A New Tool To Record And Evaluate The Radiologist's Findings With Specific Design For Malaysian Women

M Al-qdah, A Ramli, R Mahmud

Citation

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Abstract

A new powerful tool for recording and evaluating the radiologists findings has been developed. The system will help the radiologist to monitor his or her accuracy of detecting breast cancer over a specified period of time by giving the sensitivity, specifty, and ROC curves analysis. This tool also gives other useful information including statistical measures for the number of patients under one of the three main race groups in Malaysia: Malays, Chinese, and Indians with their correspondence for each patient to one of the five breast type classifications used in this study: Fatty, Minimally Fatty, Intermediate, Dense, and Moderately-Dense as classified by an expert radiologist at University Putra Malaysia and Hospital Kuala Lumpur Malaysia and based on a similar breast imaging reporting and data system (BIRADS) classifications. In short, the Client-Server tool for recording and evaluating the radiologists findings is indeed a very useful tool for the usage of either public hospitals or private hospitals.

I. INTRODUCTION

Breast cancer is one of the most common cancers for women in many countries including Malaysia. Women across the world have variations in breast cancer tissue cells depending on their body size, diet, reproductive characteristics such as age of menarche, number of children, and age of menopause. Existence rates vary from one race to another; higher rates of breast cancer have been reported in white women more than in black women [$_2$]. A study done by University Malay Medical Center in Kuala Lumpur (HUKL) in the year 2000 has shown that 60% of 952 cancer patients admitted to the UHKL in the years 1993 to 2000 were Chinese patients. It was concluded that the incidence of breast cancer in Chinese appears to be higher than the other two races, namely Malays and Indians. Also according to 1996 report of the Penang Cancer Registry, the estimated occurrence of breast cancer in Malaysia was 27 per 100 thousand population with 2700 cases each year. Breast cancer was seen to affect mainly women of ages 45 to 64 years old, and is appeared to be predominant among Chinese women with 28 cases per 100 thousand population followed by 25 cases per 100 thousand population for Indians and 16 Malay cases per 100 thousand population[$_1$]. The current radiologist detection tool of breast cancer in hospitals is through mammography.

In a mammogram image, radiologists try to distinguish normal from cancerous tissue by looking at shape and density of an up normal mass in a tissue area. Usually the malignant area is characterized by indistinct border-shapes. For early detections, radiologists try to identify micro calcifications and usually the clustered ones of them as indicators of cancer (malignant). Micro calcifications usually appear in clusters with very sharp edges, irregular shapes, and very small size and they are believed to be the first signs of breast cancer [$_2$].

Computer aids to mammography have been employed for automatic and manual computer detection of Mammograms cancers with some difficulties. The mammograms are images of high resolution and low contrast. There is also a great variation in the grayscales of different mammograms. In some mammograms cancer indicators are easily seen as white spots on a dark gray background, while in other mammograms they are visible as brighter gray spots on a slightly darker gray background. There may also be other bright regions not associated with cancerous regions, which makes straightforward methods applied to other medical images inappropriate for detection of cancerous regions. Therefore, in mammography because the contrast between the whole soft tissues of the breast is minimal and small change in the breast tissue structure can mean malignant breast tumor, medical image feature enhancement for proper mammogram interpretation techniques are usually needed to

emphasize certain feature that are clinically relevant and are not easily visualized under normal viewing conditions for example the normal x-ray images.

For a radiologist interpreting a benign mammogram from a malignant mammogram there exists an extremely wide variation in the mammographic appearance of the breast. Within the mammogram, radiographically visible density includes ducts, lobular elements, and fibrous connective tissue. The fibrous connective tissue can be of two types, intralobular or extralobular tissue, and this latter tissue type is seen as the major component of gross density variation in mammograms. Breast density is an important factor in the interpretation of a mammogram. In a breast that is considerably dense, the sensitivity of mammography for the early detection of malignancy and large cancers is reduced because of the difficulty in locating ill-defined cancers within an opaque uniform background [3]. The American College of Radiology (ACR) and Breast Imaging Reporting and Data System (BIRADS), identifies four major groups for classifying breast density [3]: predominantly fat, fat with some fibroglandular tissue, hetregeneously dense, and extremely dense. For this study a new but similar classification has been adopted which classifies breast tissue density into five groups. Earlier statistics show that radiologist tend to miss 30-35% of detection. Therefore, a system of recording the findings of the radiologist followed by evaluating the radiologist is needed.

