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EFFICACY OF COMPUTERIZED INFRARED IMAGING ANALYSIS TO EVALUATE MAMMOGRAPHICALLY SUSPICIOUS LESIONS.
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ABSTRACT

OBJECTIVE: The purpose of this clinical trial was to determine the efficacy of a dynamic computerized infrared imaging system for distinguishing between benign and malignant lesions in patients undergoing biopsy on the basis of mammographic findings.

SUBJECTS AND METHODS: A 4-year clinical trial was conducted at five institutions using infrared imaging of patients for whom breast biopsy had been recommended. The data from a blinded subject set were obtained in 769 subjects with 875 biopsied lesions resulting in 187 malignant and 688 benign findings. The infrared technique records a series of sequential images that provides an assessment of the infrared information in a mammographically identified area. The suspicious area is localized on the infrared image by the radiologist using mammograms, and an index of suspicion is determined, yielding a negative or positive result.

RESULTS: In the 875 biopsied lesions, the index of suspicion resulted in a 97% sensitivity, a 14% specificity, a 95% negative predictive value, and a 24% positive predictive value. Lesions that were assessed as false-negative by infrared analysis were microcalcifications, so an additional analysis was performed in a subset excluding lesions described only as microcalcification. In this restricted subset of 448 subjects with 479 lesions and 110 malignancies, the index of suspicion resulted in a 99% sensitivity, an 18% specificity, a 99% negative predictive value, and a 27% positive predictive value. Analysis of infrared imaging performance in all 875 biopsied lesions revealed that specificity was statistically improved in dense breast tissue compared with fatty breast tissue.

CONCLUSION: Infrared imaging offers a safe noninvasive procedure that would be valuable as an adjunct to mammography in determining whether a lesion is benign or malignant.

THE EVOLVING ROLE OF THE DYNAMIC THERMAL ANALYSIS IN THE EARLY DETECTION OF BREAST CANCER.
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ABSTRACT

It is now recognised that the breast exhibits a circadian rhythm which reflects its physiology. There is increasing evidence that rhythms associated with malignant cells proliferation are largely non-circadian and that a circadian to ultradian shift may be a general correlation to neoplasia. Cancer development appears to generate its own thermal signatures and the complexity of these signatures may be a reflection of its degree of development. The limitations of mammography as a screening modality especially in young women with dense breasts necessitated the development of novel and more effective screening strategies with a high sensitivity and specificity. Dynamic thermal analysis of the breast is a safe, non-invasive approach that seems to be sensitive for the early detection of breast cancer. This article focuses on dynamic thermal analysis as an evolving method in breast cancer detection in pre-menopausal women with dense.

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breast tissue. Prospective multi-centre trials are required to validate this promising modality in screening. The issue of false positives require further investigation using molecular genetic markers of malignancy and novel techniques such as mammary ductoscopy.

MODELING STATIC AND DYNAMIC THERMOGRAPHY OF THE HUMAN BREAST UNDER ELASTIC DEFORMATION.

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ABSTRACT

An abnormal thermogram has been shown to be a reliable indicator of increased risk of breast cancer. Numerical modeling techniques for thermography are proposed to quantify the complex relationships between the breast thermal behaviors and the underlying physiological/pathological conditions. Previous thermal modeling techniques did not account for gravity-induced elastic deformation arising from various body postures, nor did they suggest that a dynamic thermal procedure may be used to enhance clinical diagnosis. In this paper, 3D finite element method (FEM)-based thermal and elastic modeling techniques are developed to characterize comprehensively both the thermal and elastic properties of normal and tumorous breast tissues during static and dynamic thermography. In the steady state, gravity-induced breast deformation is found to cause an upper-lower asymmetric surface temperature contrast for sitting/standing up body posture, even though all the thermal and elastic properties are assumed uniform. Additionally, the tumor-induced surface temperature alterations are found to be caused primarily by shallow tumors and to be less sensitive to tumor size than to tumor depth. In the dynamic state, the breast exhibits distinctive temporal patterns that are associated with distinct thermal events: cold stress and thermal recovery induced by changes in the ambient temperature. Specifically, the tumor-induced thermal contrast shows an opposite initial change and delayed peak as compared with the deformation-induced thermal contrast. These findings are expected to provide a stronger foundation for, and greater specificity and precision in, thermographic diagnosis, and treatment of breast cancer.

THERMAL ANALYSIS OF A THREE-DIMENSIONAL BREAST MODEL WITH EMBEDDED TUMOUR USING THE TRANSMISSION LINE MATRIX (TLM) METHOD.

