

Design and Implementation of a RFID Based Prototype SmArt LibrARY (SALARY) System Using Wireless Sensor Networks

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Abstract. "There is a great deal of difference between an eager man who wants to read a book and a tired man who wants a book to read" - G.K. Chesterton

With the colossal collection of traditional and digital including books, journals, audio materials, photographs, e-journals, e-books, web resources and more in recent years, finding an o'nymous item is becoming more and more difficult, resulting in a number of practical conflicts. The accessing and the procurement of the details pertaining to a publication is becoming an ubiquitous problem. Widespread use of wireless technologies paired with the recent advances in the wireless applications, manifests that digital data dissemination could be the key to solve emerging problems. Wireless Sensor Network technology has attracted increased attention and is rapidly emerging due to their enormous application potential in diverse fields. This buoyant field is expected to provide an efficient and cost-effective solution to the effluent problems. This paper proposes a SmArt LibrARY (SALARY) System based on wireless sensor network technology which provides advanced features like automatic update in the addition/deletion of a publication, automated guidance, and item reservation mechanism. The paper describes the overall system architecture of SALARY from hardware to software implementation in the view point of sensor networks. We implemented a full-fledged prototype system for library management to realize the design functionalities and features mentioned. Our preliminary test results show that the performance of this WSN based system can effectively satisfy the needs and requirements of existing integrated library system hassles thereby minimizing the time consumed to find the slot of thou publication, real-time information rendering, and smart reservation mechanisms.

Keywords: Radio Frequency Identification(RFID), Wireless Sensor Networks(WSN), Java ME(J2ME), Context Aware.

1 Introduction

"Books serve to show a man that those original thoughts of his aren't very new after all" - Abraham Lincoln

In recent years, with the advancement of mobile and ubiquitous technologies, invisible micro-computers are embedded in to our surrounding environment. These invisible computers interconnect to our home appliances and mobile devices to provide ubiquitous services to the user. Various applications are developed using ubiquitous technologies and one such application is ubiquitous SmArt LibrARy (SALARY) system. This system is an advanced stage of library systems that enjoy the benefits of a browser-based environment, that incorporates all modules including Circulation, Cataloguing, Acquisitions, Serials and Reporting with visually appealing and customizable interface, where the user enjoys convenient access to thou traditional and digital items, books, journals and more, via the handheld device to access the library management content anywhere and anytime.

Providing the right content to the right person at the right place and guiding them to the exact location of the thou publication, avoiding the derange is a real challenge for any ubiquitous library management system application developer. Many researchers have developed many ubiquitous models and prototypes for various applications. One such model is a TANGO System [1], which uses RFID tags for vocabulary learning, RFID based context aware Ubiquitous Learning System[2], Smart PARKing (SPARK) System using Wireless Sensor Networks [3], which makes use of the WSN with advanced features like automated guidance and parking reservation mechanism, which forms the base to this system and supports in a similar manner.

In this ubiquitous system, each user is provided with a Bluetooth enabled handheld device such as a mobile phone integrated with a J2ME application. JSR-82 APIs are used to develop these mobile client applications. We also require a Bluetooth enabled RFID reader. Whenever the student enters into the library and comes nearby/within the range of the RFID reader with his/her RFID enabled mobile device, the client application running on the mobile device captures the object ID and sends it to the application server for the processing. After the processing is done, the information related to the object are sent to the server application via WLAN network , which determines the user details like name, mobile number, semester, materials relative to the user.

Information regarding the publications, books, journals, and more relative to the thou is composed and sent as an SMS to the user mobile phone. Here it also contains information like the availability of the book/journal/publication (i.e. the status), and other details pertaining to the book/publication/journal. It is assumed that all the users who are using this system are registered to the application. Even if they are not registered, users can register to the system through a simple SMS.

