

Computerized Brain Database Management System for Radiological Department in Hospital

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Abstract— A computerized brain database management system is designed and implemented to replace the existing traditional largely hand-recorded system in the radiological department of selected hospitals in Malaysia. The new system provides easy access to patient registration, diagnosis, and appointment. It can also collect, calculate and plot statistical data. Thus, it is a useful research tool. The system is applied to identify non-modifiable risks and analyze modifiable risks in brain infarction patients. The new system has higher efficiency in terms of time taken, cost and data security protection while comparing to the traditional hand-recorded system.

Keywords—Database Management System, Computed Tomography, Magnetic Resonance Imaging, Medical Records, Diagnosis, Brain Infarction

I. INTRODUCTION

Computed medical record database management is increasingly important as information and computer technology progress rapidly. Medical records contain treatment history and relevant experiences pertaining to the patients need to be documented accurately and efficiently. In many parts of the worlds, including Malaysia, clinical documentations are still being handwritten on forms and filed into paper medical records. The shortcomings of paper records are well identified, for example, illegibility and poorly organized records may lead to information gaps or inconsistencies, when used by another or even the same user later on. Hardcopies of documents are slow to be transferred around, with higher risk of being misplaced. In addition, when handled by multi-users in multi-locations, the quality of safekeeping can be significantly affected. [1, 2]. The advent of computer technology has introduced enormous possibilities for electronic documentation and usage of electronic medical records.

The motivation of this system is to create a tailor-made computerized brain database management system for the Radiology Department of selected hospitals in Malaysia. This is achieved by studying the existing system and its problems, and then designed an appropriate database system. The work flow of the old filing system is first to create record, on which the diagnosis and treatment report are documented by various

personnel. The report is then filed and stored in the department. This is repeated until the patient is discharged, where the record is then taken out and stored in the Medical Record Unit of the hospital. With respect to the scanning records, the medical images are also stored in the paper folder record.

After the installation of the new system, the database will be used to deduce certain useful information about the brain infarction patients in the hospital. In Malaysia, stroke is the main cause of mortality and morbidity, after heart disease and cancer. Stroke is a multiple factorial disease regulated by modifiable and non-modifiable risk factors. Modifiable factors include a history of hypertension, diabetes mellitus, obesity, smoking and obstructive sleeping apnea syndrome. Non-modifiable factors include age, sex and race. Stroke is known as a cerebrovascular accident (CVA), which is rapidly developing loss of brain function due to disturbance in the blood supply to the brain. Ischemia caused by blockage, or a hemorrhage is known as the common reason for stroke [3].

On brain imaging method, computed tomography (CT) and magnetic resonance imaging (MRI) are the most commonly imaging methods used in Malaysia. MRI has proven to have a better reliability and sensitivity than CT in brain imaging, and it is a proven research and diagnostic tool. However, CT scan is also widely available, being fast, easy, and less expensive than MRI [4 – 7].

II. DATABASE MANAGEMENT SYSTEM

A. Electronics Database Management System

A database system (DBMS) is an integrated collection of data which are maintained in one or more files. It allows user to organize different collection data by facilitating the efficient storage, retrieval and modification of relevant data [8]. An electronics database management system (EDMS) is a computer based software that performs the functions of the DBMS, with the added advantage of speedy and on-the-spot updating of information.

B. Features of the EDMS System

EDMS is a user-friendly application software that enhances the productivity and reliability of the database management system which has the following features:

- **Concurrent use:** The system is a multi-user operating system that allows multiple users to access the application software simultaneously. Radiologists can access the database of patients by installing the software on their computers and performing the database management operations accordingly. Nurses too will be able to carry out patient registration and other related tasks independently.
- **Data integrity:** Data of patients are recorded as structured information in an organized fashion and in a standardized format. Different types of forms are created, for example, patient registration form, patient diagnosis report form or appointment form. Different forms have different requirements of patient details for processing by the doctor or administrator. Consistency and integrity of data have significant improvement in database management. Limitations of such data redundancy will be eliminated.
- **Data persistency:** Cases such as loss of patient personal data or missing confidential reports are often encountered in traditional hand filing systems. Electronics database management system is significantly more reliable in data persistency.
- **Data accessibility and responsiveness:** With the minimum hardware and software specifications fulfilled, the system allows quick access to information for prompt decision making and efficient managing of medical records. Access time to data sets is fast and easy. Instantaneous access is available at a 'click', and the application response time is much reduced.
- **Security:** Medical records of patient are always confidential to protect the privacy and the rights. EDMS provides the security as the correct password is needed before access to database. All end users will have their own account with their unique passwords in order to log onto the system.