The system in this study was developed using Java programming language which is platform independent object oriented programming language that provides good networking support through add-in libraries. This results in extremely efficient and easy implementation of networking programs. The system also uses a client-server DBMS. The basic setup consists of a client (or several) making requests for information from a DBMS that resides on a server in the network. The client will then receive the requested data from the DBMS and present it to the user in some format. The server handles much of the workload and has to compete with such issues as Concurrency Control, Security, Data Integrity, etc. Unlike stand-alone databases, the client-server database must deal with a network to transmit data to users.

The JDBC-ODBC Bridge is a Two Tier approach that uses JDBC function calls to access the database. However, before these calls are transmitted to the DBMS they are translated to an ODBC function call by the Java JDBC-ODBC Bridge. This enables Java client programs to use existing ODBC drivers without any additional effort or cost. Because almost all databases provide ODBC compliance this bridge between standards is a very useful feature in the language [6].

II. MATERIAL AND DISCUSSION

Malaysian Radiologist Records and Evaluation System is a system for recording and evaluating the diagnosis of the radiologists. It involves a Client and Server sides. The system is separated into 3 modules: Radiologist Module, director module and administrator module. The main features of the software are: establishing connection between the client machine and server machine, building secure multiple user interfaces, and providing accurate Receiver Operator Curve (ROC curve) representation and statistic for evaluating the radiologist's findings.

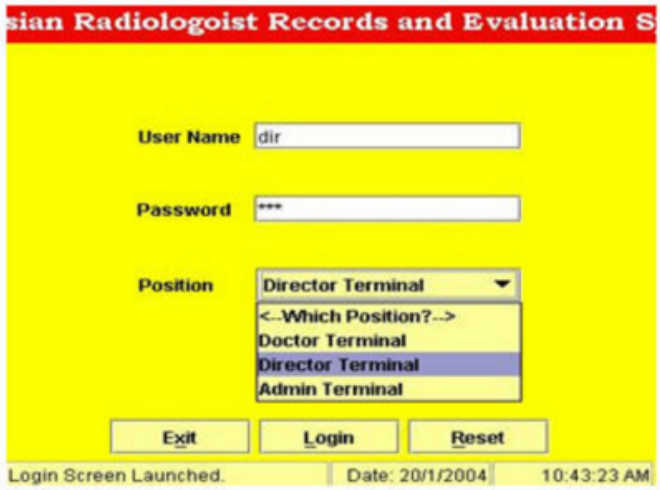
This system integrates a security that allows the radiologist, the director, and the administrator parties to log in separately. The main functions for this system are for the radiologist to use the application on the client side to key in the patient medical data then the server side will use the given parameters based on the inputs of the radiologist to produce an accurate evaluation results. The hospital director can access this system via the client side to review the evaluation of all the radiologists' diagnosis in the system. The administrator can log in to perform maintenance on the patients' information and the radiologists' accounts.

Therefore, there are three types of login account available in the system:

1. Radiologist: add new diagnosis, examination and view only his personal evaluation statistic (tab pane enabled: view diagnosis, Add new diagnosis, and statistic)
2. Director: view all radiologists' statistic (tab pane enabled: Radiologist List, statistic)
3. Administrator: Add, edit, delete patients and radiologists' account information (tab pane enabled: Patient Maintenance, Radiologist Maintenance, and Login Account Maintenance)

Figure 1

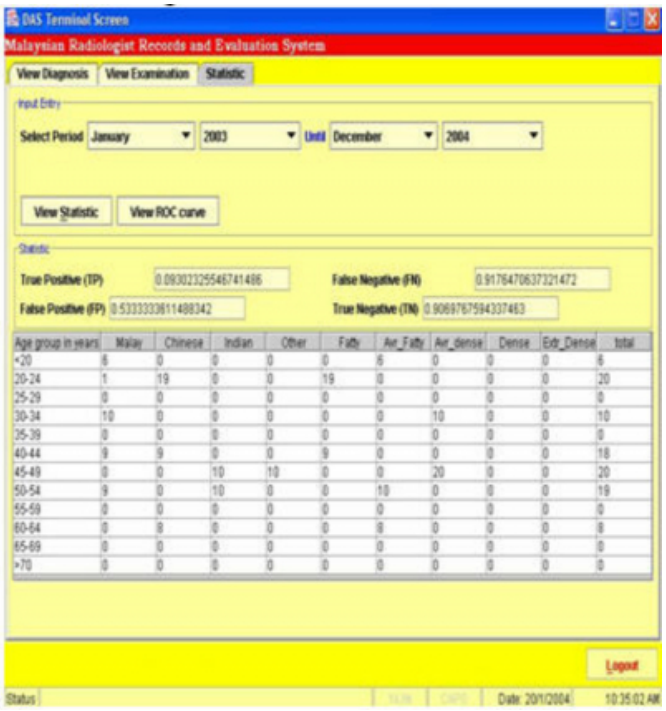
Figure 1: The main login interface of the system.



