Sistema de monitoreo de temperatura de los senos humanos en la detección temprana del cáncer de seno

Temperature monitoring system of human breast in early breast cancer detection

Jesús Alberto Verduzco Ramírez
Instituto Tecnológico de Colima, México
averduzco@itcolima.edu.mx

Wilbert Armin Cetina Alemán
Instituto Tecnológico de Colima, México
g1346001@itcolima.edu.mx

Resumen

Hoy en día, el cáncer de mama es un problema de salud pública que afecta aproximadamente al 20 % de la población mundial. El propósito de la presente investigación es sugerir una solución de bajo costo que permita detectar el cáncer mamario a través de la medición de variaciones en la temperatura de los senos humanos. El dispositivo consiste en una malla de sensores térmicos dispuestos en forma de corpiño, cómodo y fácil de usar por personas de ambos sexos. Dicho mecanismo de detección se fundamenta en un proceso fisiológico denominado angiogénesis, es decir, la acumulación de sangre que genera variaciones de temperatura en los senos, las cuales a su vez están vinculadas con tumores cancerosos.

Palabras Clave: cáncer de mama, imágenes termográficas, diagnóstico del cáncer de mama

Abstract

Today, breast cancer is a public health problem that affects approximately 20% of the world's population. The purpose of this research is to suggest a low cost solution that allows to detect breast cancer through the measurement of variations in the temperature of the human breast. The device consists of a mesh of thermal sensors arranged in a Bustier, comfortable and easy to use by persons of both sexes. This detection mechanism is based on a physiological process called angiogenesis, i.e. the accumulation of blood causing temperature variations in the sinuses, which in turn are linked to cancerous tumors.

Keywords: breast cancer, thermographic images, diagnosis of breast cancer.

Introduction

Breast cancer is a disease that affects many people in Mexico regardless of their socioeconomic status. The majority of cancers are detected at advanced stages, reducing life expectancy. Mexico currently has a population of more than 120 million people, and its institutions of health and lowincome women face the challenge of this disease; breast cancer is the second leading cause of death among women aged 30 to 45 (Marie, 2009).

In our country, 25 women of every 100 are diagnosed with breast cancer. So far, no country has failed to stop the growing number of patients affected by this disease.

The outlook on Mexico and other Latin American countries is little encouraging since the risk factors for breast cancer are difficult to modify. These apparently have to do with poor nutrition, get pregnant very young, etc. As a result, early diagnosis is the only useful tool that developed countries have been able to use to avoid that increase the rate of mortality (López, 2001).

Problem background

One of the suffering that afflicts women and most recently starts to affect men is breast cancer..
The Ministry of Health reported that mortality from breast cancer is increasing in Mexico;
According to data in 2012 17.1 deaths in every 100 000 Mexican women.

Breast cancer is the most common and most deadly disease among women. According to the
World Health Organization, this disease represents 16% of female cancers worldwide; an
estimated 30 000 million new cases occur each year (Televisa, 2014).

In Mexico, breast cancer in 2012 was the main cause of hospitalization for malignant tumors
among the population 20 years of age or older (19.4%); in women, three out of ten are
hospitalized for this reason, while in men represents only 1.2%. As shown in Figure 1, breast
cancer in women occupies the first place (INGEGI, 2014).

Distribución porcentual de morbilidad hospitalaria de la población de 20 años y más, por tumores malignos según sexo 2012			
Tumores malignos	Total	Hombres	Mujeres
Total	100.0	100.0	100.0
Mama	**19.4**	**1.2**	**30.9**
Órganos digestivos	18.4	25.5	13.9
Órganos genitales femeninos	10.1	NA	16.6
Órganos hematopoyéticos	7.6	9.9	6.1
Células germinales (testículo u ovario)	6.9	6.6	7.2
Tejido linfático y afines	6.7	9.3	5.1
Órganos respiratorios e intratorácicos	5.2	8.8	2.9
Otros tumores malignos[a]	25.7	38.7	17.3

Figure 1. Incidence of breast cancer in Mexico.

