

WAP Implementation-Based Telemedicine System for Patient Monitoring

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Abstract— Evolution of internet has linked the entire world and revolutionized the way people communicate and exchange information. A current trend in telecommunication is the convergence of wireless communication and computer network technologies such as Wireless Application Protocol (WAP) devices. Since WAP also be common feature found in future mobile communication devices, it is worthwhile to investigate its use in telemedicine. In 1999, heart disease has been accounted for 30% of all deaths worldwide[8]. They are many patients who died because they failed to detect and diagnosis of pathological symptoms earlier. For these reasons, *Web-Based Telemedicine for Patient Monitoring* has been develop as a monitoring system to monitor the status of patient's health. The parameters involved are electrocardiogram (ECG) and blood pressure (BP). Authorized users can browse the patient's general data, monitored blood pressure and electrocardiogram on WAP devices. This application written in Wireless Markup Language (WML), WMLscript, and Php Hypertext Preprocessor (PHP) resided in a content server. A MySQL relational database has been set up to store the BP reading, ECG data, patient's record, clinic, hospital information and appointment. This system consists of *Apache* server to support the system implementation. Application was loaded directly from server to computer via internet. Data has been successfully retrieved from the database and displayed on the WAP phone. This system shows how WAP can be feasible in patient monitoring and patient data retrieval.

Keywords: Wireless Markup Language(WML), Php Hypertext Preprocessor (PHP), MySQL

I. INTRODUCTION

Wireless Application Protocol (WAP) is a specification and application environment for a set of communication protocol to standardize the way of wireless device, such as cellular telephones and radio transceivers that can be used for internet access[1]. Typical application of WAP include news, games, e-banking, shopping and e-

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mail [2]. WAP will continue to be a common feature in hand-held devices and it is worthwhile to investigate its possible use in telemedicine. The ultimate goal of telemedicine is to provide a quality health care to anyone for medical diagnosis, treatment, and patient care. Usually, it is quite difficult for patients to get latest information about their health status where they need to go to hospital to know their condition. This situation must be difficult for people who are staying far away from hospital. People also need to leave their work and go to hospital or clinic to make an appointment with the doctor.

Hence, A *WAP Implementation-Based Telemedicine System for Patient Monitoring* has been developed to make user access patient data easily and to utilize WAP devices as mobile access terminals for general inquiry and patient monitoring services. User simply need to subscribe WAP data service by using WAP phone. It uses WAP devices as mobile access terminals for general inquiry and patient monitoring services. Users can browse the patients' general data, BP and ECG reading on WAP device in store-and-forward mode. Users also can browse patient record, clinic and hospital inquiry and doctor's appointment.

II. SYSTEM DESIGN

This system consists of five (5) important elements that cover the overall process of the system: WAP, WML, Web Scripting Language, Database and Design of web Page.

WAP programming model consists of a WAP device, WAP gateway and server. Figure 1 shows the architecture for the connection between WAP device and server.

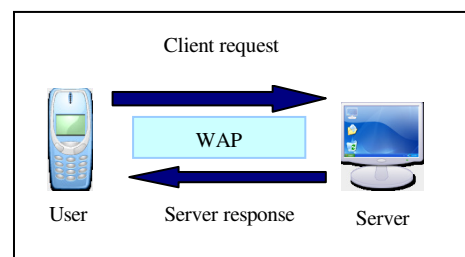


Figure 1: System Design for Client and Server

WAP device communicates with the server; which store information and responds to user's request. The gateway translates and passes the information between the

device and the server. To access an application stored at server, the WAP browser on the device first initiates a connection with WAP gateway. It then sends a request to server through gateway. Upon receiving these requests, the server sends the responding contents, which translates them into WAP format before relaying to the device.

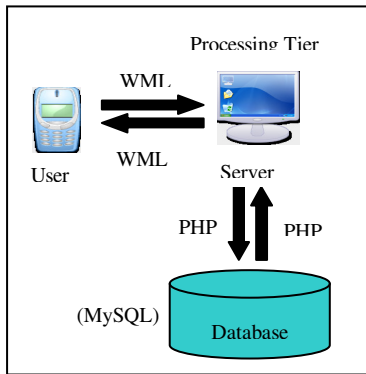


Figure 2: System Design for Client, Server BP Reading, and ECG Data with Database.

Figure 2 shows the connection with the database. User interface was written in WML, and executed at WAP device after it has been downloaded from server. The other part of the application has been written in PHP. All the data are stored in server database. During WAP access, the data are retrieved the application through PHP's database interface.

