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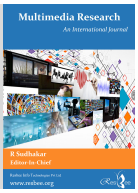

An Innovative Prototype for Diagnosing and Treatment of Breast Cancer: A Case Study of Specialist Hospital Gombe

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Abstract: Cancer is one of the most common types of cancer in women affecting approximately 12.5% of women around the world [11]. Pathology research was intended to put in place software development based on the new diagnostic technologies. These technologies are not intended to substitute the human expert but only to facilitate his/her task. This work aims to develop a tool that can diagnose breast cancer and recommend treatments under the management and supervision of a pathologist and Oncologist from a breast cancer biopsy report. The prototype was implemented using the WAMP server. The prototype recorded 88.89% specificity, 92.16% sensitivity, and 91.67% accuracy when 120 biopsy reports were examined from the pathological department of Specialist Hospital Gombe, Nigeria. The prototype can be enhanced and improved to attain electronic medical standards by other researchers. It is recommended for use by both the pathology and oncology departments of the Hospital as a fast solution to interpret a biopsy report and obtain information on the staging and treatment of a breast cancer disease.

Keywords: Benign, Biopsy, Malignant, Pathology, Prototype, Staging.

1. Introduction

One of the challenges faced by healthcare organizations is the lack of provision of quality service which includes, a poor diagnosis which can lead to disastrous consequences [10]. Such challenges can be addressed by using suitable decision support systems and computer-based information that have the ability to computationally analyze data that is stored in the diagnostic/treatment records of millions of patients [11].

Medical diagnosis is considered a complicated task that requires to be performed precisely and efficiently. The automation of the procedure of diagnosis would be highly beneficial [3]. Frequently, clinical decisions are performed on the basis of a doctor's experience and intuition [10], diagnosing a breast tumor as either benign or malignant which can be done by studying the biopsy report to detect the attributes of the tumor is one of the interesting aspects of software development [5], therefore, correct diagnosis of breast cancer is essential for patients to receive timely and correct treatment [1].

Generally, Breast cancer is considered as most common disease around the globe that outcomes in the majority of death; it is occurred to uncontrolled cell growth and the presence of lumps in the tissues of the breast which may spread to various other parts [9]. Thus, in the benign stage, only early cancer detection and avoidance from spreading to other parts in the malignant stage could save a life of persons and increase the survival rate [13]. In the benign phase, if cancer is recognized, the patient life expectancy increases. For women, Breast cancer is one of the leading cancers in developed and underdeveloped countries such as Nigeria [7]. Subsequently, it is the next most common cause of cancer death in women [8]. The malignant tumor creates while cells in the breast tissue separate and grows without the normal controls on cell death and cell division [15]. Even though scientists do not be familiar with the accurate reasons for most breast cancer [4], they do know a few of the risk factors that raise the likelihood of a woman developing breast cancer. These factors involve attributes like age, family history, and genetic risk, [16].

Biopsy, (carried out by a pathologist) is the removal of small amounts of suspected tissue for examination under a microscope [6]. It is through biopsies (or another means of diagnosing) that a tumor is classified as benign free from cancer cells or malignant that has cancer cells [14]. Reports were obtained from the pathology department of Specialist Hospital Gombe. In the breast, if a malignant

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tumor is not treated, it may grow into the muscles which lie under the breast. Additionally, it can grow into the skin covering the breast. Occasionally cells break away from the original (primary) cancer and spread to other organs of the body [17]. They can spread via the lymphatic system or bloodstream. While these cells arrive at a new area they might go on separating and form a new tumor [1]. The new tumor is often called a secondary or metastasis. Breast cancer occurs when cells within the breast ducts and lobules become cancerous [2]. If breast cancer is caught at an early phase, it can be easily cured. If cancer has spread to other areas of the body it can't typically be cured, however, it can usually be efficiently controlled for a long time [12].