In Figure 1 it can be seen that the column Women, 2012, presents 30.9 cases per 100, placing the
breast cancer in the first place from the list.
According to INEGI mortality rates of the past decade, breast cancer has been increasing, while
the cervical cancer has declined. Figure 2 shows that breast cancer reached 6.9% in 2010.
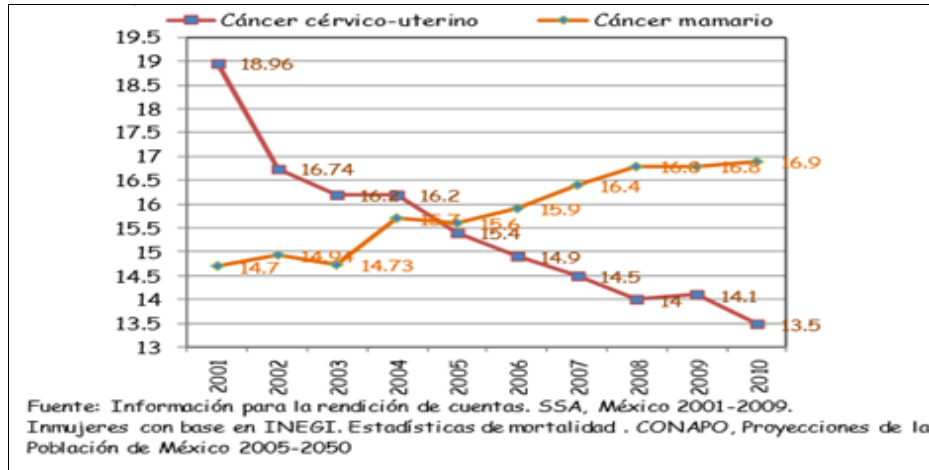
Figure 2. Mortality rate for cervical cancer and breast

One of the conditions that afflicts more women is breast cancer. According to the World Health Organization (WHO), each year 1.38 million new cases and 458 000 deaths from this disease in the world are reported.

In Mexico, breast cancer represents 30% of the diagnoses of malignant tumors. Furthermore, only 5 to 10% of tumors are identified in its early stages, according to statistics from INEGI (INGEGI, 2014).

Detection methods

There are several methods for early detection of breast cancer. Listed below are the most important.

Self-examination

This method involves touching the breast with the pads of your first two fingers, starting from the nipple. Concentric circles are drawn, extending them to cover the entire breast to detect any anomalies or unusual bulge (Medline 2003).

Figure 3 shows the process of self-exploration both standing and lying down.

Figure 3. Study of cancer by self-examination.

Disadvantages

The disadvantages of this method are several: must take place between 7 and 10 days after the last menstrual period, women may feel ashamed of being touched by another person or by herself, not knowing how to put pressure on the fingers or ignore what a normal breast regarding one having alterations, there is the fact that once the person abnormally cancer usually is already at an advanced stage.

Mammography

A mammography unit is a rectangular box with a tube which emits x-rays, using accessories that make breast is exposed only to such rays.

Two plastic plates connected to the unit compressed to flatten the breast thickness, facilitate visualization of tissues and decrease the amount of X-rays

The patient must lie still and hold your breath for a few seconds while the image, a process that takes about 30 minutes (Frisneda, 2012) is taken.

Figure 4 shows the process of making a mammogram. As noted, the breast is pressed to perform such diagnostic test.
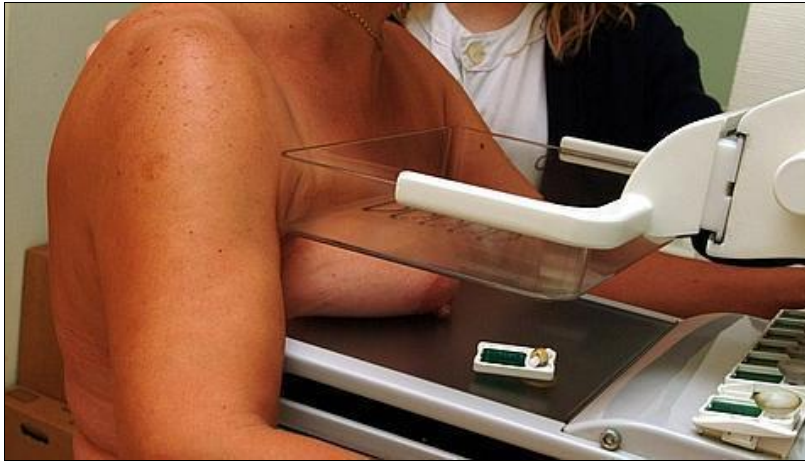
Figure 4. Method of breast cancer detection through mammography.

Disadvantages

This procedure is painful and expensive, does not have enough equipment, you do not have sufficient qualified personnel in the operation of such devices, there is some difficulty in detecting cancer in dense, bulky or implants breast, is complicated move this device to remote or difficult to access, such as in rural communities, places you can not make this study in pregnant women by radiation, handling is uncomfortable because the breast is required by the radiologist because to get good pictures you need generate pressure in the breast with paddles.