A. System Design

Figure 3 shows system design for this application where it describes the application that appears on WAP phone that can be accessed by users. After login to the application, the main menu will display patient account's page which represents the patient general data. The patient's data consists of general information which are patient's name, gender, ic number, date of admittance and the address or room number of ward where the patient is registered.

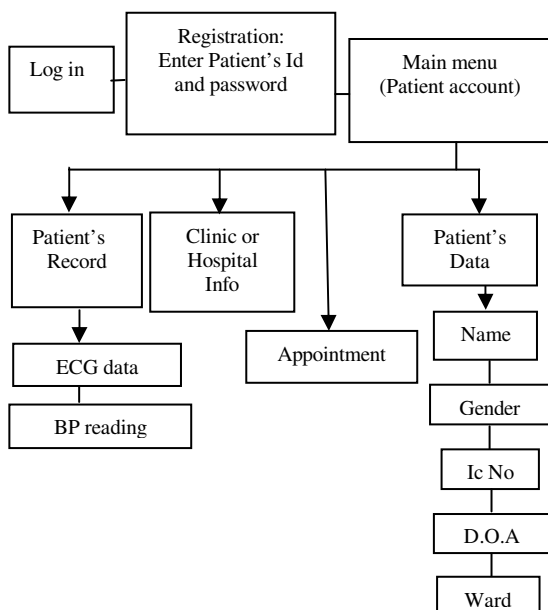


Figure 3: Flow of System Design

B. Database Management System

For database management system, SQLyog software is used to build database. Database created as *patientservices*. It consists of four (4) tables that is use to store all the data. These four (4) tables are named as *patient_data*, *bp_reading*, *ecg_data* and *appointment*. New connection has been created and named as *localdatabase* as shown in Figure 4.

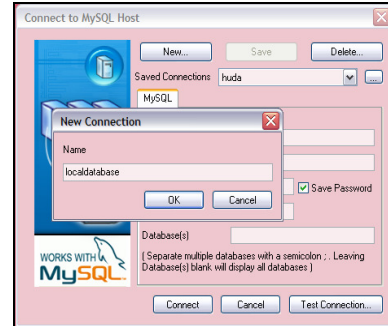


Figure 4 : MySQL Connection

New database file was created and saved as *patientservices* as shown in Figure 5.

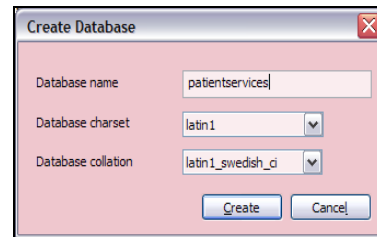


Figure 5: Create Database

Before creating database by using MySQL, it is important to know the system management and understand the *Structure Query Language (SQL)*. All instruction must be done step by step to avoid warning if the system detects an error. Database can be created after the test connection is successful by selecting *create database* in *DB toolbars*. The field was set to *Primary Key (PK)* and *Auto increment* as shown in Figure 6.

Field Name	Datatype	Len	Default	PK?	Not Null?	Unsigned?	Auto Incr?	Zerofill?	Charset	Collation
id	int	20		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
username	varchar	100		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
password	varchar	100		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
name	char	50		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
gender	char	10		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
ic_no	varchar	20		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
doa	varchar	10		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci
ward	varchar	10		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	latin1	latin1_swedish_ci

Figure 6: Create Table

The structure of database system can be explained more by using an Entity Relationship Diagram (ERD). ERD is a model that identifies the concepts or entities that exist in a system and the relationships between those entities. ERD often used to visualize a relational database where each entity represents a database table, and the relationship lines represent the keys in one table that point to specific records in related tables. Each entity will have its primary key and attributes. Figure 7 shows ERD diagram of database for this system.