This work aims to develop a tool that can diagnose breast cancer and recommend treatments under the management and supervision of a pathologist and Oncologist from a breast cancer biopsy. Thus, the aim is accomplished with the following objectives:

i- To obtain a differential diagnosis of a breast tumor as either benign or malignant.
ii- To obtain the stage of a malignant breast tumor.
iii- To use the knowledge of medical Doctors in recommending a treatment plan for a patient.

The organization of the paper is arranged as follows: Section 2 describes the literature review, section 3 illustrates the materials and techniques. Section 4 explains the implementation and result and finally section 5 concludes the paper.

2. Literature Review

A Series of research have and are still taking place to overcome the challenges of delivering high quality in the health sector, particularly in breast cancer disease.

In [13] analyzed breast cancer data using data mining techniques to devise a means of detecting cancer at an early stage. The intelligent system was tested using biopsy or CT-scan results of a patient and given a significant accuracy.

In [9] presented a comparative study on breast cancer detection and prediction by exploiting the data mining classification algorithms to predict breast cancer at an early stage through biopsy. After running the experiment in WEKA, successful approaches recorded over 90% accuracy in detection. The study was not able to present any tool or prototype for breast cancer detection that could be used in any healthcare institution.

In [11] presented a survey on various data mining algorithms in breast cancer prediction. The advantages and the corresponding disadvantages of various methods of detection of the disease were outlined. The study further recommends the implementation of automated intelligent diagnostic tools for breast cancer as it plays an important role in saving the lives of women.

In addition to this, the research of [3] the study presented an Extensible Breast cancer Prognosis Framework which includes susceptibility or risk assessment, recurrence or redevelopment of cancer after resolution. The study also developed a representative feature subset selection that was used along with a support vector machine to improve efficiency in diagnosis. A prototype was claimed to have been developed for the study to demonstrate the proof of the concept. However, there is no insight and how the prototype was developed.

3. Materials and Techniques

Extensive literature reviews, case studies, and discussions with medical experts exhibit that there is a number of factors influencing breast cancer. These factors are recognized and used as attributes for this prototype implementation.

3.1 Data Source

The data for testing the prototype was collected from the pathological department of Specialist Hospital Gombe. The data consist of attributes that include; the presentation of the tumor, mode of growth of the tumor, rate of growth of the tumor, and metastasis associated with the histological differentiation.

These attributes are exploited to train and model the prototype and it is utilized to examine its importance. These attributes play a significant role in diagnosing breast cancer through the user interface and thus make the prototype behave intelligently.

3.2 Database/Knowledgebase Design

MYSQL database (5.1.30) was used for the design of the prototype and has the following tables:

1- Login Table
2- Tumor Table
3- Staging and Grading Table

3.3 Interface Design

Hypertext Text Mark-up Language (HTML), PHP, and cascading style sheet (CSS) were used in designing the interface.

4. Implementation and Results

To implement this prototype, the hospital needs at least two (2) computers for the Pathologist and the Oncologist. Each with the following specifications: 60GB of the hard disc with 512MB of RAM, Local Area Network, Windows Operating System (Windows XP, Windows Vista, Windows 7, etc), browser (internet explorer, Mozilla firefox, opera, etc), WAMP (installed on the Pathologist's system to serve as the local server), and antivirus.

4.1 Prototype Testing

To start with the functional testing in which the primary concern here is validation. All you need is a browser to enable content retrieval and server-side processing testing.

By typing the correct Uniform Resource Locator (URL), the Home page will be displayed. It will prompt the user (a doctor or pathologist) to log in with a valid username and password to enable him/her to access his/her page. Fig. 1 demonstrates the Home page.

To ascertain whether the tumor is benign or malignant, the following information is needed from the pathologist. Fig. 2 illustrates the Benign/malignant Differentiation page.

Based on the information from the pathologist, the prototype displays the following information if the tissue is found to be malignant tissue. Hence, all results displayed to the pathologist can equally be accessed by the oncologist. Fig. 3 exhibits the Benign Tumor Report.

