On-line Retrieval and Management System based on Wireless Communications for Schools

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Abstract—**Information keeping and manipulation is vital for any society. This paper aimed at combining the power of wireless communications with the strength of database information keeping through Internet as a media to make it possible to implement an automated record keeping system. The system not only facilitates remote record keeping, but also utilizes very popular devices to do so. The minimal cost and friendly environment of those devices adds to the advantages of the system. The way the system was implemented is by using a wireless portable device that sends a number of requests to Java servlets residing on a Web Server Which will manipulate the data, store it on the database and respond to the wireless devices with required information. The paper uses University Attendance taking as a case study that can be modified to be applicable for any of the record-keeping applications.**

Index Terms—**Automation, Record Keeping and Retrieval, Wireless, GSM, Attendance.**

I. INTRODUCTION

Due to the rapid development in computer and network technology, the use of the Internet has been expanding exponentially. It is now extensively used as a reference tool for personal, educational, commercial, and industrial use. For many years the Internet has been used extensively in browsing homepages, searching for information, chatting, downloading and uploading information. The rapid development of new technologies such as Java, made the Internet an efficient medium that allows monitoring, control, and interaction with machine and devices.

In recent years and due to the revolution in information technologies there has been a great interest in rerecord keeping and retrieval. An record keeping is an electronic system in which records are collected, organized, and categorized to facilitate their preservation, retrieval, use, and disposition may be either, a distinct system designed specifically to provide recordkeeping functionality, or part of another system. A distinct electronic record keeping system will comprise an application program which provides recordkeeping functionality, data and metadata needed for management of the records controlled by the system, and any electronic records managed by the system. An electronic recordkeeping system may be part of another system, such as an application system or an electronic document management system, when the design of that system includes record keeping functionality [1,2].

This work proposes the design and implementation of a distinct electronic record keeping system. The system utilizes the state-of-the art technologies in wireless communications using advanced software engineering approaches.

Record keeping has been used in the core of many management systems. The work presented by Safran [3] implements an electronic record keeping system for patients across all medical hospitals in Singapore. The system utilizes the power of the Internet and database systems. Similar systems are presented for medical applications in [4-8]. The above systems propose solution of record keeping providing records are created and entered manually to the computerized system. Our system automates the whole process; from data entry to report generation.

Among many applications that require record keeping, attendance taking for class session at schools is, probably, the most demanding one. Almost, in all course syllabi instructors highlight the statement "*class attendance is mandatory for all students; multiple absences will affect a student's final grade for the course.*" Currently, most instructors take attendance in a classical way during class session. This task is time-consuming and inefficient, especially for class with large number of students attending it. For online courses, this is an easy task since class attendance is automatically logged whenever a student performs a task on the course page. In general, as the mass of information for a class session accumulates, the methods of organization, storage, and retrieval of that information become extremely important. Florida Department of Education, for example, has made the use of automated record keeping a mandatory on school [9]. The statute in [9] further requires that the enrollment register shows the absence or attendance of each student enrolled for each school day of the year in a manner prescribed by the State Board of Education. Although the system automatically generates various types of attendance and absence reports, yet, instructors enter daily data manually, consuming time and efforts.

Thus, the need fully automated record keeping will be soon becoming a must for several applications [10]. We are not aware of a published record keeping system that is fully automated. In this paper we present a complete implementation for record keeping and retrieval system. We take class attendance as case study for such system. However, it easily can be mapped to any application with similar needs.