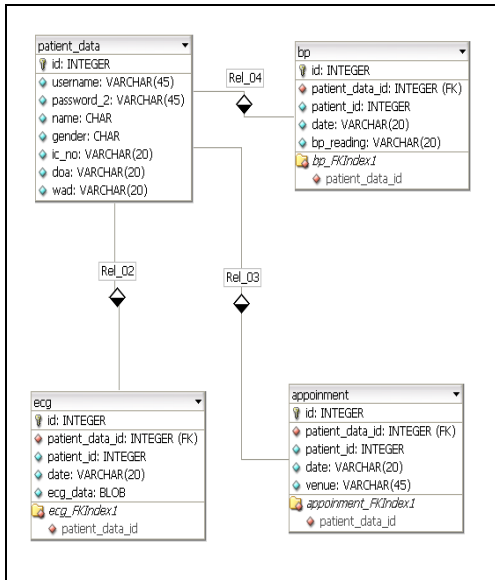


Figure 7: Entity Relationship Diagram

C. Web Site Implementation

Adobe Dreamweaver CS3 is used to design a dynamic web site of this system. Adobe Dreamweaver performs action between client and server site. This software is connected with database which is MySQL while the programming language used for this connection is PHP.

Before starting a new project, it is important to identify a default folder to keep the working files including php's file, image's file and other important files. The project folder has been created at *D:\wamp\www\psm09*. The system is executed by typing *http://localhost/psm09*. A site definition is the essential starting point to the development of any web site. Figure 8 shows site definition wizard for designing the web page.

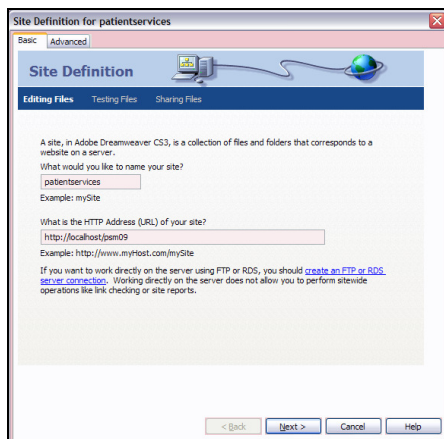


Figure 8: The site definition wizard

While all the value has been entered, the URL should be tested to ensure that everything is working. Figure 9 shows the URL prefix test that was successful. Then, the process can be proceed to the next Site Definition Wizard. Figure 10 shows the summary for this site definition wizard.

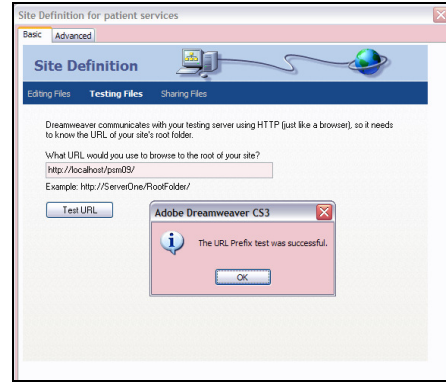


Figure 9: Successful URL Test

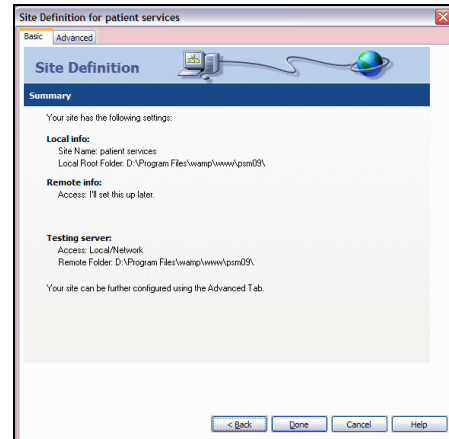


Figure 10: Summary of the site definition.

D. Establishing Database Connection and Recordsets in Dreamweaver.

Contents of database can be viewed through the web table by creating *recordset* in Dreamweaver. Before that, Dreamweaver must created an establish connection file between the web page and the database. Figure 11 shows the MySQL connection with Dreamweaver. This step is only done once for every project. The connections have to be tested to ensure it is successful to connect with the selected database.

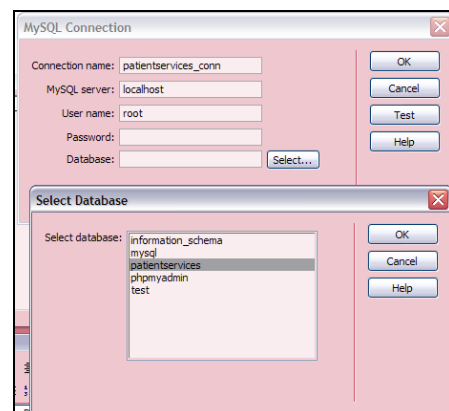


Figure 11: Connection between MySQL and Adobe Dreamweaver CS3

After assigning a new connection, Dreamweaver will create a folder called connection at the site root for the server side including files as shown in Figure 12. The same file is referenced on every page that used the defined data

sources connection. By using a server site which includes file as shown in Figure 12, Dreamweaver provides a one step method for updating the entire page using the same connection in the site.

