

THE USE OF A DATABASE AS AN AUXILIAR TOOL IN THERMOGRAPHIC DIAGNOSIS FOR EARLY DETECTION OF BREAST DISEASES

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Abstract. *The purpose of this study is to examine the use of digital infrared thermography as a tool for the early detection of breast diseases. With a FLIR® S45 infrared camera we intend to take images from 300 outpatients of a public hospital, that is located in a tropical region. Asymmetrical vascularization of the breasts were detected for example in patients with Paget carcinoma. Thermography can be used as a new auxiliary tool in the detection of breast pathology. A database was developed to manage all of the informations about the patients and the additional data provided by the thermogram. It will be able also to analyze if there exists a difference between the malignant and benign breast tumor temperatures. The database is a software that was developed in PHP(Hipertext Preprocessor), using MySQL (multi-user SQL database management system) databases. This system is responsible for the storage and the analysis of the informations about the patient, and it is capable also of making specific relatories based on these data.*

Keywords: *Thermography, medical images, database, breast cancer.*

1. INTRODUCTION

Thermography inspection is a nondestructive technique that measures the infrared radiation emitted from any body which temperature is above the absolute zero (-273 °C). The Stefan-Boltzmann law defines the relation between the radiated energy and the temperature by stating that the total radiation emitted by an object is directly proportional to the object's area, to its emissivity and to the fourth power of its absolute temperature. The camera software converted measurements of infrared radiation into accurate measurements of temperature. This is done by the use of internal correlations. Additional information must be set in the camera, like the emissivity of the body, the distance of the object to the camera and the environment temperature and the humidity.

In medicine, this principle can be utilized to measure the temperatures of the surface of the breast. Changes in temperature can for example be altered by the presence of a tumor. The tumor cells promote the growth of new blood vessels from pre-existing vessels. This phenomenon is called neovascularization. The increased vascularization yields an increase in temperatures over the breast surface which is detected by the thermography.

The main advantage of the use of thermography in medicine is the fact that it works without ionizing radiation, which is present in other imaging methods for example, in mammography. One other advantage over other non invasive imaging methods is that thermography is a physiological test, since it measures the heat generated from the circulating blood, while other traditional types of diagnostic test are, in general, anatomical tests like ultrasound and mammography (Love, in: Shitzer and Eberhart, 1985).

Some breast diseases could be detected by thermography. This is the case of Paget's carcinoma, where there is no formation of tumor, but there is the presence of high asymmetry in the vascularization of the breasts (Fig.1,b) (Araújo et al., 2007). Young patients who have big density of the breast tissues and are not suited for mammography may benefit from infrared thermography as an additional diagnostic tool. This is the case of Fig. 1, a.

The whole study (Bezerra et al., 2007) in where the present work is inserted was designed to analyze the thermography images from approximately 300 outpatients from a public hospital, which is located in a tropical region. In order to store the data from these patients, a database has been developed in PHP (Hipertext Preprocessor) using the MySQL(multi-user SQL database management system) database. This software will allow the scientists to make the analysis of their interest, at the end of the capititation images stage. After all, a statistical analysis must be done with the help of the developed database. Also, numerical simulations must be done in order to compare calculated temperatures with those measured by the thermograms.

2. METHODOLOGY

2.1. Image capture

The thermograms were been taken with a FLIR® S45 infrared camera. The patient population consisted of patients with a suspected tumor, whose diagnosis was confirmed or not by clinical examination, followed by ultrasound, mammographic and biopsy exams.

Thermographic imaging should be performed in a controlled room to avoid thermal interference from external sources like uncontrolled temperature outside of the examination rooms. But the clinical rooms of public hospitals in tropical regions of the Brazil do not have good thermal conditions. To control for better thermal conditions, subjects were required to an acclimatization period at least of 10 minutes so their body temperatures can reach the thermal equilibrium with the room and to lower the metabolic heat production. Considerations for the environment and for the patient's conditions are described in "Araújo *et al.*" (2006). Infrared images were obtained from the frontal and lateral planes for each breast in each patient.