When the user first startups the client application, the user needs to use a valid login ID and password in order to login based on his or her type of login account available in the system. Figure 2 shows the main interface for the radiologist.

Figure 2

Figure 2: Main interface for Radiologist



In order to create new diagnosis, the radiologist has to use Add New Diagnosis tab pane under the View Diagnosis Tab. On this tab pane the radiologist has to choose one of the six appropriate diagnosis categories for each patient from the list below, which is based on the BIRADS assessment categories:

0. Needs additional evaluation.
1. Negative-one year follow up.
2.Benign finding with one year follow-up.
3.Probability benign findings short-use interval follow-up.
4. Suspicious abnormality-biopsy should be considered.
5. Highly suggestive of malignancy- appropriate action should be taken.

Then the radiologist has to enter the patient ID or if the radiologist has forgotten the patient ID, he or she may search the needed patient by using the search patient function. After the diagnosis information has been entered, the radiologist just clicks the add this diagnosis button to update the remote database.

For searching a patient, the radiologist can choose any of the important data for the patient by using any of the search constraints (name, gender, race, CP, disease family). The radiologist may also use more than one constraint by checking the appropriate box and choosing the available option.

Options available for race are:

1. Malay
2. Chinese
3. Indian
4. Other

Options available for CP (Categories of patients' breast tissue) as recommended by radiologists at UPM University for the three main races in Malaysia:

1. Fatty background
2. Minimally fatty background
3. Intermediate
4. Dense
5. Moderately dense

After the radiologist clicks the search button, a list of patient info will be displayed as table 1 below shows:

Figure 3

Table 1: shows patient searched information

Patient_ID	LastName	FirstName	Gender	BirthDate	Address	Phone	Race	Age	CP

In the view diagnosis tab pane the radiologist can choose whether to view only active (current) diagnosis, closed (previous) diagnosis, or all diagnosis. After selecting one view, the radiologist can just click the view button and a dynamic table will be generated for all the related patient diagnosis as table 2 below shows:

Figure 4

Table 2: each patient diagnosis data

Diagnosis ID	Diagnosis Type	Patient ID	Description	Start date	End date

In order to view the diagnosis details, the radiologist has to highlight the appropriate row on that table and click view detail. On the diagnosis details, all the related examination taken for selected diagnosis will be displayed as table 3 shows:

Figure 5

Table 3: detail view of each patient diagnosis

Examination ID	Examination date	Have mammogram	Description

Once the radiologist enters the diagnosis, he or she has to conclude the finding. To do this the radiologist has to click on the close this diagnosis button and the Finding window appears. Then he or she enters the diagnosis end date and the finding for that diagnosis, which is important for the radiologist's statistics part. The findings that can be chosen by the radiologist are based on BIRAD assessment categories:

1. Category 5 and biopsy proven malignant.
2. Category 5 and biopsy proven benign.
3. Category 4 and biopsy proven malignant.
4. Category 4 and biopsy proven benign.
5. Category 3 and biopsy proven follow-up malignant.
6. Category 3 and biopsy proven follow-up benign.
7. Category 2 and biopsy proven follow-up has proven malignant.
8. Category 2 and biopsy proven follow-up has proven benign.
9. Category 1 and biopsy proven follow-up has proven malignant.
10. Category 1 and biopsy proven follow-up has proven benign.

To view the radiologist statistics, the radiologist can click the Statistic tab pane. He or she has to enter the start date and end date related to his or her diagnosis to calculate certain metric values, in which the diagnosis end date is in between this period. After clicking the view button, the system will calculate and display the following:

1. True Positive (TP) value: cancer diagnosed within one year after biopsy recommendation based on biopsy proof.
2. False Positive (FP) value: No known cancer detected within one year after biopsy recommendation based on biopsy proof and one year follow up.
3. False Negative (FN) value: Detection of cancer within one year of examination with benign or probably benign based on biopsy proof.
4. True Negative (TN) value: No known cancer detected within one year of examination with normal findings based on biopsy proof and one year follow up.