This paper is organized as follows. Section 2 presents the system requirements including functional and sites requirements, followed by an overview of the system in Section 3. The software design and development is presented in Section 4. Then a discussion for the implementations is made in Section 5. Results and conclusion is presented in Section 6, followed by the conclusion in Section 6.
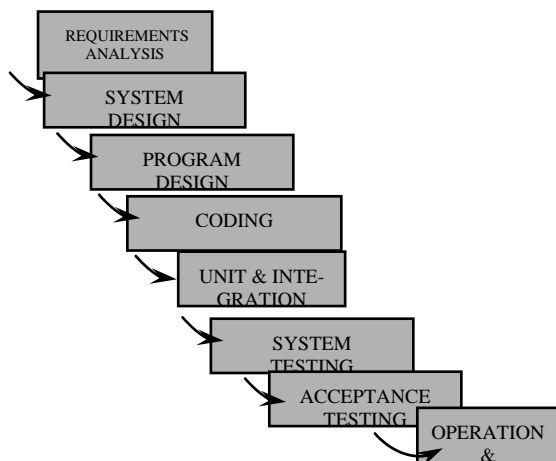

Figure 1. Waterfall model.

II. FUNCTIONAL AND PERFORMANCE REQUIREMENTS

As shown in Figure 1, as the design methodology, we chose to use the software engineered waterfall model because it helps to understand the nature of the system we build. This section specifies the software requirements for the proposed system. The specifications of the system described here are based on the needs of and constraints recommended by experts in the fields [9, 10]. These requirements are as follows.

A. Class Room Site Requirements

− Each student should have an identification (ID) card number that carries a barcode.
− A barcode reader shall capture students' IDs at class room during a class session.
− The reader should work with the existing portable wireless devices that have the capability to connect to the Internet.
− The readings (IDs) shall be transferred to the wireless device.
− The readings shall be sent to the server immediately after every scan, or after a group of scans.
− A reading is sent to the server via a wireless connection.
− In case of remote class, readings are sent via the GSM/GPRS network as a message.
− The instructor should be able to access the attendance system during and after class sessions.
− All clients including instructors and students should be able to submit their requests to the server via Internet browsers.

− Requests issued by instructors shall be able to run on a handheld device.

B. The Server Site Requirements

− The attendance server should stay functional and up all the time regardless of wireless (GSM)   network availability.
− The server should continuously receive the SMS messages sent by all wireless devices from class rooms sites
− The server should extract the request details from the SMS and do the necessary modifications and analysis on the attendance data base.
− The server should continuously update each class profile accordingly.
− The server should automatically generate reports up a request from the client.
− The system shall send the requested information to the client's device via SMS messages.
− The system shall receive messages from clients (students) to inquire about their relevant information.

C. Attendance Database Requirements

− The database should keep track of all users allowed to access the database and their password for authentication purposes.
− The database should keep track of the personal information of each student such as student name, ID, mobile number, region, telephone and P.O. Box.
− The database should keep track of all students attendance for predefined period of time (e.g. one semester/year).
− The class attendance can be accessed at anytime by all authorized instructors.
− The number of class attendance for a student can be accessed at anytime by the associated instructor and by the authorized student.
− The database should be able to support dynamic attendance policy where needed.

Based on the above requirements, the sequence diagrams for the systems are depicted in Figure 2 through 4.