Biopsy

A biopsy is the removal or removal of breast tissue in order to perform pathological analysis for cancer cells or other disorders. After removing the tissue is sent for consideration by the pathologist to determine if breast cancer or not. This is the mother par excellence test for the detection of breast cancer because no margin of error (Dam, 2011). Figure 1.5 shows how the needle enters the breast to achieve some of the tissue is required, extracting liquids and fluids are then analyzed.

**Figure 5. Process breast biopsy.**

Disadvantages

Biopsy is an invasive, painful and expensive procedure. Another drawback of it is that is performed when the lesion is very evident and / or very advanced, or when the physician has doubts about the results of the above mentioned methods.

Thermography

Thermography is an alternative technique for early diagnosis of breast cancer through the collection and analysis of infrared images. It is simple, noninvasive, inexpensive, fast, painless and harmless.

It variations in the skin temperature are detected during a period of time and thermal images are used to determine the health of the area. Each breast has a particular thermal pattern that should not differ over time, like a fingerprint. Temperatures of healthy and cancerous breasts are different due to metabolism present in the tissue injury (Ameca, 2012).

Figure 6 shows an infrared thermal camera that takes pictures of the breasts of the patient. At the bottom a computer and displaying said heat stored photos observed.
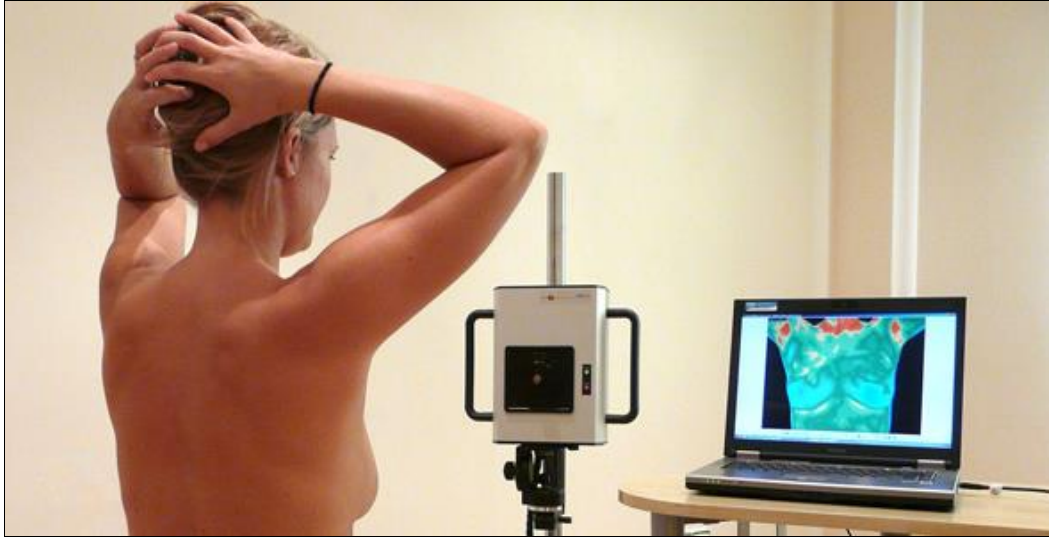

Figure 6. Example of thermographic images obtained by the study.

Justification

Breast cancer is a major public health problem worldwide. It is the most common malignancy in women and the second leading cause of cancer death in the world (Perez, 2013).

Breast cancer is a complex disease. Its main feature is the uncontrolled cell growth, which it shares with other cancer diseases. Inside each cell there are numerous mechanisms, many of which are dedicated to control cell growth, while others inhibit it. This delicate balance, under normal conditions, causes the cells to develop properly; however, when this balance is affected favors mechanisms that promote cell growth, causing the cells start growing out of control. To this   chaos   known   as   cancer.
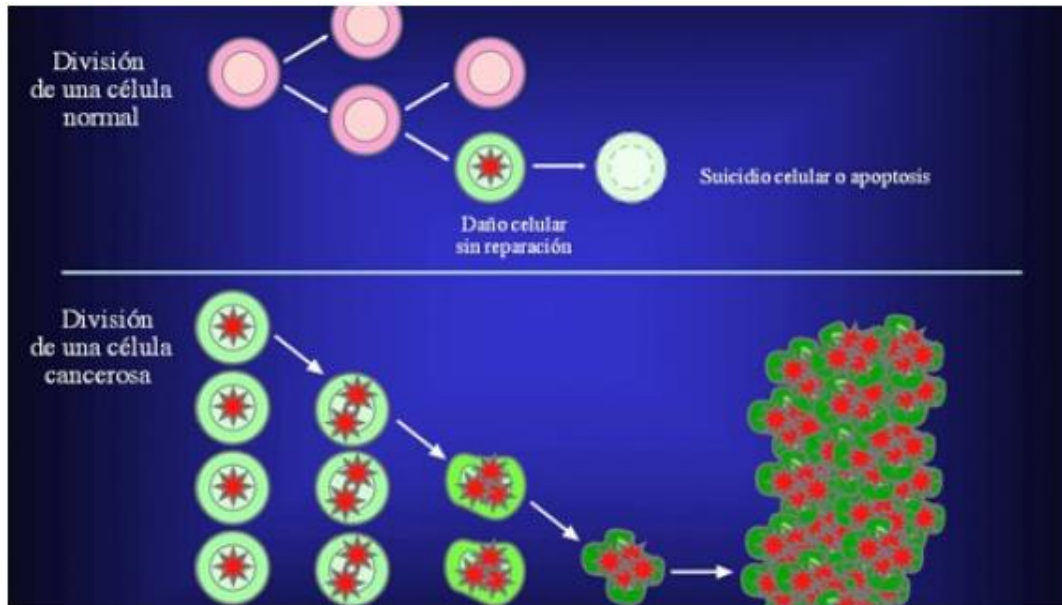
Figure 7. Example of cell division.