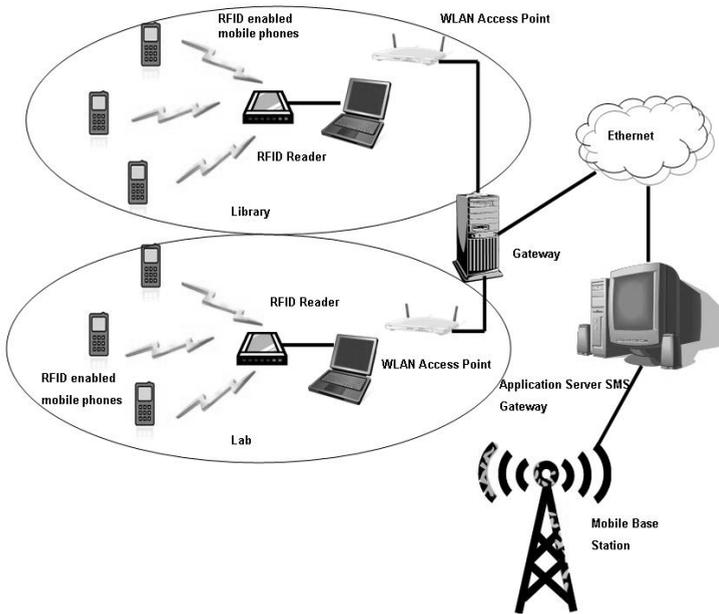
The user can reserve the book/journal/publication via WLAN network through a simple SMS, and also can procure the same in a similar way. This ubiquitous system also contains a WSN which also provides advanced features like automated guidance to the particular slot in which the thus elected book/journal/publication is located in real-time.

2 Related Works

2.1 RFID Based Context Aware Ubiquitous Learning System

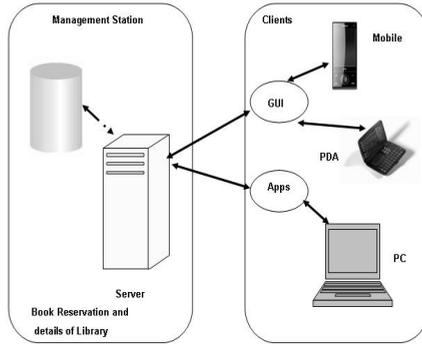
Electronic learning is used to access the learning content using the desktop computers. Mobile learning is an advanced stage of e-learning where in the user is equipped with

the handheld device such as a mobile phone, to access the learning content using various wireless technologies. A new mode of learning mechanism called ubiquitous learning (u-learning) is context aware and also provides anywhere, anytime learning using the handheld devices and sensors. The real challenge is to deliver the learning content to the mobile devices depending upon the surrounding context. Here context plays an important role in delivering the right content to the right device, right person, in the right place and at the right time. This context can be the person who is using the system, surrounding the environment in which the system is being used or the device itself.



2.2 Design and Implementation of a Prototype, Smart PARKING (SPARK) System Using Wireless Sensors

Most of the existing parking management systems rarely address the issues of the parking space management, vehicle guidance, parking lot reservation etc. These systems majorly have control at the entrance and the exit and use vehicle detectors as an essential element to provide smart parking. The widespread use of the WSN technologies paired with the advancements in wireless applications implies that digital data dissemination could be the key for the growing parking challenges. WSN has a great potential towards providing an easy and a cost effective solution to this credible application for various reasons, of which ease of deployment and flexibility to couple with sophisticated but cheap sensors are attributed majorly.



3 System Architecture and Technology

3.1 Radio Frequency Identification

Radio Frequency Identification Technology (RFID), is one of the short range wireless communication technologies used to capture remote object ID using radio waves. Basically it consists of a RF interrogator or reader used to interrogate RF transponder or tag within its radio range. Radio transponders are used to store and retrieve the object details embedded inside the memory of the tag. There are various air-interface protocols used to retrieve the object ID from a distant location. Frequency standards like Low Frequency (LF), High Frequency (HF), Ultra High Frequency (UHF), Microwave Frequency (MF) are being used for developing various RFID applications.

The read range depends on the chosen frequency, orientation of the tag and the reader, working environment and the kind of application being used. RFID can also be used to locate a person or get the contextual information using the electronic sensors and radio tags embedded inside the surrounding environment. This contextual data can be used to provide various services depending upon the person, location, time and the device being used.