III. SYSTEM OVERVIEW

The automated record keeping system provides an easy and handy way to keep track of those students who miss classes during an academic semester or year. It is aimed at making the attendance taking process an easy and fast one via the use of the Internet and wireless technologies. As shown in Figure 5, all what is needed for implementing such a system includes a barcode reader, a wireless portable device, and a host server. The barcode reader is used for scanning the IDs of students while entering the class room. The wireless device (A PDA in our case) is sued as an intermediate point which establishes a communication link between the class room and the attendance server.   Hence, the instructor is
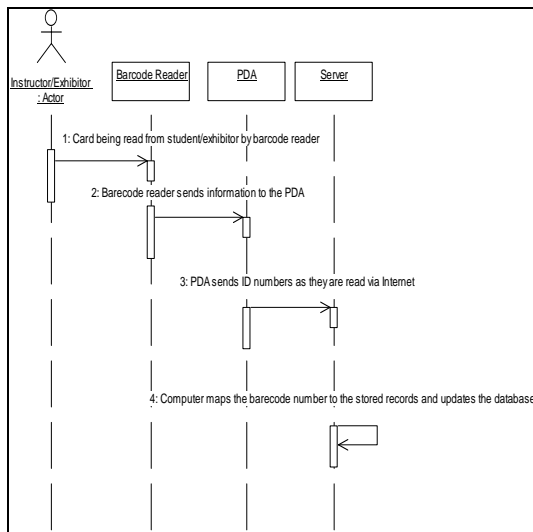
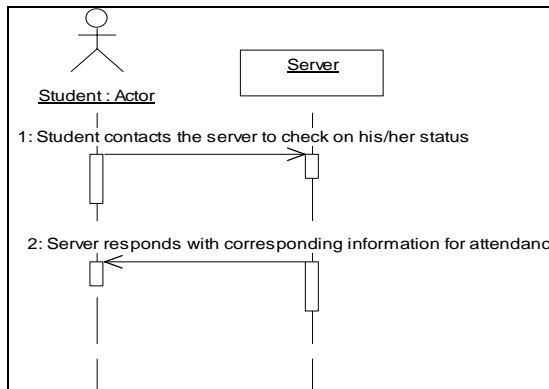Figure 2. Operational Sequence Diagram.
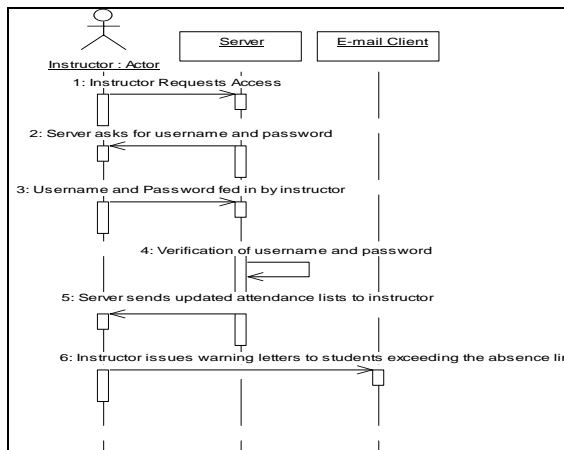

Figure 3: Student's Sequence Diagram

Figure 4: Instructor's Sequence Diagram

required to bring his/her PDA to the class room. It receives the reading from the barcode and, thereafter, each ID read will be immediately written into the main database on the server which is running remotely. Connection to the Internet is established via the card phone installed on the PDA using the PCMCIA jacket or via wireless access points that are present. The mobile

phone shown in Figure 5 is used in case the PDA has no mechanisms for mobile communications. The instructor may check attendance status in-class, or later using a nice graphical interfaced JAVA application that runs on his/her desktop, as shown in Figure 6.
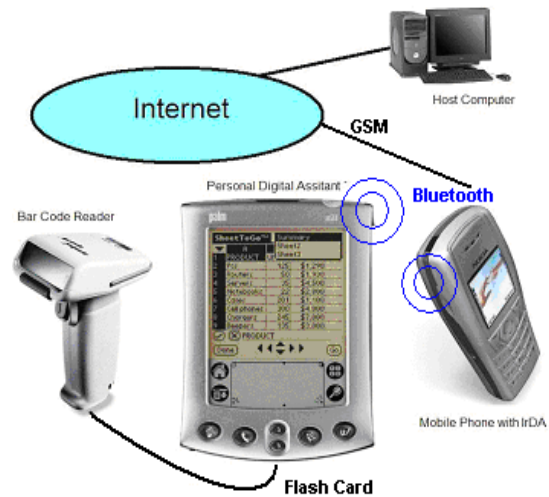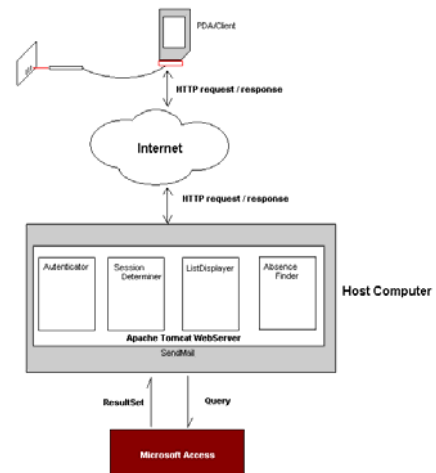

Figure 5. System Components

Figure 6. Client Java-based Applications.