Other calculated values will be the sensitivity and specificity. These two values will be displayed graphically

using a Receiver Operator Curve (ROC). Sensitivity is the probability of detecting cancer when cancer exists as defined by equation 1.

Figure 6

$$Sensitivity = TP/(TP + TN) \longrightarrow Equation$$

Specificity is the probability of concluding normal benign findings when no cancer exists as defined by equation2.

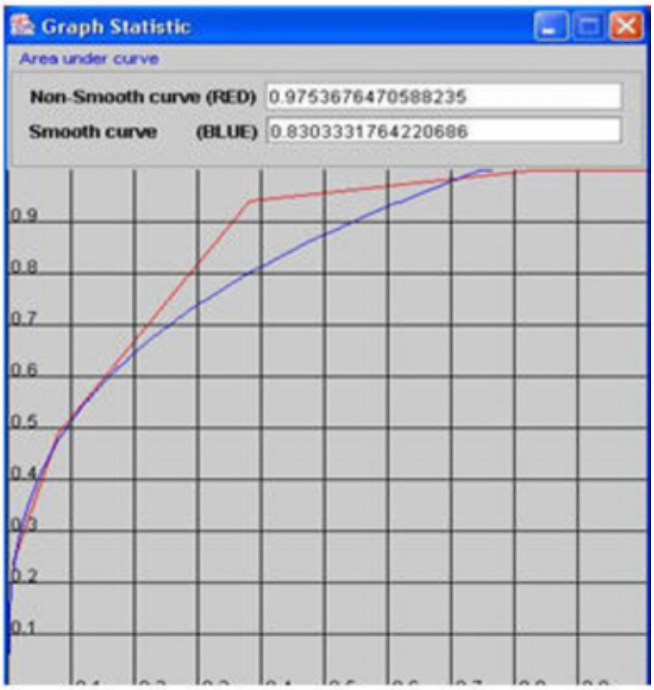
Figure 7

$$Specificity = TN/(FP + TN) \longrightarrow Equation$$

From the sensitivity and specificity values the Receiver Operator Curve (ROC) can be drawn, which gives the radiologist a good indication of his or her diagnosis accuracy by calculating the area under the ROC curve for a certain diagnosis period of time for a number of patients. The closer the area-value to one the more accurate is the radiologist to the right diagnosis for every patient. ROC curve is a graphical depiction of the sensitivity (y-axis) vs. 1-specificity (x-axis). The radiologist gets his or her own ROC for one specified period by clicking the view ROC curve. Figure 3 shows two ROC curves with the area under each curve: the non smooth curve is an approximation ROC curve and the smooth curve is an ROC exact curve.

Figure 8

Figure 3: ROC curves



Other important statistics the system can calculate and provide for the radiologist are:

1. Total number of patients under each race groups: Malays, Chinese, and Indians.
2. Total number of patients under each one of the five patient breast tissue categories: Fatty background, minimally fatty background, Intermediate, Dense, and moderately dense.
3. Total number of patients under each age group in increments of five associated with one race group and one patient breast tissue category.

III. CONCLUSION

A new powerful tool for recording and evaluating the radiologist has been designed and implemented. It is system that can help the medical staff in hospitals and clinics to document the findings of the Malaysian radiologist for the presence of breast cancer in Malaysian patients and help the radiologist to monitor his or her own progress in detecting breast cancer by keeping track of the sensitivity, specificity, and ROC curve for some period of time to be compared with other time periods' performances for the same radiologist and for comparison purposes with other radiologists. In addition the system is capable of providing important

statistical measures to be used by the management of medical institutions about breast cancer occurrences in the Malaysian population. In short, the Client-Server tool for recording and evaluating the radiologist is intended to simplify the lives of hospital management and hospital staff by providing an automated system for recording all the diagnosis examinations performed by the radiologist.

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Author Information

Majdi Al-qdah
Faculty of Information Technology, Multimedia University

Abd. Rahman Ramli
Associate Professor, Institute of Advanced Technology, University Putra Malaysia

Rozi Mahmud
Associate Professor, Faculty of Radiology, University Putra Malaysia