Figure 7 shows that the disordered cell division causes cancer, whose causes are unknown.

One characteristic of a cancer cell is that this is very different from the cell from which it originated; also has the ability to spread locally and elsewhere in the body, a process known as "metastasis". On the other hand, there are cells that despite showing an uncontrolled behavior, are similar to the cell from which they originated. These types of cells are known as "benign" because they have no local involvement and not metastasize.

When the mammary glands have a disorderly growth of the cells begins to develop breast cancer, a complex process that involves several stages before reaching form a malignant tumor. Development time depends on the aggressiveness of each tumor (Perez, 2013).

Human breasts, specifically the female breast, are a pair of glandular organs located in the middle of the chest, while the nipple and areola are mainly located in the center of the breast. The breast consists of adipose tissue and a conduit system connecting the mammary glands to the exterior. The larger ducts are located on the nipple, branch inside the breast and lead to a set of acini in clusters called lobes or mammary glands.

The breast has a drainage into the lymphatic vessels that drain into a small, round organs called lymph nodes, this drainage is directed mainly to the axillary lymph nodes. Sometimes there is

drainage to lymph nodes under the clavicle or above the collarbone and more rarely to lymph nodes located between the breast and the sternum (Pérez, 2013).
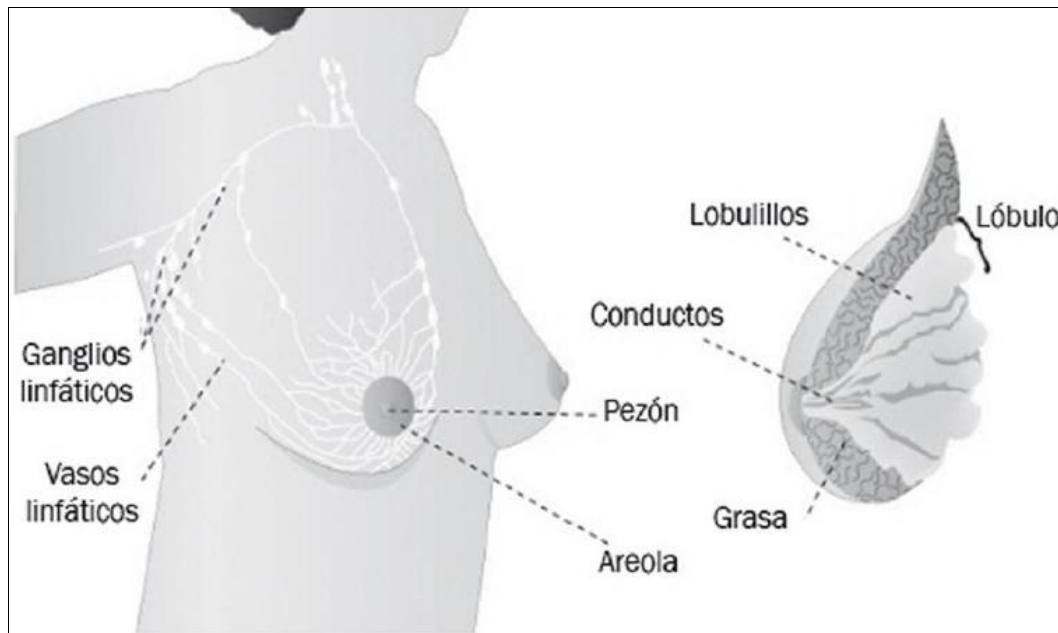
Figure 8. Structure of the mammary gland.