by the EDMS. It translates any retrieved data back to the same level as per request by user. The details on schemata are shown as following:

- **Conceptual schema:** Conceptual or logical schema specifies the data stored in terms of the data model of the hospital EDMS. Relations stored in the database are described here. The conceptual schema simplifies the construction of queries, reduces redundancy, and eliminates update anomalies.
- **Internal schema:** This schema specifies how the data are being physically stored and accessed by employing the facilities which provide by the system. For example, the databases of patient diagnosis reports are organized so that the end user can retrieve them in a single operation.
- **External schema:** It describes the portion of the database structure from the point of view of different users or application programs. For example, administrators might not require details of the diagnosis reports. The software application will not only shield them from unauthorized information, but also insulate from making amendments.

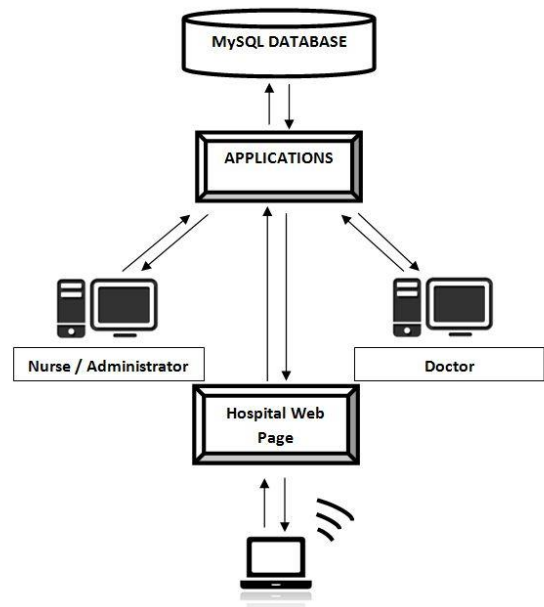


Fig. 1. General diagram flow of EDMS

C. System Module

The general diagram of the EDMS is shown in Fig. 1. Doctors and administrators of the department can access the software. Vice versa, the staff can retrieve the data from MySQL database by utilizing the software application. There is always an interrelated connection established between MySQL database and software application for information storage and information retrieval.

There is also a web based page of hospital designed for the end user group such as patients of the public, and accessible via the internet. The purpose is to publish information such as those related to stroke or hospital staff list, as well as enabling the patient to make an appointment with the desired doctor by filling a form. The appointment request will be sent and stored in MySQL database.

D. Architecture in Schema

The schemata shown in Fig. 2 is the flow descriptions of data. User who requests is expressed on a particular schema and translated or mapped down to request at the physical level

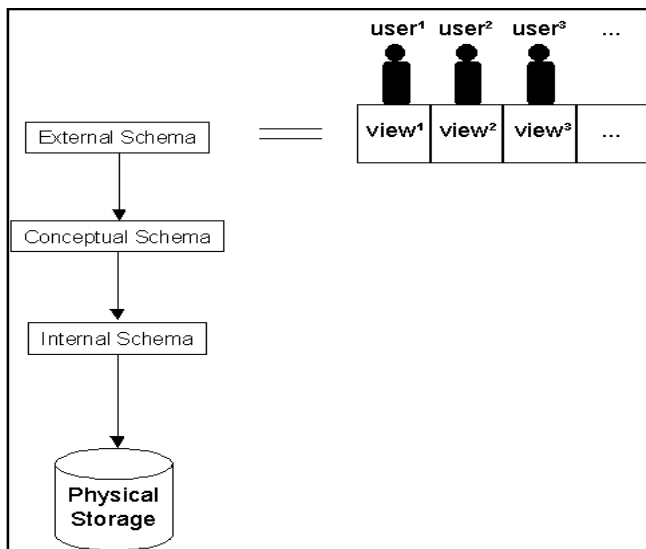


Fig. 2. Three schemata

By employing three-schema architecture, logical and physical data independence is obtained. The system is also a multi-user operating system for three main groups of end users, namely, doctors, administrators and patients or the public users. It enables several users to access to the same resources simultaneously without interferences.