IV. JAVA SERVLETS FOR SOFTWARE DEVELOPMENT

Many considerations were kept in mind while building the system. The initial thought was to have a Java program running on the PDA which requires either Java 2 Micro Edition [11, 12]. Java has been proven as a powerful and efficient tool for real time systems [13-15]. However, since the goal was to make it easy to implement the system on any PDA, the idea was modified. The entire work is done on the server and the PDA exchanges HTTP requests and responses with the host computer. Having done this, the overhead of programming on the PDA was eliminated.

Table 1. Functions of Java components.

Java Component	Function
Authenticator. java	A servlet page to enable user authentication through a login-ID and a password.
SessionDeterminer .java	If the user is granted access to the system, this servlet will ask him or her for the session number.
ListDisplaye.java	This servlet provides the means for inputting the student ID and displaying the list of entered ID's. It also validates whether the entered ID is among the registered ID's of the system.
AbsenceFinde.java	Once ID's are entered, the list is passed to the absence finder that issues the required SQL queries using JDBC environment to determine absent students. It also updates the student absence records and asks the instructor if he or she wishes to send warning letters to students exceeding a certain number of absences. Makes communication through get Data and User State beans
get Data & UserSate	Directly connected to the database and the actual performers for the Absence Finder requests.
SendMail.java	A normal java class that utilizes Simple Mail Transfer Protocol (SMTP) to send the warning letters to the selected students.

The host computer runs a number of servlets and other Java components that reside on Apache Tomcat Web Server [12] to handle the HTTP requests and responses and perform the tasks of authenticating, querying the database and returning back the result to the browser (See Figure 5). There are five different components running on the application server. These are namely, *Authenticator, Session Determiner, List Displayer, Absence Finder,* and *Send Mail.* The first four components are written as servlets, whereas the last component is a normal java class. The function of each component is shown in Table 1.

The interactions taken place between different software components in the system are shown in the following steps and illustrated in Figures 7 and 8.
(1) The Client requests a pass
(2) Authenticator confirms identity from the database and forwards if pass to session determiner.
(3) Session determiner returns an HTML page that asks for session information.
(4) Users selects the required sessions and return it to session determiner for integrity verification

i.e. attendance for this particular session was already taken.
(5) Session determiner forwards the control to List Displayer.
(6) List Displayer asks for IDs' of available students.
(7) List Displayer makes a list of those IDs' and shows the list to the client.
(8) The list is passed to the Absence Finder that will get the student who are absent by comparing the list of attending students and the class list.
(9) The Absence Finder will send back to the client the IDs of absent students. And will ask the client if a warning letter is to be sent to absent students.
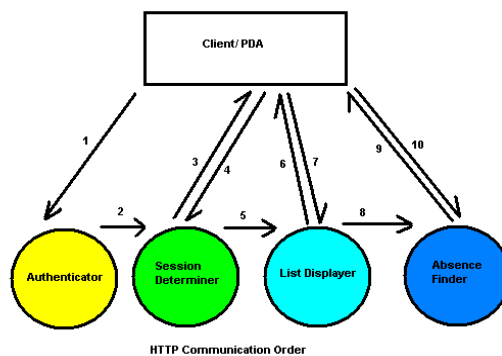(10) The response of the client will be returned to server to be executes.
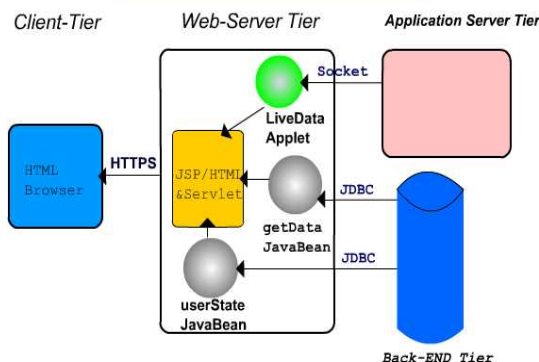

