The Magic Door: Smart Interactions between Students and Lecturers using Contactless Technologies

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ABSTRACT
In this paper we describe an information system designed to simplify the interactions which occur frequently between students and lecturers within a Higher Education environment. The concept focuses on utilizing both objects in the physical world and online services to create new experiences to support flexible learning for educational settings. With the opportunities offered by Radio Frequency Identification (RFID) / Near Field Communication (NFC) technologies, tags can be used to identify and perform interactions between users. The system allows for the timetabling of meetings, delivery of messages and course announcements between the students and lecturers. The objective is to eliminate the problems which are encountered when arranging appointments or convening with students. By placing the responsibility of booking appointments in the hands of students using their mobile devices; the system aims to provide an interactive and ubiquitous support technology for both student and faculty members.

Author Keywords
Information Retrieval; Ubiquitous Information System; Mobile; Near Field Communications; RFID Tags; QR Code

INTRODUCTION
With the emergence of RFID technology, mobile devices and increasing network availability; physically-based user interfaces have become a possibility for augmenting everyday interactions. Ubiquitous computing technologies are finding their way into commercial information systems. The London underground and its Oyster Card system (Transport for London, 2012) is an example of a large scale RFID deployment which has simplified users commutes (Konomi et al, 2007). There are commercially available products such as 'Tikitag' (Reid, 2008) consisting of a small USB scanner, rather like the Oyster readers, enabling the use of RFID wireless technology to link any type of offline device such as a sticker or a tag with information online. This includes web pages, web applications or rich online media such as video.

This technology has been demonstrated to produce an improvement in motivation and at the same time a reduction of cognitive demands for learning by information retrieval (Manches et al., 2011). With the current and future climate in further education meaning that students expect continual support, the concept of 'office hours' and supporting learning is important for sustaining the students' engagement with their courses. Delivering information to mobile devices from central information systems, such as virtual learning environments (VLE) and learning management systems (LMS) to support student engagement have been previously explored with positive outcomes (Crane et al.,2012). Furthermore, studies into mobile organization systems within learning environments like have also been investigated with students, (Corlett et al,2005.) with scheduling becoming a major function of the users activity.

Interaction between students and lecturers is one of rising importance with the increase in tuition fees, student's expectations have increased (Littlemore, 2011); requiring a higher level of interaction and an increase in face to face time with their supervisors and lecturers. Distinctly, this problem is two sided with lecturers also suffering from a lack of support when organizing appointments with students. Methods of coordinating such activities resort to post it notes or reminders, as a method of informing students of their schedule and location. Systems such as the Hermes (Cheverst, 2002) have been used in the past, but are costly to install and therefore are of limited availability.

The concept of the project is to create a solution to support course supervisors and students concurrently by positioning an interactive smart poster on the academics office door. By definition, a door in the physical world is "a means of access, admission, or exit"; it can also provide a means of access to virtual areas. By creating virtual interactivity with commonplace physical objects, the hope is to optimize the current system, and sustain student engagement with their courses. The solution would act as an add-on service in order to encourage access to an online diary and information on demand. These micro interactions ideally would be used to leave a small notes/reminders or for students to have a quick access link to retrieve the educator's availability.

This system demonstrates methods of solving the communication problems using a set of low cost NFC tags that can be scanned by a student and which will then update them with the comings and goings of the lecturer whose tag is scanned. The student can use RFID tags to book a slot to meet with the lecturer, leave a message or simply check up on any announcement that has been left. In addition we have added a series of QR codes, providing an alternative method to access the same service for those students who will not have NFC-enabled smart phones. Also, cheap commercial devices are appearing as alternative to mobile phones. Poken allows users to collect people, places and things with a touch (Poken, 2012). All these available products enable different solutions to existing problems for a range of various sectors and industries. Within an educational field, the organization and efficiency of activities can be increased. One example which is explored by this paper is the affixing of RFID tags onto the office door of a lecturer, to consequently; reduce the cognitive demands on the user by associating that lecturer with his room instead of using complex web portal software or calendar software. The user would be able to interact directly using such devices, creating new methods of communication between faculty and students.