III. MYSQL DATABASE SERVER

Database server selection is a crucial factor in determining the long term success of the system application and maintaining its stability at all time. Before making a decision on an appropriate selection of database server, several influencing factors from different aspects have to be considered adequately. The selected database is required to be suitable for the purpose of usage of end user and full-fill the ultimate objective of end user. Criteria on selection of database consists of scalability, costs/license, efficiency, stability, security, functions, platform supportability, data types and data size limits. To construct hospital database management system, MySQL database server has been chosen to store patient medical record in hospital.

MySQL is a relational database management system which stores data in separate tables, instead of storing all data sets in a single massive storage room. It runs as a server, providing multiple users to access a number of data sets concurrently.

A. Factors considered for MySQL selection

There are several factors considered in selecting MySQL for hospital database management system such as:

- **Cost:** The most obvious cost associated with database software is the purchase price. MySQL is the most popular free relational database management system and eliminating any related costs for the system software. While some users may think that free software should be inferior to commercial product, MySQL has been evaluated in a review in PC Magazine as “one of the top five databases”. Also, training and support materials that are also freely

available on the web as MySQL is being widely used and grown in popularity.

- **Performance:** MySQL database system takes a very less storage in disk space while provides a well performance on UNIX and LINUX system. Although MySQL may fall shorts in consisting less features when comes to comparison with other database system, however its own features and capabilities is usually more than enough to handle system that requires a reliable database. Besides, MySQL has complementary features in many areas. For example, partitioning MySQL provides more options for various type of partitioning as it offers range, hash, key, list and composite partitioning.
- **Ease of use:** The aspects of ease of use include the ability to install the software without difficulties, allows user to maintain the software with minimal effort and problems, and also access the software from remote location. Also, supporting materials and documentations can be acquired easily as a reference tool for end users. MySQL comprises all the aspects stated and hence it has become a fast, robust and a reliable open source system. Compare to other existing relational database management system software, MySQL is relatively easy to install and maintain. Furthermore, with the MySQL Server, there are several GUI management tools provided by MySQL for users to download and use. Facilities such as strong modelling tool in MySQL Workbench helps user visually design databases. For beginner who is starting at the most basic level, there are a number of command line monitoring options that can run to get a handle on general server operations.
- **Security:** Security is a vital factor in database selection process, especially when the software system may be accessed remotely by connecting to Internet. Risk can be minimized if security mechanism is adequately employed. MySQL adopts ample security measures from the very beginning. The advantages in security are to allow user to change the port if it becomes vulnerable. Besides, user is required to update software from time to time to shield them from unwanted users or intruders.

IV. DESIGN OF DATABASE MANAGEMENT SYSTEM

As mentioned in previous section, relational database consists of collection of table and hold the relationship between the tables. Each table consists of specified number of columns or field, but it can hold any number of rows as long as it is less than the maximum number allowed. In this paper, it consists of five tables under one database. The tables are described as following:

- **Patient diagnosis report table:** In this table, medical report of patient is generated according to the fields stated on the table. This allows doctor to have a clear and neat view of patient diagnosis report. Primary key is set to ‘Name’ in this table.

- Patient appointment form: By using the software application, doctor would be able to view for the confirmed appointment of patients. This table includes the appointment number, appointment date and also the start and end time for the particular appointment.
- Incoming appointment form: Requesting clinician can make an appointment by browsing the hospital web page. In order to send the appointment to the Radiologist, the user is required to fill the relevant details on the web. Once it is submitted, data sets will be sent to the database system which enable doctor to see by entering the software application. If the appointment is accepted, doctor will assign a new appointment number and it will be automatically send to confirm appointment list and eliminate from the incoming appointment list.
- Patient registration table: This table stores the registration number, registration date and relevant patient details for check-in patient of hospital. Registration number is suitable to store as primary key as the registration number tends to be unique and non-replicable.
- Staff registration table: This table is meant for the account registration for doctor or administrator who needs to be authorized in order to access the private data sets of patients. It contains personal details of staff, the education specifications and also their working hours in scheduled routine. Moreover, they also required to fill in desired username while accessing the software application and storing password for security purpose. This table also includes 'Title' which referring to the identity of the staff, as whether user is a doctor or administrator.