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ABSTRACT

Breast thermography is a non-invasive tool for early detection of breast cancer. It was subject for many years to some controversial issues regarding its efficiency. Advances in infrared camera technology and progress in image processing systems had brought thermal breast imaging back as a valid tool for mammography. Numerical modelling of heat transfer within a woman breast is being an attractive tool that may reveal the conditions under which tumours can be detected in a thermogram. The aim of this work is to use the transmission line matrix (TLM) to model a regular three-dimensional breast with embedded tumour and analyse sensitivity parameters.
COMPUTER SIMULATION IN CONJUNCTION WITH MEDICAL THERMOGRAPHY AS AN ADJUNCT TOOL FOR EARLY DETECTION OF BREAST CANCER.

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ABSTRACT

BACKGROUND: Mathematical modelling and analysis is now accepted in the engineering design on par with experimental approaches. Computer simulations enable one to perform several 'what-if' analyses cost effectively. High speed computers and low cost of memory has helped in simulating large-scale models in a relatively shorter time frame. The possibility of extending numerical modelling in the area of breast cancer detection in conjunction with medical thermography is considered in this work.

METHODS: Thermography enables one to see the temperature pattern and look for abnormality. In a thermogram there is no radiation risk as it only captures the infrared radiation from the skin and is totally painless. But, a thermogram is only a test of physiology, whereas a mammogram is a test of anatomy. It is hoped that a thermogram along with numerical modelling will serve as an adjunct tool. Presently mammogram is the 'gold-standard' in breast cancer detection. But the interpretation of a mammogram is largely dependent on the radiologist. Therefore, a thermogram that looks into the physiological changes in combination with numerical simulation performing 'what-if' analysis could act as an adjunct tool to mammography.

RESULTS: The proposed framework suggested that it could reduce the occurrence of false-negative/positive cases.

CONCLUSION: A numerical bioheat model of a female breast is developed and simulated. The results are compared with experimental results. The possibility of this method as an early detection tool is discussed.

EFFECT OF BLOOD FLOW, TUMOUR AND COLD STRESS IN A FEMALE BREAST: A NOVEL TIME-ACCURATE COMPUTER SIMULATION.

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ABSTRACT

Breast cancer is a dreadful disease among women and early detection helps in achieving a cure. The mammogram is presently the standard tool for detecting breast abnormality, but its sensitivity is lower for women with dense breasts. It has been found that women with an abnormal thermogram are at a higher risk and have a poorer prognosis. However, performing and interpreting thermograms requires meticulous training. Computer simulations can be an additional tool to help the clinician in the interpretation. In this paper, a novel and flexible finite element model of a female breast is developed. Both steady state and time-dependent solutions are obtained. Steady state solutions globally match experimental thermographic results with the proper choice of blood perfusion source terms, tissue thickness and geometric scaling factor. Although the simulations may not be useful in providing a unique solution (i.e. exact size and location of the tumour owing to the complex physiological relationship between the tumour and the breast surface temperature), it would nevertheless help in the 'analysis by elimination'. An example of this type of analysis is also presented.
NUMERICAL UNCERTAINTY AND PERFUSION INDUCED INSTABILITY IN BIOHEAT EQUATION: ITS IMPORTANCE IN THERMOGRAPHIC INTERPRETATION.
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ABSTRACT
The use of engineering in biomedical sciences has opened new facets in research. The present paper deals with problems arising from numerical simulation, in order to develop an expert system for the diagnosis of breast cancer using thermography. A female breast is modelled in three dimensions and the surface temperature pattern is obtained by solving the bioheat equation. This solution will be used in conjunction with a database of thermograms to develop an intelligent diagnostic tool. The focus of the present paper is to build and check the confidence level of the numerical scheme before proceeding to model the actual problem. The parametric study is done along with a check for mesh insensitivity and wiggle free isotherm contours. This process yielded a benchmark nodal distance, with which the 3D model is generated and isotherm pattern analysed. It can be seen that this enhances the accuracy of the surface temperature distribution. The use of this is tested in a close-to-actual numerical breast model and the results compared with the thermographic results. The outcome is very encouraging. Finally, a typical clinical protocol in conjunction with the use of numerical prediction for breast thermographic interpretation is outlined.

PMID: 11695664 [PubMed - indexed for MEDLINE]

EFFECT OF FORCED CONVECTION ON THE SKIN THERMAL EXPRESSION OF BREAST CANCER.
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ABSTRACT
A bioheat-transfer-based numerical model was utilized to study the energy balance in healthy and malignant breasts subjected to forced convection in a wind tunnel. Steady-state temperature distributions on the skin surface of the breasts were obtained by numerically solving the conjugate heat transfer problem. Parametric studies on the influences of the airflow on the skin thermal expression of tumors were performed. It was found that the presence of tumor may not be clearly shown due to the irregularities of the skin temperature distribution induced by the airflow field. Nevertheless, image subtraction techniques could be employed to eliminate the effects of the flow field and thermal noise and significantly improve the thermal signature of the tumor on the skin surface. Inclusion of the possible skin vascular response to cold stress caused by the airflow further enhances the signal, especially for deeply embedded tumors that otherwise may not be detectable.