NFC CONNECTIVTY & INTERACTION

When computers were first conceived, interaction with these devices was performed via abstract but fairly intuitive methods. For example, the computer mouse requires the user to translate movement on the horizontal physical plane to the vertical plane seen on their monitor. These usage abstractions have now extended to all aspects of the way in which we use these virtual environments. Rather than physically visiting a person or sending a message directly to them we now interact with an email address rather than an actual person. Paul from the university can now be identified as paul@lancaster.ac.uk. These abstractions increase the cognitive demands required by the user to interact with already complex systems.

People naturally think of these systems in physical terms and as such designers have tried to design interfaces with real world analogue. Email has been compared to sending letters; Skype is akin to the 'phone network and File managers imitate folders and documents in an actual filing cabinet. Similarly, when communicating directly using other devices, actions in multiple scenarios can be described as Near Physical Interactions (Nandwani et al, 2010). Being able to transfer information from one person to another by simply touching each other's phone or a tag related to someone, allows for this near physical sensation. The tactile and haptic nature of 'tapping', becomes an informal approach yet meaningful and direct.

Informative Things (Barret et al, 1998) takes this approach further by mapping physical objects to a unique ID. This ID can then serve as a look-up key for a piece of arbitrary information. This system closely follows the idea of hotel keys or identification badges where the cards and keys are physical items that represent other data and are attached to a specific room or person. With the Informative Things system physical objects such as a book or floppy disc can be linked to documents or processes. For example a dictionary could be used to look up the meaning of a highlighted word or the physical hard copy of a document could be used to move the digital copy of the same document, transferring it between PCs. We can apply this concept to modern technologies and use mobile phones, follow a very similar system architecture and logic of managing data. Figure 1 and 2 show how we adapted Informative Things to develop the magic door architecture system.

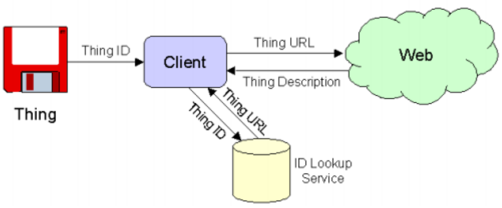

Figure 1. Informative Things

Figure 2. Magic Door Concept

The earlier methods of interacting with physical objects can become extremely complicated. There may be difficulties with passwords, IP addresses, and human error in copying data and spelling errors. Human error is the greatest problem which could lead to loss of data or breach of security and methods had to be developed that would reduce this risk. The Informative Things approach avoids these problems by reducing the concepts into more easily understandable ideas. However this approach requires intensive set-up and has large security concerns. If a physical item mapped with a unique ID, is lost, then the digital item is also lost. Using the physical ID on the doors by using tags, it ensures that whatever device a user may be using they can identify themselves easily.

Others, such as Want and Fiskin have expanded on this concept to bridge the physical and virtual with the use of RFID and wireless networking to create seamless interaction with electronic services (Want et al, 1999) .These approaches improve on Barret and Maglio by allowing for multiple interface mechanisms on one physical object. Their systems are unobtrusive as tags are small and essentially invisible unlike bar codes and other glyphs. One key point of their research is their work on location and tagging items such as tables or doorways to induce context into information systems.

Near field communication (NFC) is a wireless connectivity technology that allows embedded NFC chips to send encrypted data over a short distance to a reader. It was co-developed by NXP Semiconductors and Sony in 2002 and is being added to mobile smartphones for use in mobile payment, data sharing and other applications.

Radio-Frequency Identification (RFID) technologies such as NFC, send radio waves to passive electronic tags to power them and receive a return signal. RFID was first patented in 1983 and in 2006 the Nokia 6131 was the first NFC capable mobile phone. More recent devices include the Nokia C7 and the Samsung Nexus S.