Most often breast cancer starts in the cells lining the ducts and less frequently in the lobules; however, you can begin in the cells of other tissues in the breast. The latter are known as sarcomas or lymphomas, which are not considered breast cancer.

The lymphatic system is the main way in which breast cancer can spread to other body parts. The breast cancer cells may travel to the lymphatic vessels and begin to grow in lymph nodes, so that there would be a higher probability that these cancer cells have also spread to other body parts. The more lymph nodes contain cancer more likely it is that this return or spread to other organs (American, 2014).
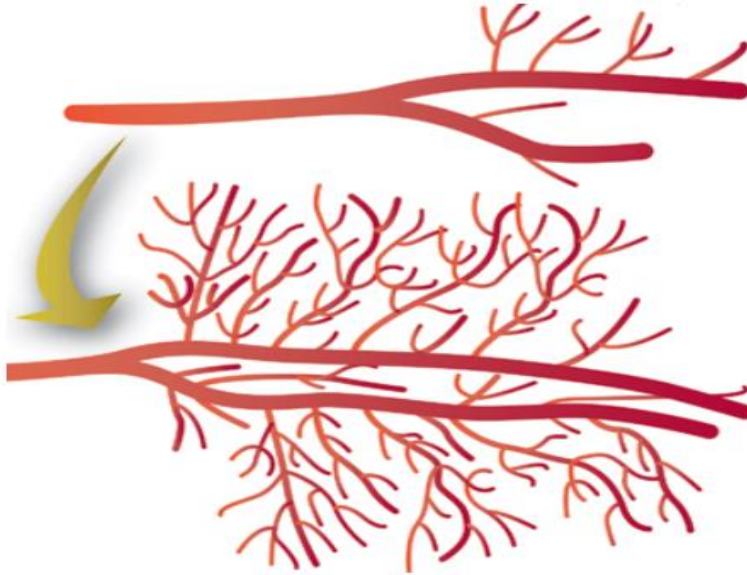
Figure 9. The process of angiogenesis.

Figure 9 shows the physiological process of angiogenesis. On top of this figure a healthy blood vessel and shown at the bottom transformed a blood vessel, which may result in a breast tumor illustrated.

Hence the importance of detecting the disease early, because once it reaches the lymphatic system is considered an advanced breast cancer (invasive), making it more difficult to treat and increasing the likelihood of spread. Conversely, if detected early lobular and ductal carcinoma, its eradication is easier and increase the likelihood that this will not reappear.

Each breast has a particular thermal pattern that should not differ over time, like a fingerprint. Temperature patterns of healthy and cancerous breasts are different mainly due to metabolism present in the tissue injury. Tumors increase the circulation of nutrients to your cells by opening existing blood vessels and the creation of new ones; this is known as angiogenesis. These activities result in a temperature increase in the surface region of the breast lesion.

The skin temperature of the breast tumor may be up to 3.2 ° C higher than that of normal tissue. There are methods to improve the detection of temperature differences between healthy and diseased breast. These include cooling the breasts with alcohol and immersing the hands in cold water before the study, in a controlled environment. When comparing the thermal patterns taken