The captured images obtained are visually analyzed using the ThermaCAM QuickView software which is provided by the manufacturer of the camera. This software can show the temperatures on every pixel of the infrared image. In the sequence, both qualitative and quantitative high-resolution graphical representations were obtained with high sensitivity, and an accuracy of 0.08 ° C.

Some examples of thermograms obtained from patients are shown below.

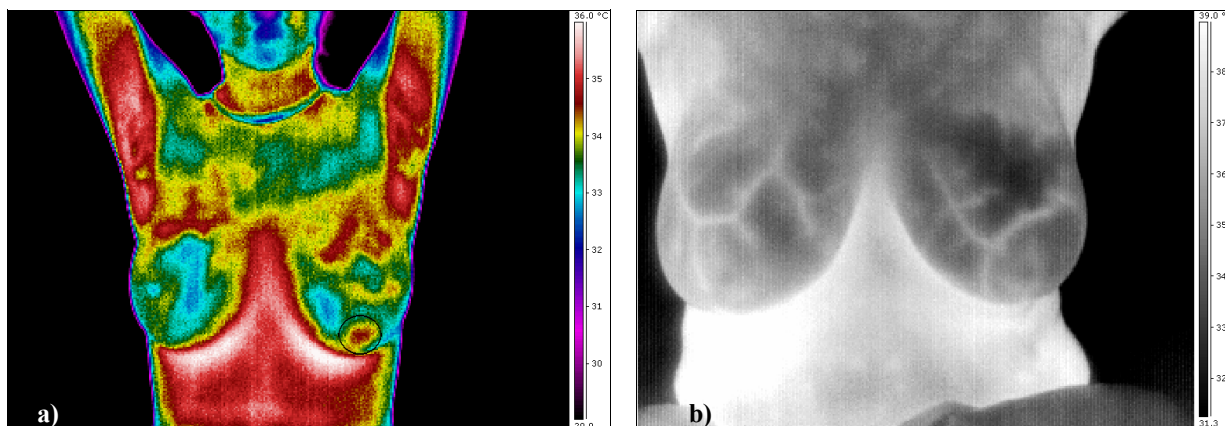


Figure 1. a) Infrared image of a young woman. The region demarcated by a circle represents a benign tumor; b) Patient with asymmetric vascularization.

2.2. Database

The developed software was written in PHP (HiperText Preprocessor) embedded in the HTML (Hiper Text Markup Language) code, that uses the MySQL database (relational database management system that uses SQL protocol). The computational structure used a 756 MHz computer, with 512Mb of RAM memory running as a computational server. PHP is a computer scripting language (not compiled), originally designed for web development. Although it was developed for server-side scripting, it can be used by a standalone application. HTML is an open source language which is compatible with all the popular browsers in the web. In syntax, PHP is like "C" and C++, and is more accessible for a variety of applications. This is an extremely modulated language, which makes it ideal for installation and use on web servers.

The main advantages of the use of PHP for database development are: its high velocity, the ease to connect with MySQL, the possibility to have an on-line use, the compatibility with all available browsers (both at Windows and Linux ambients). The developed system can be installed in an on-line server which provides full access from any computer linked to the web.

To manage the data in the database it was used the relational model based on first-order predicate logic, where the structures inside were allocated like tables, with rows and columns. It was used the PHPMyAdmin, that is a free source PHP tool for the management of SQL databases. Two tables in the database, named: "Id" and "Login" were created (Fig. 2). The first table was responsible to gather the information about the clinical exam and the patients' personal information. The second gathered information about the security privileges for the use of the system, like usernames and passwords.

The developed system is able to identify users by password (Fig. 3), and also to insert and remove patients from the database and to change the register if necessary. There is also a site to look for registered patients, which can display the combination of the variables involved in the search. Each patient can be viewed in an independent window. Several windows for different patients can be showed simultaneously, allowing the view of different patient information at one time. Reports can be printed at the end of the search, with the selected data in order to examine a possible relationship between the observed temperatures on the surface of the breast and whether the tumor is malignant or benign.