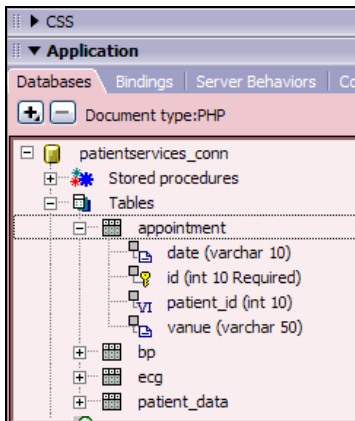


Figure 12: Database Connection

E. Displaying database contents into web table

Recordset is created to view the contents of database into web table. Result in Dreamweaver could be previewed by clicking the *test* button. Figure 13 shows the *recordset* that was created for this system.

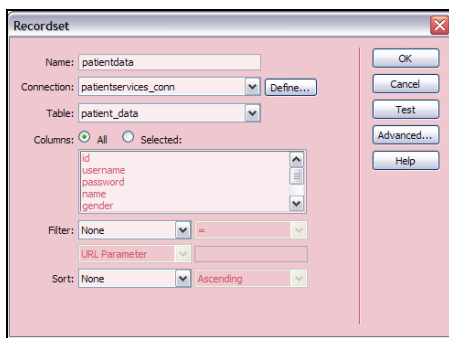


Figure 13: Recordset bindings.

Recordset that has been created need to dragged to the row of web table. This step has been done to bring the data preview into the web table. Figure 14 shows the content from database which is dragged into the website table.

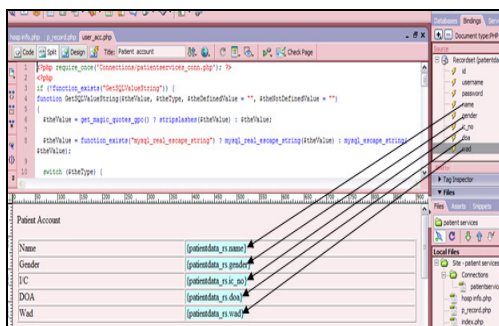


Figure 14 : Drag content from table in Database

For log in process, *recordset* was created to view username and password from table *patient_data*. Log in process was set up to ensure the user access the required data from the system. This process successful if the user

enters the right username and password which match with the data on the database.

III. RESULT AND ANALYSIS

A. Web Interface

All the data and information that appear from this application in the web site is loaded directly from database. The program will process a required data from the user and will responds to the user's request. The web interface for this system includes *home*, *login*, *patient account*, *patient record*, *blood pressure reading*, *electrocardiogram data*, *appointment* and *hospital information*.