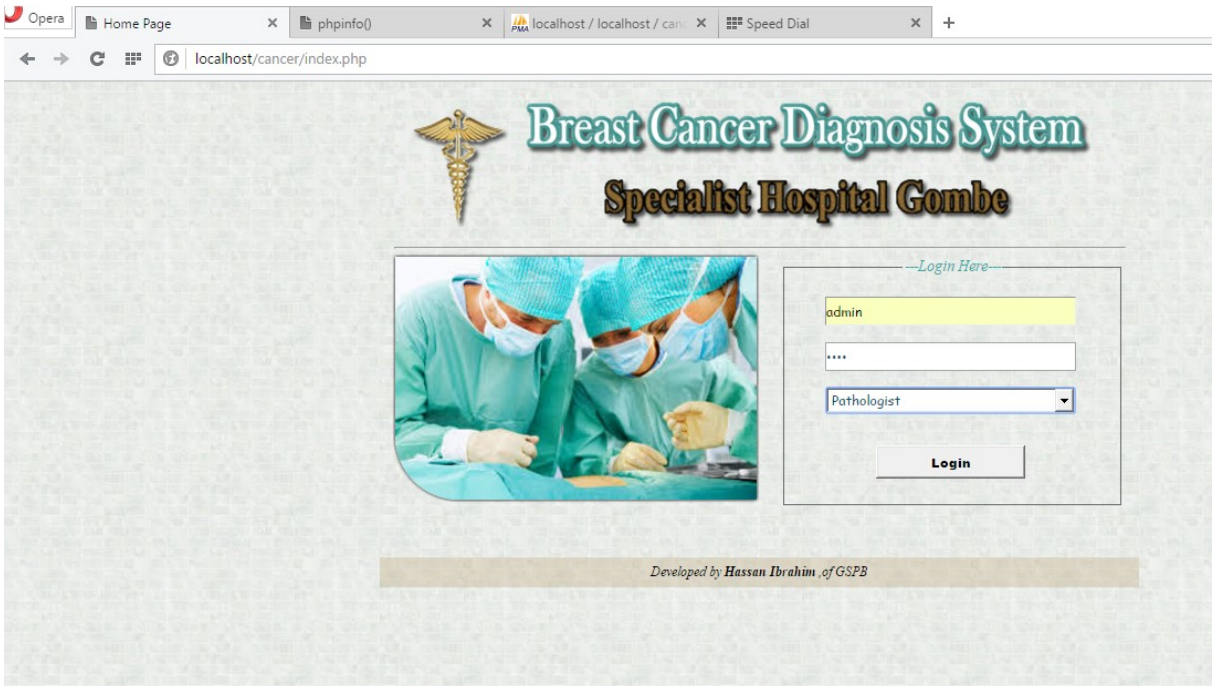

Fig. 1. *Home page*

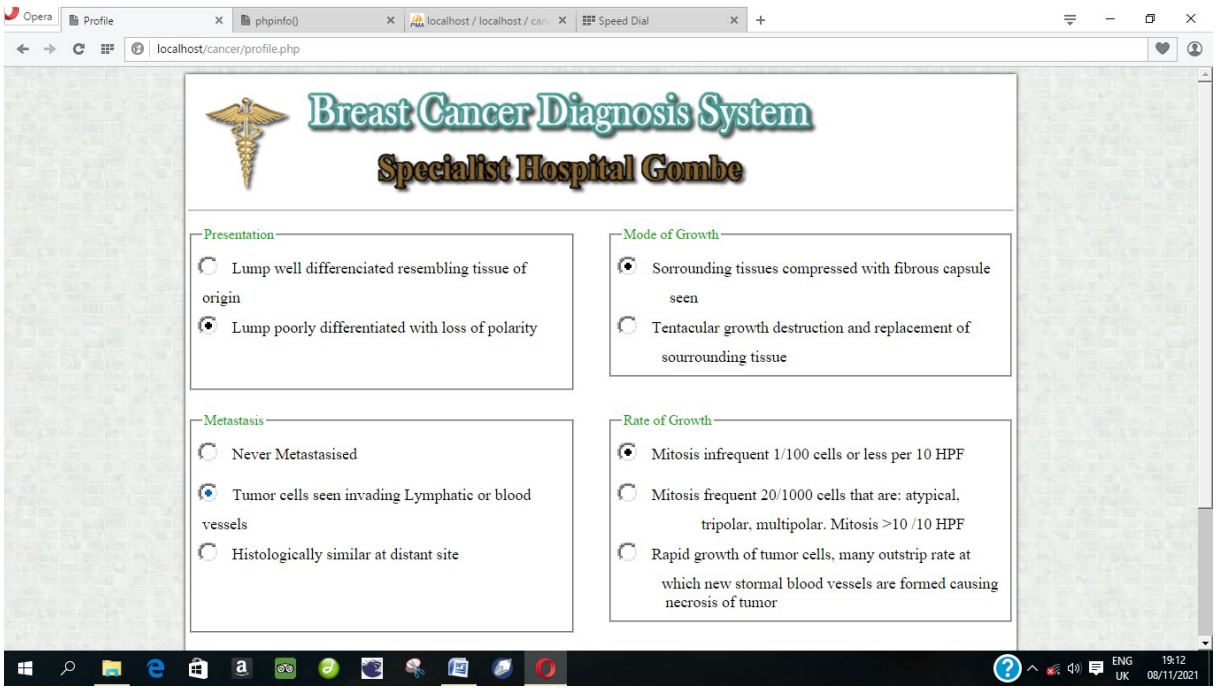

Fig. 2*. Benign/malignant Differentiation page*

Fig. 3*. Benign Tumor Report*

4.2 Discussion

A total number of one hundred and twenty (120) biopsy reports of patients suffering from breast cancer were obtained from the Oncology department of Specialist Hospital Gombe. These biopsy reports were interpreted by the prototype to determine whether it is benign or malignant, if it is malignant, a further biopsy is done to obtain the stage of the disease. The interpretation and staging of the prototype were compared with that of the oncologists

From the results we deduce;

TP: True Positive. The prototype correctly identifies patients with the disease = 94.
TN: True Negative. The prototype correctly identifies patients without the disease = 16.
FP: False Positive. The prototype identifies patients without the disease as positive =2.

FN: False Negative. The prototype identifies patients with the disease as negative =8.

Sensitivity = $(TP/(TP+FN)\times 100)$ …….. [3]

Sensitivity= $(94/102)\times 100 = 92.16\%$

While *Specificity* = $(TN/(TN+FP)\times 100)$ …….. [3]

Specificity = $(16/18)\times 100 = 88.89\%$.

Thus, *Accuracy* = $((TP+TN)/(TP+TN+FP+FN))\times 100$ …….. [3]

Accuracy = $(110/120)\times 100 = 91.67\%$

Hence, the percentage error recorded from the prototype = $100 - 91.67 = 8.33\%$

5. Conclusions

The research has determined how breast cancer could be diagnosed in order to know whether the tumor is cancerous that is malignant or not that is benign. The stage of the malignant tumor can be obtained from the prototype and recommend a treatment plan. Both functional and performance testing of the prototype was obtained. Out of the one hundred and twenty records obtained, the prototype detects 92.2% of patients with the disease and 88.9% of patients without the disease. It equally has 91.7% accuracy with an error of 8.3%. Even though the team oncologists' interpretation is better than that of the prototype, it is not the aim of the design to substitute expert or professional intervention in the diagnosis of breast cancer. However, the prototype can be used as a guide in learning, presenting, and interpreting biopsy reports by medical practitioners. The prototype can be enhanced and improved to attain electronic medical standards by other researchers. It should be used by both the pathology and oncology departments of Specialist Hospital Gombe as a fast solution to interpret a biopsy report.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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