over a period of time with the pattern of normal baseline, it detected any significant change indicates that something new is being developed within the breast and warrants investigation (Ameca, 2012).
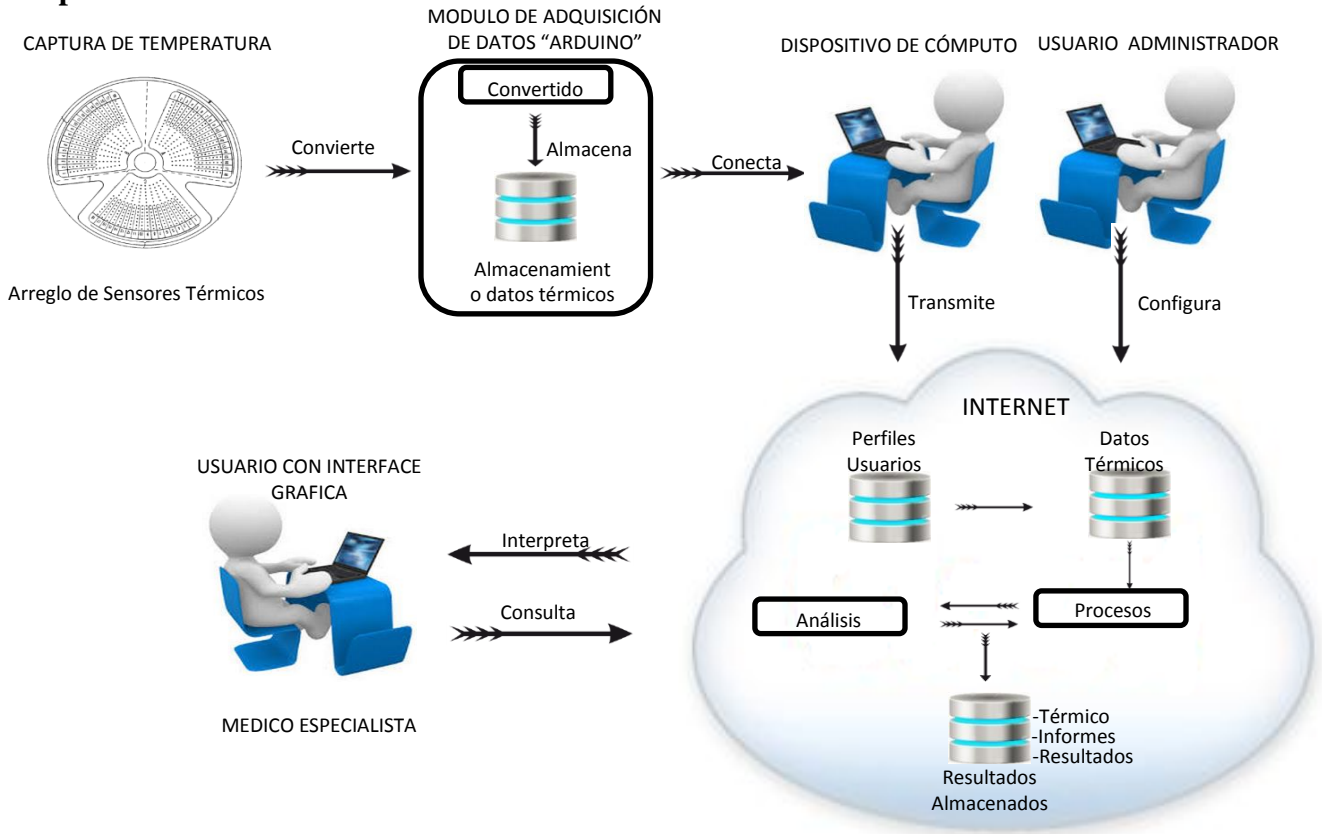
Proposed solution

Figure 10. General outline of the project.

Our proposed solution is to implement a prototype for breast cancer research, which is easy operation to be used in house and inexpensive; They should also implement current technology and provide reliable results, all this in order to reduce the incidence of breast cancer. Useful information, as assessed by the specialist, can lead to early detection that allows the patient to receive appropriate attention and often lifesaving.

The prototype is divided into two modules, the first is to monitor the temperature of the breasts and the second analysis specialist who analyzes and interprets the data.

During the monitoring module 16 a bra with sensors placed in each glass uniformly, so that there are inconvenient or bothersome used. Next door is a receiving device with USB connection. In it the sensors are connected to store values that emit heat.

In the second step, the user connects the device to your computer via the USB port and download on the Internet at a site previously designed for that purpose. The page has several menus where both the user and the physician can visualize and analyze information, which helps the doctor make a better diagnosis.

Results

It has developed software for the web and implemented in the cloud in order that both the patient and the doctor can access the information from anywhere via the Internet. 11 shows the controlling access login user profiles.
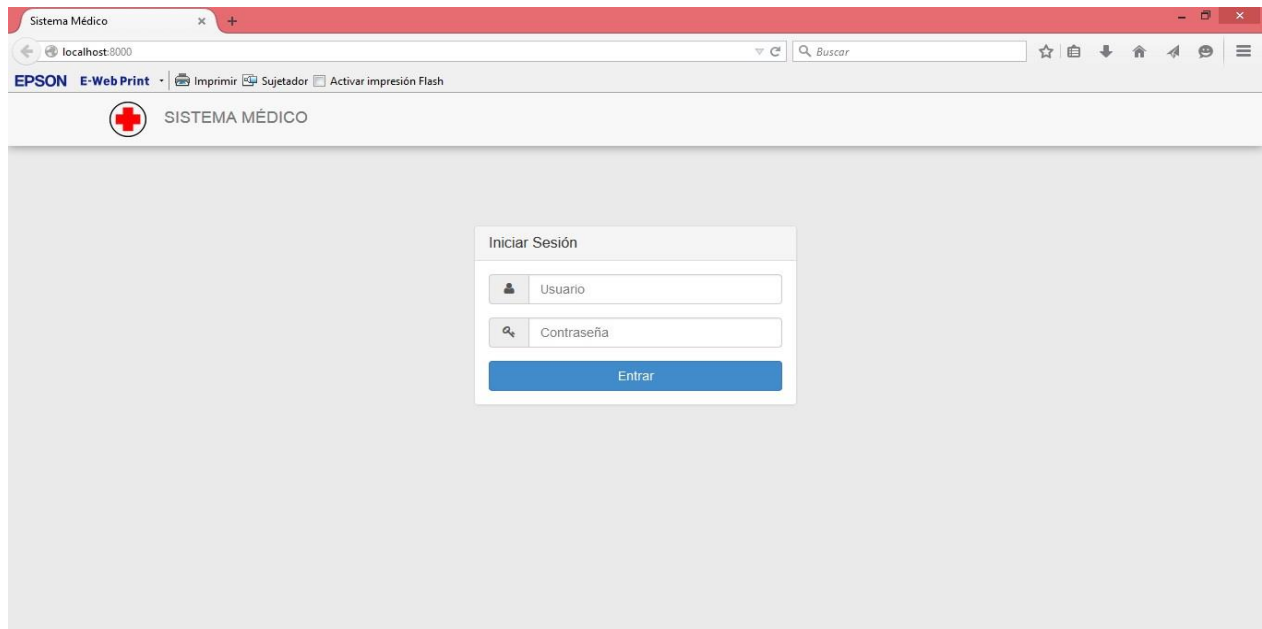