Figure 7. Software Interactions

Figure 8. Architecture of the Software Engine

V. IMPLEMENTATIONS

Moreover, our system was supposed to connect to the internet via a mobile using Bluetooth technology. The initial implementation has included such option, Then we thought of provide an alternative implantation. Thus we decided to use a PCMCIA [16] jacket in which we can either insert a WIFI wireless card that connects to the internet using the available access points or a PC phone

card that connects to the internet using the GSM network. Our approach will not only reduce the hardware tools involved in the system, i.e., mobile device, but will also increase the range that the PDA works on, thus making it a better system for future expansions. However, the use of Bluetooth will make it cheaper to implement the system for small scale applications.

Although GSM was proven to an efficient communication technology in many applications [17-20], the use of GPRS technology reduces the cost of mobile communications. This is mainly because GPRS has higher data rate and carries more information within one packet [21].

For the web server we have used the Tomcat Apache server which is a free and open source developed by Sun Corporation [12]. It is easy to use and provide easy mechanisms for interacting with most of database server including Microsoft access. After dealing with system, we recommend the use of MySQl server for the database since it is an open source and compatible with the Apache Server [12]

VI. RESULTS AND DISCUSSION

Based on the above development process we have built the system with all requirements in minds. The system has been tested and proven to a working tool for school learning process. Figure 9 shows the system waiting for the user commands. Recall that there are two types of users: instructors and students. The instructor can interact with the system using a PDA during the class session, or from the office using a desktop. Figure 10 shows a list of students' names who are absent for a given session.

Another interesting scenario is shown in Figure 11 in which the system displays a list of names who have exceeded the allowed number of sessions that a student can be absent. The system here triggers the instructor to send warning letters to these students in form of email messages. At any time the instructor can view the entire class attendance record for all her/his sections, as seen in Figure 12. However, a student can only check his attendance in the courses he or she is registered in, as see Figure 13
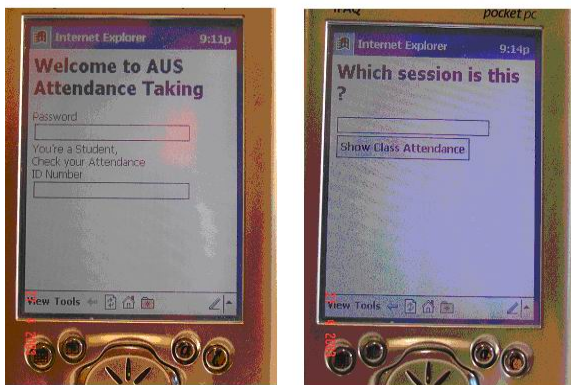

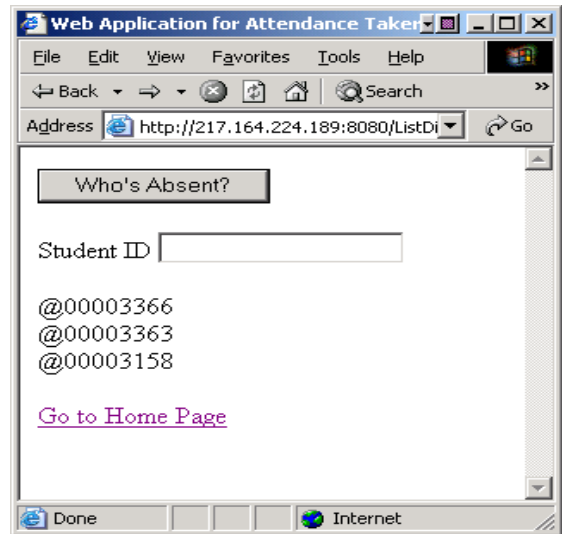Figure 9. Record keeping system on the PDA.
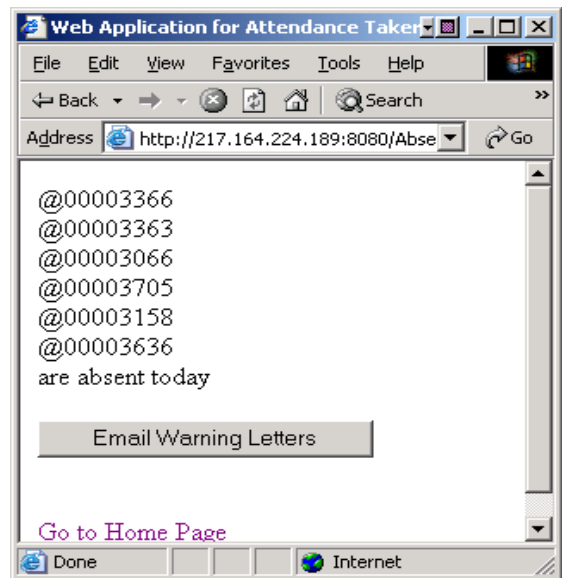