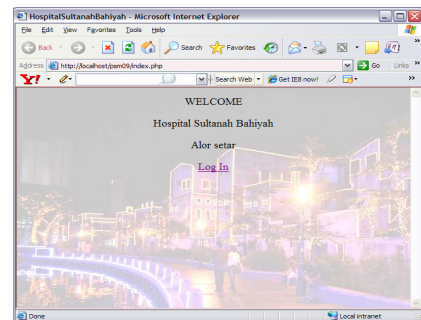


Figure 15: Home Page

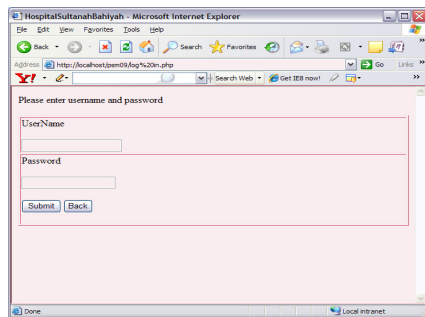


Figure 16: Log In Process

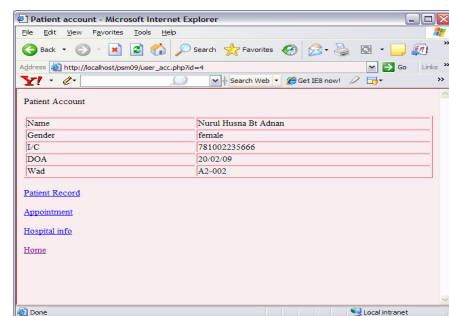


Figure 17: Patient Account

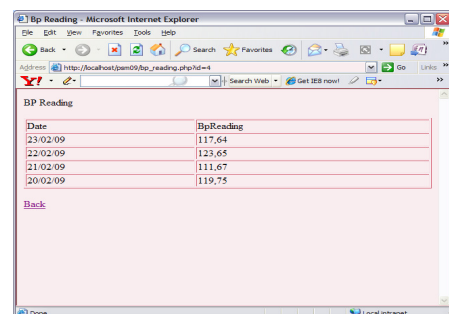


Figure 18: bp_reading

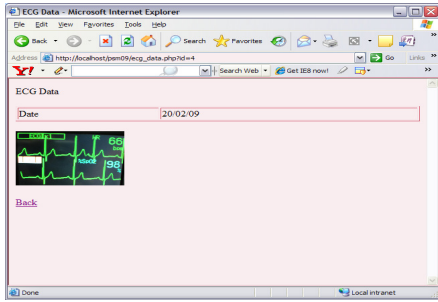


Figure 19: *ecg_data*

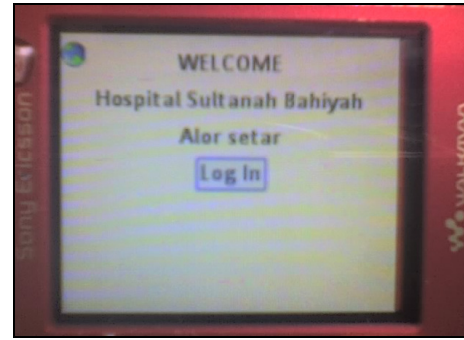


Figure 22 : Home

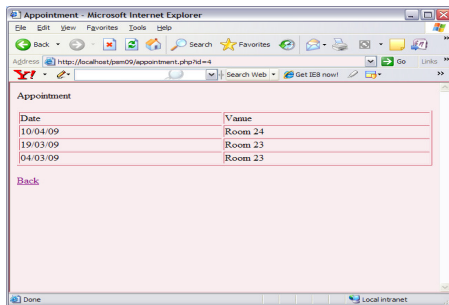


Figure 20: Appointment

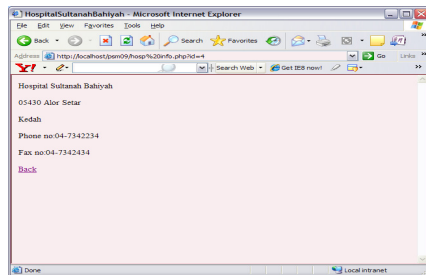


Figure 21: Hospital Information

B. Prototype

The application has been tested by using mobile phone model Sony Ericsson (W660i) which has been loaded directly from server to mobile phone through internet. All the data and information that appeared from this application or at the screen is loaded from the database. The program process required data from the user and responds to the user's request. The WAP browser on the devices initiates a connection with a WAP gateway to access an application stored at the content server. It then sends the request for contents to the gateway, which convert the request into hypertext transfer protocol (HTTP) format for the content server. After receiving this request, the server will send the responding contents to the gateway, which translate them into WAP format.

The screen in Figure 22 shows the first page of the application for *WAP Implementation-Based Telemedicine System for Patient Monitoring*. Users need to select the Log In button to access this system application. Users can use scroll button on their mobile phone to select the required menu.

Figure 23 shows the screen where the user needs to enter a registered username and password by using keypad on their mobile phone. The system will check whether the username and password are valid or invalid by referring to the *patient_data*'s table in database.

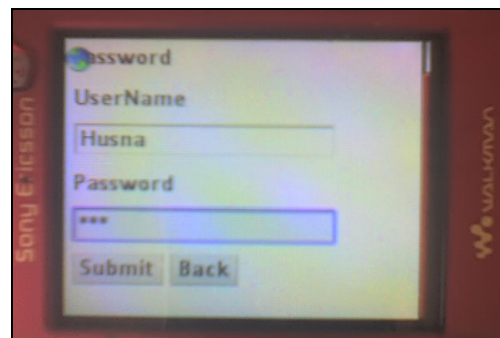


Figure 23 : Log In process

If user successfully enters a valid username and password in *Log In* process, the page will then generate the next page which is *patient account*. From the screen of mobile phone, general information about the patient can be observed as shown in Figure 24.