Data can theoretically be transmitted up to 20cm but the practical distance is about a couple of centimeters. As NFC uses a single frequency multiple tags cannot be read at one time and most devices either pick the strongest signal or throw some form of error. The main advantage of NFC over other communication technologies is that NFC does not require any setup. Unlike Bluetooth or WiFi the device does not need any pairing or security setting to communicate with the target. A wave or touch can establish an NFC connection.

THE PROPOSED PROTOTYPE SYSTEM

Figure 2 shows an enhanced approach as a block diagram using NFC. The system proposed, constructed and described uses a Smart Poster containing a series of RFID Tags and alternative QR codes to create the gateway access point to the service. A NFC-enabled phone will be the only requirement to access the services of this magic door. The user would tap a tag, and this would automatically display required information in there screen. The system allows the user to add appointments or send a direct message. A second user could access the services instantly sequentially as a "Tap & Go" action.

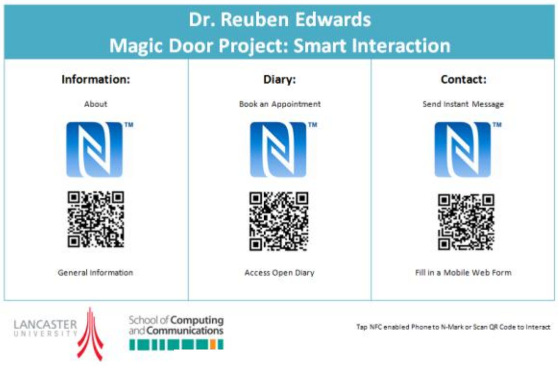

Figure 3. Magic Door Smart Poster

Figure 4. RFID Sticker placed behind N-Mark in Smart Poster (1 of 3)

Figure 3 illustrates the Smart Poster developed for the Magic Door System. It has been split into 3 sections: information about lecturer; a link to an open diary; and a direct messaging service. This allows users a clear, simple and intuitive approach to a lecturer. NFC enabled stickers (Figure 4) have been placed on the reverse side of the poster, mapping the N-Marks, the industry standard logo and universal symbol to identify NFC (NFC Forum). Also, considering the early stage in the deployment and availability of the technology to the end consumers, an alternative has been added to the system using QR codes to access the same solutions with any smart phone. The main difference being, QR codes have to be generated for a specific location, the code redirects users to a website, can take more time and an application is required. Also, these are less effective depending on lighting and users ability to scan the code. The tag just needs to be touched, and contains more meaningful information, and cannot not be marred or damaged and would work in any conditions such as in a dark room. Figure 5 shows a student using the system. That simple touch launches a mobile display in the students phone. Figure 6 illustrates an example of a users phone display after tapping the diary tag or scanning its QR Code.

Figure 5. Student Interacting with Door

Figure 6. Booking an appointment with a lecturer through Magic Door

From a single tap, the diary is launched presenting the user at the current day. Available slots are blank and can be accessed. Clicking on the specific slot required would then display an entry form which the student can fill, specifying a title, description of the meeting, location and time. Once the appointment is saved, the lecturer is notified and it is noted on his/her diary. Similarly if the user decides to contact the lecturer, the same process is followed, but in this case emails are sent or the tag would enable for other messaging services such as a SMS through a safe gateway.

The system improves in many aspects the current interactions by allowing an instant feedback functionality which generates time saving to students and lectures; by not having to write, wait and respond to emails. It also enables the students to physically interact with a lecturer even if he is not present, giving him/her the opportunity to manage the appointment. It is easy to use and intuitive, the implementation costs are very cheap and there is no installation required.

The lectures can manage the tags and QR codes to display what they prefer and adapt the poster to their needs. This solution would compliment what is currently provided in higher education environments and holds the potential to be developed and expanded into more complex services such as declaring attendance or tracking student's interactions with analytics. Real-time interaction mechanisms and similar technologies in education exist. (Hwang et al, 2011). These technological developments relate to existing e-libraries libraries (Chu et al 2010) and Museum guides (Chiou, 2010).