Figure 10. Absent Students for a Session.

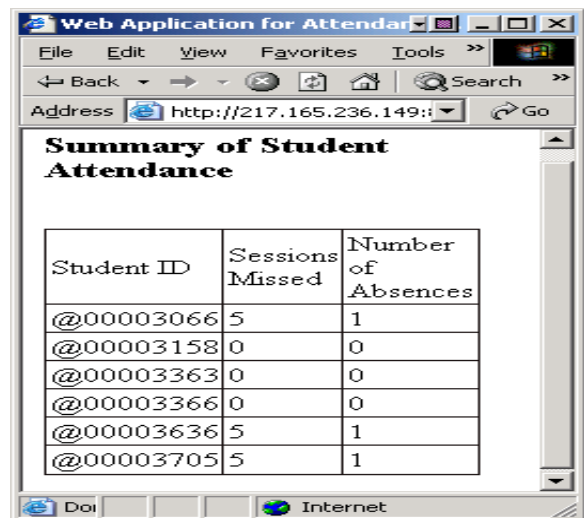Figure 11. Issuing Warning for students exceeding limits.
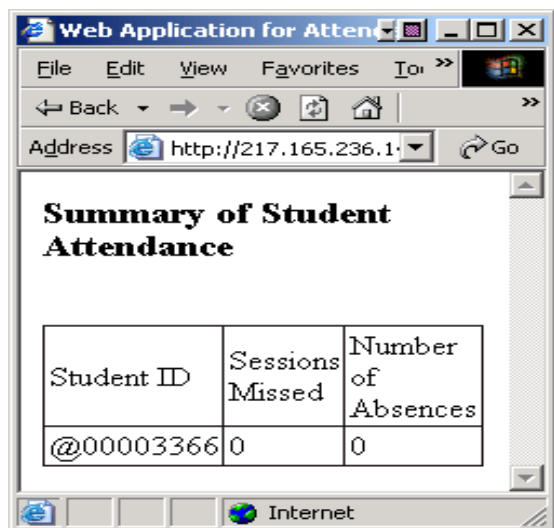

Figure 12. Summary for Instructor.

Figure 13. A report requested by a student.

VII. CONCLUSION

The system designed and implemented in this work fulfills society needs in many fields in instant information retrieval and management. Out objective in this work was after a solution that is easy to install and use, yet powerful and efficient. The main goal was to utilize off-the-shelf hand held devices that are already popular without the need for any external complex circuitry in order to make the system available to society.

The system components include a PDA, a bar code reader (or any other input device that can be interfaced with the PDA), a mobile phone and the host computer running our tool. The software engine, which is a number of communicating servlets and beans, handles HTTP requests and responses from and to the client PDA to retrieve information.

One of the advantages of the system is the optional use of mobile phones and the GSM network to connect the PDA to the Internet which gives it an ultimate wireless power. After the connection is established any database can be accessible by the implemented server. The use of Bluetooth technology makes the connection between the mobile and the PDA very convenient to the user since no line-of-sight is required as in IrDA nor an extra jacket that adds up to the weight and size of the PDA. Moreover, this option allows connectivity even though there is no wireless infrastructure around the classrooms.