Figure 11. Accessing the system.

Figure 12 shows the two main modules of the system: the module which is discharged to doctors and patients module with all the information regarding these, eg monitoring data.
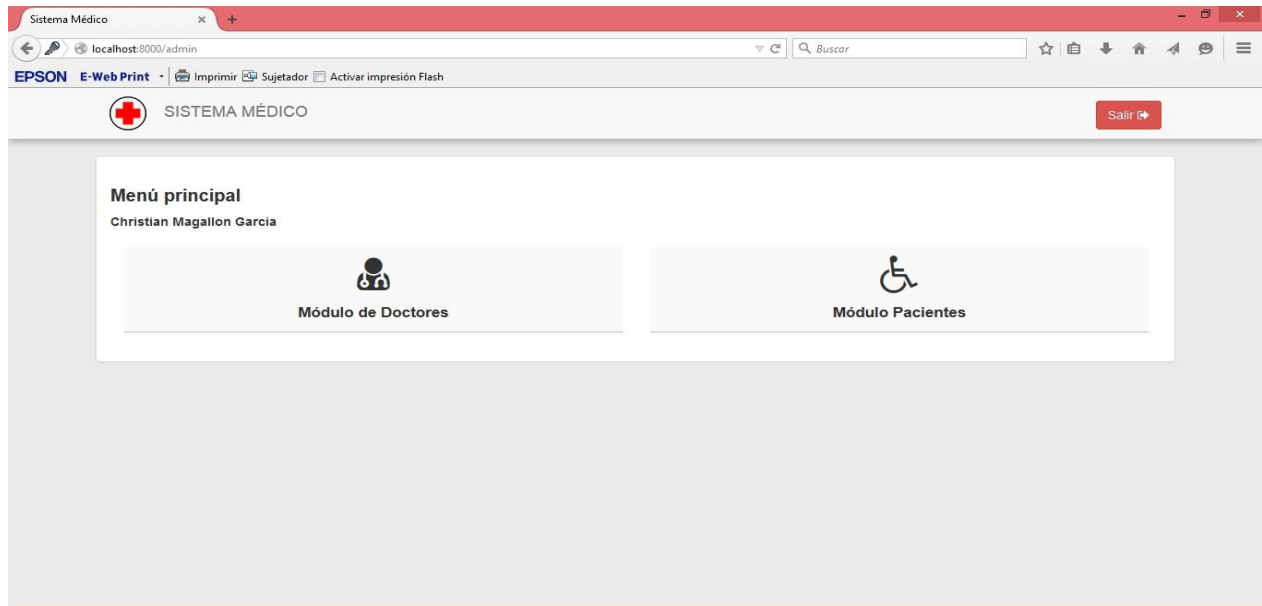

Figure 12. Main Module system.