CONCLUSIONS

We propose a prototype system that enables a new way to interact and communicate with lecturers using mobile phone and emerging contactless technologies generating a learning management system where lecturers do not have to be physically present or respond. The students have the opportunity to make arrangements without direct confirmation of the lecturer. Unlike previous attempts, the system is current and can be deployed now without expensive and time consuming installations. Students are able to deliver and retrieve information in context and the service enhances their experience within the higher education environment. The system supports student's organization of learning by utilizing pervasive mobile technologies and by disseminating information from the central information systems to the user's mobile devices. Lecturers have full control of the system, being able to manage public and private appointments and have a pre-scheduled diary without having to worry to plan their days and meetings with students in advance, solving current common issues in academia. The innovative approach using an actual door to enable interactions with the specific lecturer, the mobility and speed of the process all differ in how students are currently able to engage with their educators. Future work requires the evaluation from both students and faculty into the engagement of the users with the system, although fully operational; the system will be extended across differing departments in preparation for a long term study. The goal of the system is to allow learners another extra way to engage in higher education, collect extra materials/hints and stay motivated. Whilst lecturers have a tool they can customize to their needs and engage with their students with different techniques by allowing doors to act as an extra point of contact to deliver relevant information.

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REFERENCES

Barrett, R., Maglio, P.P. (1998). Informative things: how to attach information to the real world. In Proceedings of the 11th annual ACM symposium on User interface software and technology (pp. 81-88), ACM Press.

Cheverst, K., Dix, A., Fitton, D., Friday, A., Rouncefield, M. (2003). Exploring the Utility of Remote Messaging and Situated Office Door Displays. Proceedings of Human Computer Interaction with Mobile Devices and Services (pp. 336-341).

Chiou, C. K., Tseng, Judy C. R., Hwang, G. J., & Heller, S. (2010). An adaptive navigation support system for conducting context-aware ubiquitous learning in museums. Computers & Education, 55(2), 834-845.

Chu, H. C., Hwang, G. J., & Tseng, Judy C. R. (2010). An innovative approach for developing and employing electronic libraries to support context-aware ubiquitous learning. The Electronic Library, 28(6), 873-890.

Corlett D., Sharples M., Bull S. & Chan T. (2005) .Evaluation of a Mobile Learning Organiser for University Students. *Journal of Computer Assisted Learning (*21),(pp. 162–170.)

Crane, L.,Benachour, P. and Coulton,P. A Study of Student Engagement Course Information Delivery Using RSS and Twitter: Mobile Widgets for M-learning, Accepted to International Journal of Mobile & Blended Learning. March 2012.

Hwang, G. J., Wu, C.H.,Tseng, Judy C. R., & Huang, I.W. (2011). Development of a ubiquitous learning platform based on a real-time help-seeking mechanism. British Journal of educational Technology, 42(6),992-1002.

Konomi, S., Roussos, G. (2007). Ubiquitous computing in the real world: lessons learnt from large scale RFID deployments. Personal and Ubiquitous Computing 11 (7), 507-521.

Littlemore, S. (2011). Higher education must prepare for growing student expectations. http://www.guardian.co.uk/higher-education-network/higher-education-network-blog/2011/mar/25/great-expectations Accessed 01.05.2012.

Manches, A., Sharples, M., Cook, C. (2011). Technology in context: summary findings from the Capital Project. In: CAL 2011, (pp. 13-15).

Nandwani, A., Coulton, P., Edwards, R. (2011). NFC mobile parlour Games Enabling Direct Player to Player Interaction. In Near Field Communication (NFC), 2011 3rd International Workshop on (pp. 21-25), IEEE Computer Society.

N-mark. http://www.nfc-forum.org/resources/N-Mark Accessed 01.05.2012.

Poken. http://www.poken.com/ Accessed 01.05.2012.

Reid, R. (2008). tikitag: RFID for the masses. http://crave.cnet.co.uk/gadgets/tikitag-rfid-for-the-masses-49300038/ Accessed 01.05.2012.

Transport for London. http://www.tfl.gov.uk/ Accessed 01.05.2012.

Want, R., Fishkin, K.P., Gujar, A., Harrison, B.L. (1999). In Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit (pp. 370-377), ACM Press.