Tabela	Ações	Registros	Tipo	Collation	Tamanho	Sobre Carga
Id	     	6	MyISAM	latin1_swedish_ci	2.8 KB	-
login	     	1	MyISAM	latin1_swedish_ci	1.0 KB	-
2 tabela(s)	Soma	7	--	latin1_swedish_ci	3.8 KB	0 Bytes

Figure 2. Tables in the database: Id stored the information about the patients. Login stored the fields for usernames and password.

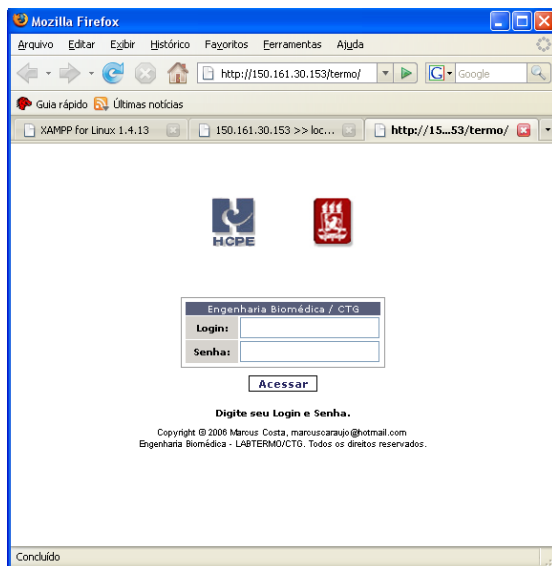


Figure 3. First screen of the database.

3. RESULTS

The developed program enabled the following possibilities (tasks) of use:

- Access by password: it does not allow a third party access to specific areas such as registration and search of patient information. This feature avoids the deliberately removal or alteration of data.
- Registry of Patients: Patient register is similar to the spreadsheet used by the doctors during the examination at the hospital.
- Search for Patients: Is it possible to conduct researches by combining different items.
- Upload of thermographic pictures to be attached to the patient register.
- Possibility to include new data for patients already registered.

Figure 4 shows the patient registration window. The electronic form was designed by the physicians of the local hospital. It contains the patient history and examination records following the recommendations of those doctors. It contains the following items: patient identification, main complaint, secondary complaint, past medical history,

The screenshot shows a web browser window with the URL 'http://190.161.30.132'. The page title is 'REGISTRO DE PACIENTES'. The form is organized into several sections:

- IDENTIFICAÇÃO:** Fields for Name, Sex (M/F), Date of Birth (D(a)), Type (Tp), and Image (imagem).
- QUEIXA PRINCIPAL 1 & 2:** Fields for QP (Queixa Principal), Duration (Duração) in years, months, and days, and Interrogatório Sintomático (Mastalgia, Descarga Papilar).
- ANTECEDENTES:** Fields for Antecedentes Familiares, Antecedentes Pessoais, Hábitos Alimentares, and Fatores de Risco. Includes DUM (Menarca) and Climatério (PRE/POS) options.
- EXAMES REALIZADOS:** Fields for USG and Mamografia, each with a Local (MD/ME) dropdown.
- INSPEÇÃO:** Fields for Inspeção Estética (Forma, Ak. Cutânea), Inspeção Dinâmica (Normal, Retração, Abaulamentos), and Palpação das Mamas (Mama Direita/Esquerda normal).
- DIAGNÓSTICO:** Fields for Hipótese de Diagnóstico (CID 1, CID 2, CID 3, CID 4) and Conduta (Orientada, Medicada, Elopisa, Punção, Cirurgia).

An 'ENVIAR' button is located at the bottom of the form.

Figure 4. Patients' registration screen.

The screenshot shows the same web browser window, but now displaying search results. The search results are shown in a table at the bottom of the page, which is circled in black. The table is titled '3 Pacientes encontrados.' and has the following data:

Pontuação	Nome Paciente	Idade
123456	Marcos Costa de Araújo	42 anos
123321	Testando	idade
123344	Antecedentes	idade
123456	Fulana da Tal	idade

A 'Buscar' button is located below the table.