Figure 13 shows the scan of a patient's right breast from 10 am to 7 pm with an interval of 30 minutes. To this 6 sensors distributed along the breast, leaving the sensors 5 and 6 in its lower inner part and whose temperature is different from those located at the top, mostly uncovered.
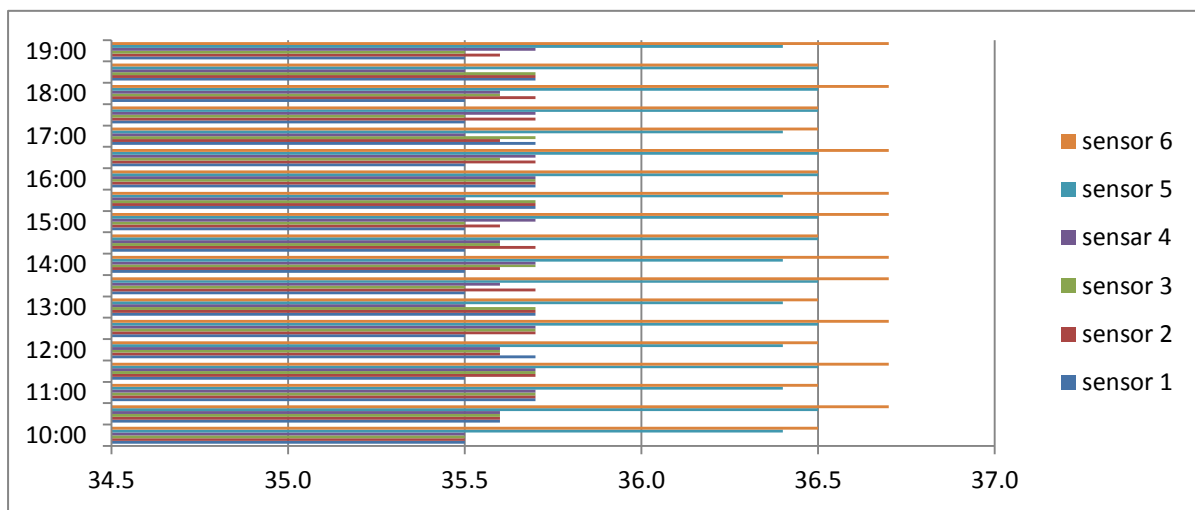

Figure 13. Monitoring the right breast.

Conclusions

Undoubtedly a device that monitors the temperature of the breast is a viable option for people prone to developing breast cancer option. Using current technologies available, it is possible to create a monitoring system with thermal sensors inexpensive, portable, convenient, safe, reliable, it can be used by the user at any time, who downloads the information on your personal computer through USB drives and then upload it to the Internet and let available to the treating physician. Graphs, statistics, analysis and reports generated serve as support in the development of better diagnosis of this disease.

Bibliography

American Cancer Society (2014, Enero 31). "Resumen sobre el cáncer de seno". Recuperado de http://www.cancer.org/acs/groups/cid/documents/webcontent/003038-pdf.pdf

Clínica Dam (2011, Enero 28) "Imagen de Biopsia con aguja del seno". Recuperado de http://www.clinicadam.com/imagenes-de-salud/17016.htm

Pedro F., Frisneda (2012, Octubre 17) "La mamografía paso a paso". Extraído el 23/XI/2014 desde http://www.eldiariony.com/Mamografia-paso-a-paso

INEGI (2014, Enero 31) "ESTADÍSTICAS A PROPÓSITO DEL DÍA MUNDIAL CONTRA EL CÁNCER". Recuperado de http://www.inegi.org.mx/inegi/contenidos/espanol/prensa/Contenidos/estadisticas/2014/mama0.pdf

López Carrillo, Lizbeth (Mayo, 2001) "Identificación de lesiones mamarias malignas en México" Recuperado de http://www.scielo.org.mx/scielo.php?pid=S0036-36342001000300004&script=sci_arttext

Marie Knaul, Felicia (2009, Junio) "Cáncer de mama en México: una prioridad apremiante" Recuperado de http://www.scielosp.org/scielo.php?pid=S0036-36342009000800026&script=sci_arttext&tlng=es

Medline Plus (2013, Noviembre 15) "Autoexamen de mamas". Recuperado de http://www.nlm.nih.gov/medlineplus/spanish/ency/article/001993.htm

Televisa (2014, Octubre 02) "Autoridades advierten de aumento de muertes por cáncer de mama". Recuperado de http://noticieros.televisa.com/mexico/1410/autoridades-advierten-aumento-muertes-cancer-mama/

Pérez García, Manuel (2013). "Comprender el Cáncer de Mama". Barcelona: Amat. Extraído el 14/09/2014 desde http://books.google.es/. ISBN 978-84-9735-686-2

María Yaneli, Ameca (2012, Diciembre 17). "Validación Cuantitativa de Información Termográfica para el pre-diagnóstico de Cáncer de Mama (Tesis de maestría, Laboratorio Nacional de Informática Avanzada)" Recuperado de

http://www.lania.mx/~emezura/util/files/TesisYaneliAmeca-

FINAL.pdf

Figures