology, past, present and future. ISNDB is the third sub-system. Data will already be exchanged between users of Electronic Bookshelves, so that a database will be attached to that sub-system. 'White Spaces' has its own database for storage of the ideas emerging from IWB discussions. Nonetheless, technology innovation focuses on designing and developing new products, services, ideas and principles using creative methods and best practices, whereby the ISNDB, the third sub-system, comes into play to support both the other sub-systems. With its distinctive design, the ISNDB is at the heart of the SEES framework, as it will be able to extract different types of data from the Electronic Bookshelves and White Space users, in addition to what is available through suggestions emerging from social networks.

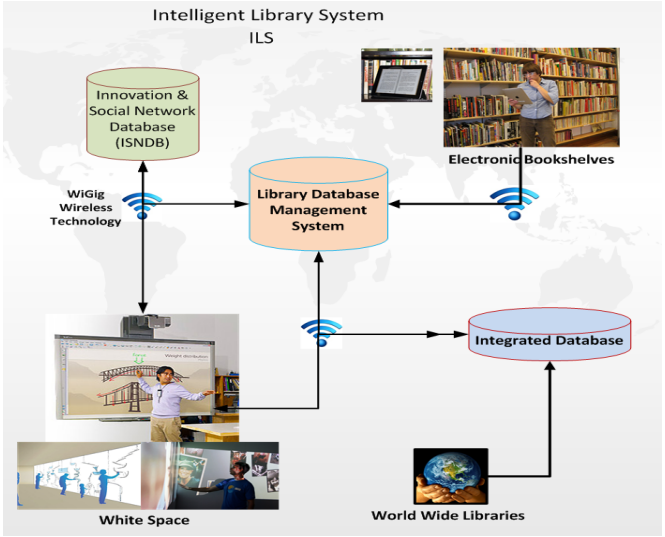

Fig. 1. Sub-systems of

3. Support of Innovation

3.1 Research and Development

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Implementation of the SEES requires extensive research activity in terms of developing the virtual white space and indoor wireless technology. Research and development will focus on IWBs, wireless communication, search algorithms and databases for end-user development and implementation.

The SEES framework goes far beyond the traditional facilities usually provided by a library in which individuals work in isolation and find it difficult to work on a project as part of a team. Teaching can become project-led, which shadows the way commercial companies undertake a task. For example, it follows the practice of technologically-oriented universities such as Eindhoven University in the Netherlands, which is sponsored by Philips Electronics.

3.2 Adaptive Information Retrieval

Adaptive information retrieval [8] covers areas such as search, browsing and navigation over document collections ranging from enterprise search applications to digital libraries. The fundamental idea is to turn unstructured or partially structured data into usable knowledge structures. A range of adaptive algorithms are possible, some of them biologically inspired, that make use of knowledge extracted from documents, from log data, and from click-through information.

What makes a digital library context particularly appealing is the fact that one has access to a range of different input sources. First of all these are structured records that represent metadata, which comes with every single publication (author, title, keywords, UDC classification etc). Then one has access to the full text in a library where most books are available in electronic form. In the first instance, this can be made available using open source software, such as Apache Solar [9], to make this easily information accessible and searchable using keyword search or a faceted search.

In addition, one can also make use of all additional usage data that can be recorded [10] such as information about what people borrow, what they search for (as recorded in the search logs or in the White Space discussions). This will allow additional structures to be imposed on the document collection that allows somebody, for example, to link closely related books. It will also allow the library content to become searchable in a user-oriented fashion, i.e. based on what the users of the library actually do rather than. An application of that would be to make book recommendations similar to the way a company such as Amazon already does. A further advantage of such an approach is that the database can learn relations over time but also forget links as they become out of date.

3.3 Indoor Wireless Technology

Wireless transmission systems allow flexibility in communication and networking between different ILS applications and end users. Under the pressure of a highly competitive open market the number of mobile applications is increasing, targeted at specific areas, providing more flexible services, improved multimedia interfaces, and enhancing data management. Furthermore, some applications can utilize several different wireless technologies simultaneously. The selection of the appropriate wireless technology depends on the number of the users, the types of application, data quantities, and the use of streaming. Streaming within ILS implies that real-time access is needed but requires error resilience and/or forward error correction in a hostile wireless environment to reduce retransmissions.

The ILS framework intends to exploit 60 GHz wireless technology [2], which is highly directional but supports sufficient bandwidth even for transfer of uncompressed high definition video. For example, standardization efforts are underway as IEEE 802.11ad, as well as a number of other initiatives [1], though the implementation of a tri-band (2.4, 5, and 60 GHz) commercial system may be several years into the future. The framework also intends, in its Electronic Shelves component, to use near-field communication (NFC), based on recent smart-phone NFC interfaces. There is additional interest in exploiting Ultra-Wideband (UWB)-based communication with RFIDs, as UWB is short-range but is not noise-limited (as is NFC). RFIDs are more familiar when

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employed as merchandising tags but can also be used within library books as a way of identifying which books are being browsed. For example, a user can gain information about a book by using NFC to the RFID to extract the book's id and hence use the id to connect to online information. Connecting high-bandwidth wireless systems may also lead to the use of an optical network [11], as copper-based networks do not have sufficient bandwidth.

The introduction of such systems will stimulate: the development of traffic modelling within the ILS system, autonomic management systems (requiring computational intelligence) for the library, assessment of quality-of-experience and quality-of-service of its users, and novel applications of wireless-based multimedia, all of which can lead to original research. Furthermore, experience with these advanced wireless systems can lead to technological spin-offs, which in turn act as an engine of growth.

4. Conclusion

SEES represents a way forward in the application of IT and e-Learning to the traditional library. The proposed framework can be cloned with all its elements (as an integrated system) or just the selected subsystem can be replicated in another institution. The Electronic Bookshelves will enable an improved learning experience for students. The Virtual White Space is an efficient tool for the development of novel research ideas. What is quite different about the ILS system is unique blend of software search techniques with the innovatory technology. Moreover, the approach of ILS is not one of individual students working in isolation but collaborative work based around projects. To this end the various sub-components set up the infrastructure to allow that to happen. White Spaces and Social Networks are both enablers for collaboration. The integrated databases, though organized in a structured way, will access as a large logging device for the investigations that take place. The concept is in accord with the current generation's constant use of pervasive electronic media, which is so different from previous generations. To make libraries relevant for the upcoming generation a radical framework of the type outlined is necessary. Future work will refine the planning of the framework to bring its vision closer to fruition.

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