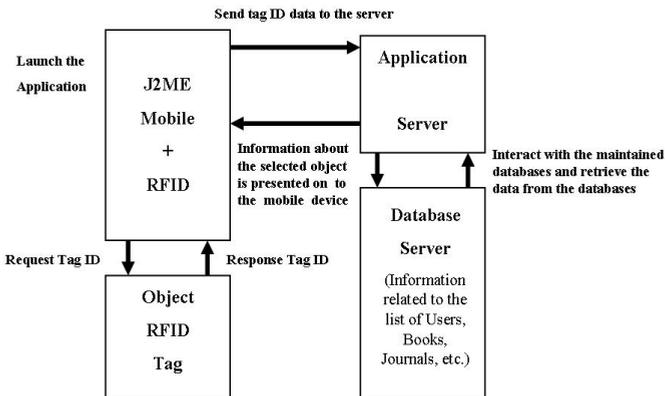


Fig. 1. System architecture of SALARY based Content Presentation

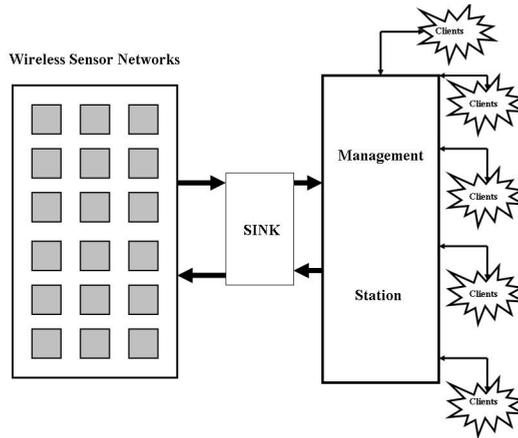


Fig. 2. System architecture for SALARY in guiding the client to the exact location of the item

3.2 Java Platform, Micro Edition

Java Platform, Micro Edition or Java ME is a Java platform designed for mobile internet and embedded systems. It consists of various profiles and configurations like Mobile Information Device Profile (MIDP)[4] and Connected Limited device Configuration (CLDC)[5] as apart of the core architecture. Other optional APIs like JSR-82(Bluetooth) [6], JSR-172(XML Parsing) [7] etc. can be used to develop mobile client applications. Java 2 Enterprise Edition(J2EE) can be used to develop and host server side components like XML files and Servlets.

4 Implementation Details

Mobile client application is developed on J2ME[7] platform. Server application is developed using JAVA Servlets and SMS data is composed from SAX Parsers which is implemented in J2EE. Servlets are deployed in APACHE Tomcat and the user and the objects database is designed using the MySQL[8]. SMS server on Linux platform. Management server is also rigged up for the management of WSN including, Sensor nodes, Sink Node, Guiding Nodes, Status LEDs and the GSM devices.

When a student/ person enters the library, his presence is captured using the RFID Reader located at the entrance of the library block and the RFID Tag ID along with the information related to the student/ person are sent to the server application via WLAN network. At server, user details like the name, mobile number, and the registration number corresponding to the Tag ID are fetched from the database and the contextual information is composed and sent to the user mobile phone as an SMS. Here the contextual information can be his semester, textbooks, journals, reference books and cd & e-journals, also might be the information regarding the attest journals and books, that is relevant to the user in that surrounding context.

5 Results

In this section we present the results of our project with an Application Startup snapshot, obtained after a successful coding and linking of the database and all the

other inter-related systems as mentioned earlier. This result will finally create a .jar/.jad file, which can loaded onto a mobile device and can be run to have a successful communication with the system and the interaction can be done. The snapshot is that of an emulator of NetBeans 7.0.1 IDE/Eclipse IDE.

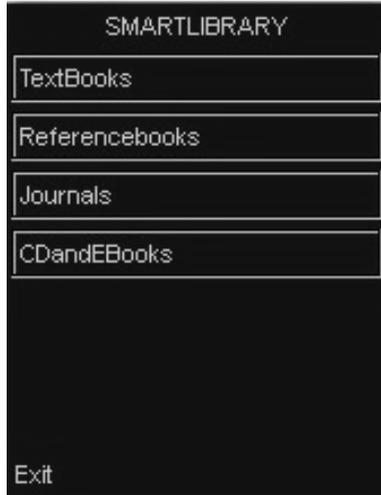


Fig. 3. Startup Application screen snapshot

6 Conclusion

The implementation of the ubiquitous SALARY System is a classic example of using the ubiquitous technologies for a proper management system. Due to the rapid advances in the ubiquitous computing technologies like RFID, large scale deployment of sensor network technologies, the management systems can be made anywhere, anytime, and real-time providing the suitable and necessary services to the client based on the preferences and the context, relatively as given in the table. This is related to RFID based Learning Services Model[2]. The below table describes the future cases in various scenarios of its implementation and the services that are vulnerable with the design of the same.

Table 1. Various learning services corresponding to various surrounding environments

Location	Services
Classroom	Exam Alerts, Marks, Assignments
Laboratory	List of experiments to be done for that day
Canteen	Information about the College Cultural Activities

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