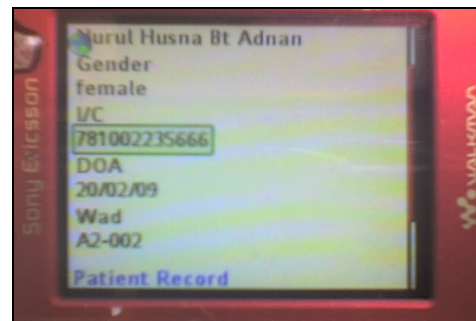


Figure 24: Patient Account

The screen on Figure 25 represents the patient record. There are two menus to be selected from; which are blood pressure reading and electrocardiogram data. There is also a *back* button that loads the previous page.

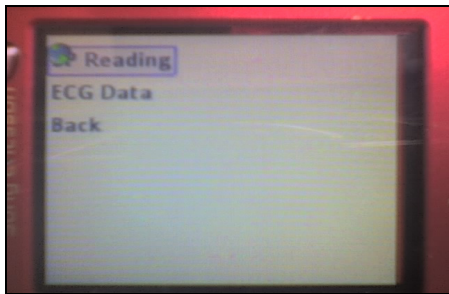


Figure 25: Patient record

Figure 26 shows the screen of blood pressure reading with recorded the date respectively. Users can use scroll button to view the overall data that is unable to be seen on a small screen. The highest data shows the latest blood pressure reading.

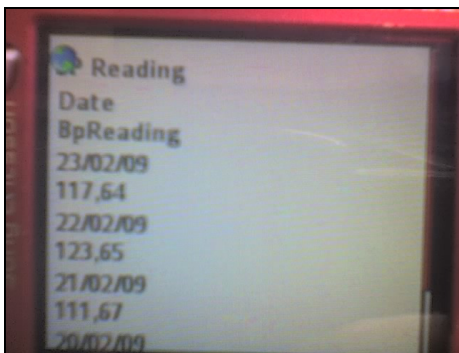


Figure 26: *bp_reading*

Figure 27 shows the electrocardiogram data with recorded date. Electrocardiogram is displayed as image which is saved in database's *ecg_table*.

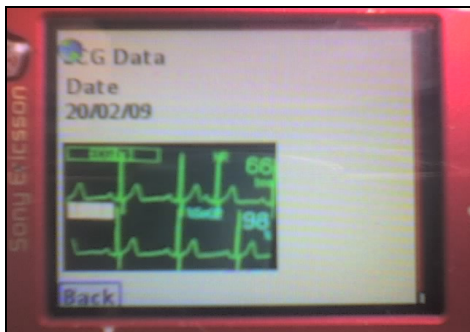


Figure 27: *ecg_data*

Figure 27 shows the page of appointment date. The highest date and venue shows the latest appointment date and venue. Users can use scroll button to view the overall data that is unable to be seen on a small screen.

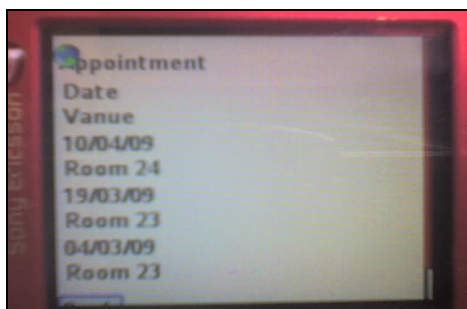


Figure 27: Appointment

Figure 28 shows the screen of hospital information. It consists of the hospital's address, phone number and facsimile number.

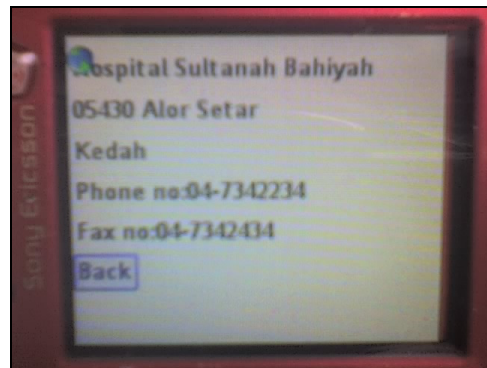


Figure 28: Hospital Information

IV. CONCLUSION

By using this application, patient general data, BP reading, and ECG data will be displayed on a mobile phone. Application will be loaded directly from server to computer or mobile phone via internet. All the accessed and manipulated data are stored in a relational database system. This design demonstrated telemedicine application that uses cellular phones and the internet.

ACKNOWLEDGEMENT

Special thanks to all friends for sharing the invaluable assistance. We also would like to convey thanks to the Faculty for providing the laboratory facilities.

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