Figure 5. Search screen. The marked area shows the results of a search.

tests performed, inspection, and diagnosis. Each item has specific sub items which were designed to provide physicians with additional.

The search for patients is done on the same basic document and can combine several items. For example, all the patients that showed the main complaint as "pain". The result of the search is displayed on the same screen, at the bottom of the page of search, as shown in Figure 5.

The patients pulled by each search are displayed in independent windows. And several patients can be displayed simultaneously (Fig 6). Each individual form may contain one of the thermographic images along with other filled fields. Blank fields are not shown.

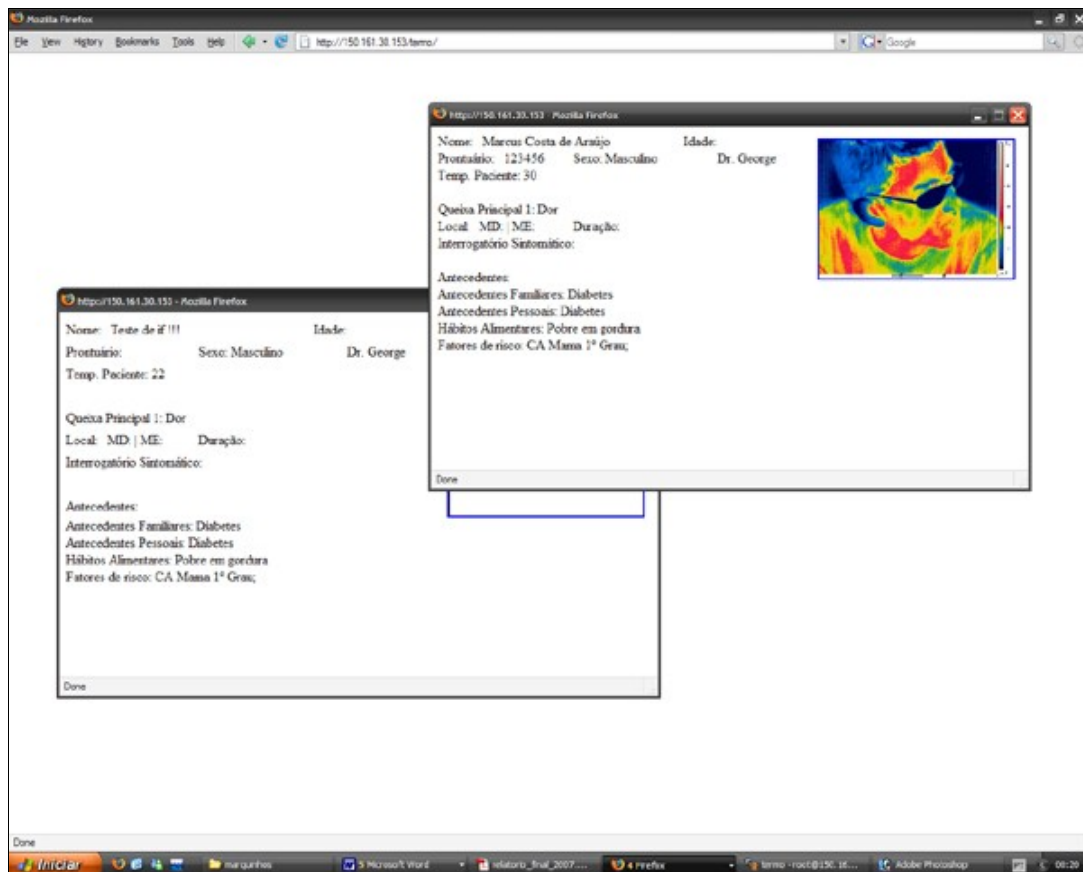


Figure 6. Exhibition of a possible window.

4. CONCLUSIONS

Because thermography can be used as a screening tool, it was not designed to replace existing diagnostic methods.

The analysis of specific information generated by our database may validate thermography as a useful tool for the early detection of breast diseases.

In the future this database may be expanded to include an additional feature in which temperatures can be directly extracted from patients' thermograms.

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6. RESPONSABILITY NOTICE

The authors are the only responsible for the printed material included in this paper.