In constructing an integrated and user friendly EDMS, there are number of application system structure that have to be created. To manage a database of the radiology department, the management requires an administering system to supervise and manipulate the patient data for daily basics. For management system, it is integrated with the department database to retrieve or store information and interface with online appointment system available on hospital webpage for patient or public as shown in Fig. 3.

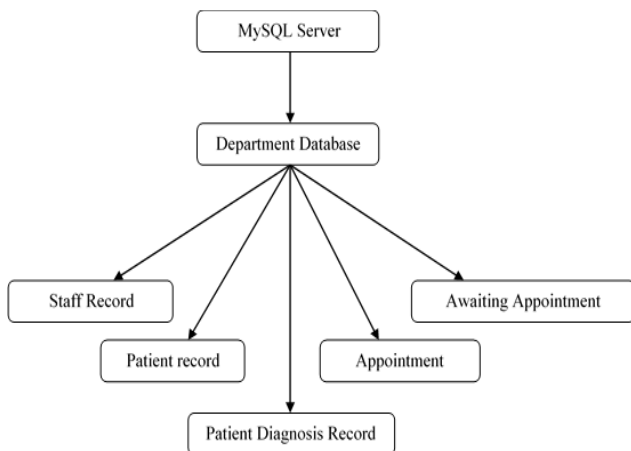


Fig. 3. General structure of radiology department database

Firstly, to access the EDMS, the user must have an individual account with unique password for authorization purpose. The first step for the staff login system is to choose whether the user is doctor or administrator. Doctor will be directed to specialized application software which mainly manipulates the database of medical reports, statistical analysis for current patients and database of appointments. However, nurse or administrator will be directed to manage the check-in patient record on registration database.

After the user identity selection has been done, username and password for application software is required to insert for validity verification. If the username or the password is incorrect, the system will automatically prompt a warning message to indicate an invalid password or username has been inserted. Once the username and password are corrected and verified, different identity of user will lead to respective application page to perform the individual operation. The management system is divided into two main panels; the doctor and the nurse or administrator. Each is given different usage and operation. This division ensures that only the authorized doctor has accesses to change the diagnosis report, thereby also preserving the privacy of the patient. The nurse or administrator is only permitted to view or edit the personal account information for the purpose of monitoring the movement of the patient.

V. RESULTS AND DEMONSTRATION ON DATABASE MANAGEMENT SYSTEM

Firstly, the user is required to choose their identity or position in the radiology department. Next, usernames and passwords are compulsory for access. The system will prompt an error message if an incorrect username or password has been inserted. Fig. 4 shows the login page.

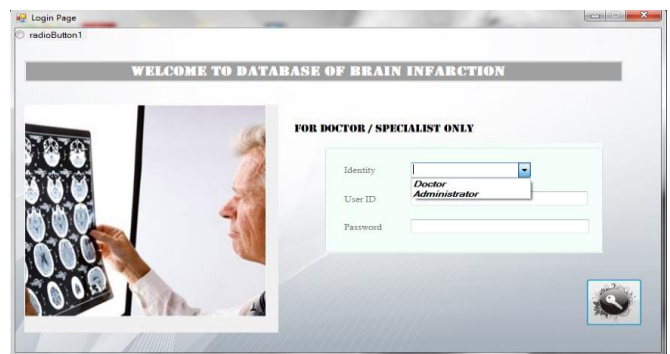


Fig. 4. Screenshot of login page

If the user is identified as an administrator or nurse, the user will be directed to the interface form as shown in Fig. 5. They are mainly responsible for patient registration and staff registration with modification of data being allowed. Notice several buttons at the left allow insertion of new patient data or their subsequent modifications. In this way, the latest version of patient data will always be available.



Fig. 5. Screenshot of patient registration interface

Fig. 6 shows the interface of the user account setting for modifying or updating the latest personal information. The username and password can be changed anytime.

However, the doctor will be led to a panel of different pages and the user may enter into the desired page by switching to a different tab on the left side of the designed interface. After login, the user will be led to a home page which consisting of a calendar and a welcome message. The doctor can study on the diagnosis data of a patient in 'Patient Management'. User is allowed to insert a new report, edit or delete an existing report. A search box is at the upper right of the interface and it allows the immediate search of a particular patient within the list view as shown in Fig. 7.