The Attendance Taking was used as a complete case study. However, the system can be modified easily to fit a various number of applications such as Business Card Keeping, Traffic Violation Report and E-Supermarket.

REFERENCES

[1] Margaret Hedstrom, "Descriptive Practices for Electronic Records: Deciding What is Essential and Imagining What is Possible," *Archivaria* vol. 36. (Autumn 1993), pp. 53-63.

[2] David Bearman, "Item Level Control and Electronic Recordkeeping", Archives & Museum Informatics, Vol. 10, No.3 1996, pp. 195-245.

[3] C. Safran and H. Goldberg, " Electronic patient records and the impact of the Interent," International Journal of Medical Informatics, Vol. 60, No. 2, 2000, pp. 77-83.

[4] Andrea Jones, Flis Henwood, Angie Hart, "Factors facilitating effective use of electronic patient record systems for clinical audit and research in the UK maternity services", Inyernational Journal of Clinical Governance, Vol. 10, No. 2, pp. 126-138.

[5] Van Bemmel JH, van Ginneken AM, van der Lei J. "The computer-based patient record: an essential technology for health care," Technical Report, Rev. ed. Washington DC: National Academy Press, 1997, pp. 21-43.

[6] M. Abraham, Siikaa, K. Joseph "An electronic medical record system for ambulatory care of HIV-infected patients in Kenya," International Journal of Medical Informatics, Vol. 74, No. 5 , 2005, pp. 345-355

[7] Yen-Liang Lee, " Development and deployment of a web-based physical order entry system,", International Journal of Medical Informatics, Vol. 62, No. 1, 2001, pp. 135-142.

[8] National Institute of Health, website:"http://oma.od.nih.gov/ms/records/rkeeping.html"

[9] Florida Department of Education, "Automated Student Attendance Record Keeping System,", Handbook, 2006

[10] Mohsen Attaran, Ilja VanLaar, " Managing the use of school technology: an eight step guide for administrators," Journal of Management Development, 2001 Vol. 20, No. 5, pp. 393 – 401.

[11] H. Deitel, and P. Deitel, " Java How to program,", 6th edition, prentice Hall, 2005.

[12] Sun site, "http://java.sun.com/

[13] A. Al-li and M. AL-Rousan "Java-based remote," IEEE Transacrion on Consumer Electronics, Vol. , No., 2004, pp. 498-504.

[14] M.Chetty, S. Hu, and J. Bennett, "An interactive Java-based educational module in electromagnetic," International Journal of Electrical Engineering Education, Jan 2003.

[15] S. Deftereos1, C. Lambrinoudakis, P. Andriopoulos, D. Farmakis, and A Aessopos, "A Java-based Electronic Healthcare Record Software for Beta-thalassaemia," Journal of Medical Internet Research, Vol. 3, No. 4, 2001.

[16] Compaq/Hewlett Packard Wireless Solutions: Ericsson T68i/T68 and iPAQ 3870/3970 Bluetooth configuration guide, 2004.

[17] B. Woodward, R S. H. Istepanian and C. I. Richards, "Design of a Telemedicine System Using A mobile Telephone," IEEE Transactions on Information Technology, Vol, 5, No. 1, March 2001. pp. 13-15.

[18] P. Bauer, M. Sichitiu, R. Istepanian, and K. Premaratne, "The mobile patient: wireless distributed sensor networks for patient monitoring and care", Proceedings of the Information Technology Applications in Biomedicine-IEEE EMBS International Conference, 2000, pp: 17 -21.

[19] A. T. S. Chen, "WWW + Smart card: towards a mobile health care management system", International Journal of Medical Informatics", Vol., 57, Issue 2-3, July 2000, pp. 127-137.

[20] S. Pattiches, E. Kyriacou, et., "Wireless Telemedicine Systems: An Overview", IEEE Antenna's& Propagation Magazine, Vol. 44, No., April 2002, pp 143-153.

Nokia 30 GSM Connectivity Terminal User's Guide for modem use, 2002 Nokia Corporation, www.noka.com