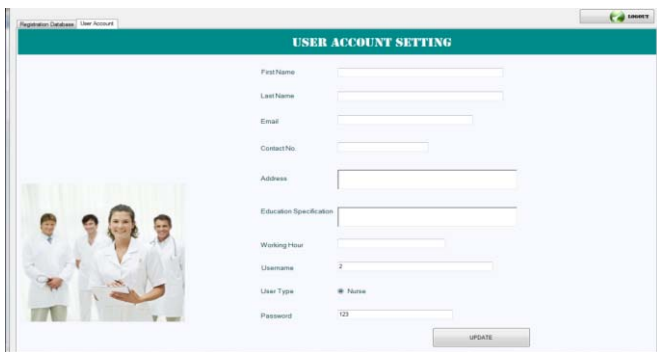


Fig. 6. Screenshot of user account setting interface

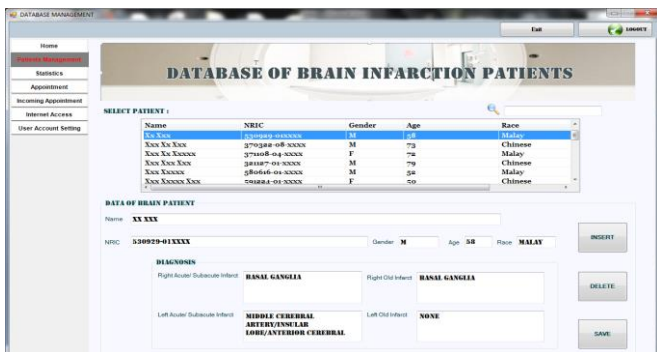


Fig. 7. Screenshot of database of brain infarction patient

The system will automatically extract information such as gender, age, race and infarction territory to calculate and perform a statistical chart in the 'Statistics' page for doctors' viewing and analysis. The statistical data are displayed on a pie chart as shown in Fig. 8.

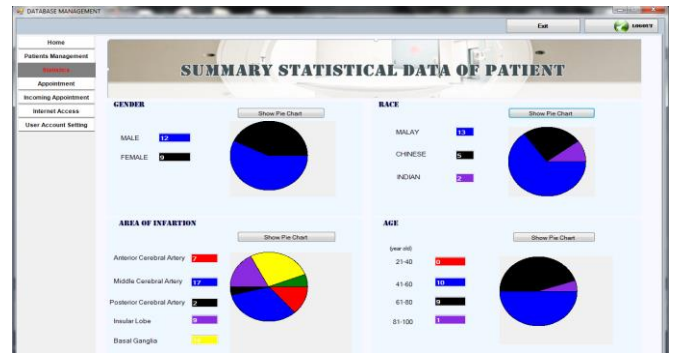


Fig. 8. Screenshot of statistical data of stroke patient

The doctor is also able to manage appointment of patients by viewing it in the list view or insert, edit and delete appointment in the interface. Moreover, from the list view, a selected appointment can be sent via an email as a reminder. Thus the feature is a convenient and efficient way for a doctor to keep his appointment when he is away but accessible to the internet.

The doctor will be able to see the appointment allotted to the patient by the radiologist. This interface stores the data and information of an appointment which can be accessed by the public user or the patient at the hospital web page. If doctor has an appointment request, he is required to insert the appointment number and time and hence, it will then be sent as a query in 'Appointment' interface after this appointment has been confirmed. However, doctor can reject an appointment request by deleting it or contacting the patient through email. There is a 'refresh' button at below that allows refreshing to view the latest appointment request.

Lastly, modification and update of the user account setting is also allowed for the doctor. Most of the function is similar with the user account interface of the nurse or administrator. However, the doctor is permitted to register a new account for a new doctor or nurse, which cannot be done by a nurse. This is to ensure that only authorized staff is permitted to register a new account to access to this system and control the access verification for system user.

VI. CONCLUSION

An electronic medical record database for data collection, storage and retrieval system has been successfully created. The benefits of utilizing this system is realized in reduced cost, enhanced efficiency, reduced start up time and improved security protection towards confidentiality of patient medical information. Clinical data accessed by different identity such as doctor and nurse has fulfilled the requirement of authority, legibility and accuracy. Furthermore, this system has integrated statistical analytic tool which can assist doctors in research of stroke easily and clearly.

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