PMID: 15179850 [PubMed - indexed for MEDLINE]
Mikulska D.

ABSTRACT

INTRODUCTION: Thermal imaging is a non-contact, non-invasive diagnostic method for study human body temperature. Therefore infra red thermal imaging finds increasing application in clinical medicine.

PURPOSE: The aim of this paper was to present and discuss the history and applications of thermal imaging in medicine.

MATERIAL AND METHODS: The literature dealing with the history and applications of thermal imaging in medicine has been reviewed.

RESULTS: Medical thermography was born in 1957 when a surgeon, Dr. R. Lawson discovered that his breast cancer patients had higher skin temperature over the cancer area. Since the 1970's thermography has been used in many areas of medicine. Early problems such as low detector sensitivity, but most significantly, poor training of thermography technicians was the source of error in thermography and retarded the acceptance of this technique until 1990. Since that time, thermographic equipment has evolved significantly. Modern thermal imaging systems comprise technically advanced thermal cameras coupled to computers with sophisticated software solutions. The recorded images are now of good quality and may be further processed to obtain reliable information. Thermography can be applied as a diagnostic tool in oncology, allergic diseases, angiology, plastic surgery, rheumatology, and elsewhere. Contemporary thermal imaging must be performed according to certain principles aimed at reliability and reproducibility of results.

CONCLUSIONS: 1. Thermography is a safe, accurate and, most importantly, a non-invasive diagnostic method in clinical medicine. 2. Ignoring any of the principles worked out by the European Association of Thermology leaves thermography open to error and thus reduces acceptance of this technique in medical diagnostics.

PMID: 17131845 [PubMed - indexed for MEDLINE]

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ABSTRACT

The differences of body surface temperature reflect the changes of the status of body tissues. In this regard, detecting and forecasting the changes of the surface temperature is the objective of the technique of medical thermal diagnosis, and how to diagnose the disease earlier with the use of thermal images is a common problem in the field of medical diagnostics and biological engineering. The authors put forward that utilizing the soft-sensing techniques in the field of engineering will be a good solution.

PMID: 16422084 [PubMed - indexed for MEDLINE]
FUNCTIONAL INFRARED IMAGING IN MEDICINE: A QUANTITATIVE DIAGNOSTIC APPROACH.

Merla A, Romani GL.

ABSTRACT

The role and the potentialities of high-resolution infrared thermography, combined to bio-heat modelling, have been largely described in the last years in a wide variety of biomedical applications. Quantitative assessment over time of the cutaneous temperature and/or of other biomedical parameters related to the temperature (e.g., cutaneous blood flow, thermal inertia, sympathetic skin response) allows for a better and more complete understanding and description of functional processes involved and/or altered in presence of ailment and interfering with the regular cutaneous thermoregulation. Such an approach to thermal medical imaging requires both new methodologies and tools, like diagnostic paradigms, appropriate software for data analysis and, even, a completely new way to look at data processing. In this paper, some of the studies recently made in our laboratory are presented and described, with the general intent of introducing the reader to these innovative methods to obtain quantitative diagnostic tools based on thermal imaging.

PMID: 17946387 [PubMed - indexed for ME

SUPERIMPOSITION OF THERMAL IMAGING TO VISUAL IMAGING USING HOMOGRAPHY.

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ABSTRACT

InfraRed Thermal Imaging (IR) permits to non-invasively map the skin temperature distribution of the human body. Combining together thermal and visual imaging enriches the informative content of IR images and provides to the physician an anatomically-based and more friendly visualization--on the thermal images--of the presence of possible pathological processes. In this paper we use a homography technique to overlap a thermal image to a visible one. The technique provides an effective pixel-to-pixel correspondences between the two images or their portions.

PMID: 18002718 [PubMed - indexed for MEDLINE]

THERMAL DETECTION OF EMBEDDED TUMORS USING INFRARED IMAGING.

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ABSTRACT

Breast cancer is the most common cancer among women. Thermography, also known as thermal or infrared imaging, is a procedure to determine if an abnormality is present in the breast tissue temperature distribution. This abnormality in temperature distribution might indicate the presence of an embedded tumor. Although thermography is currently used to indicate the presence of an abnormality, there are no standard procedures to interpret these and determine the location of an embedded tumor. This research is a first step towards this direction. It explores the relationship between the characteristics (location and power) of an embedded heat source and the resulting temperature distribution on the surface. Experiments were conducted using a resistance heater that was embedded in agar in order to simulate the heat produced by a tumor in the biological tissue. The resulting temperature distribution on the surface was imaged using

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an infrared camera. In order to estimate the location and heat generation rate of the source from these temperature distributions, a genetic algorithm was used as the estimation method. The genetic algorithm utilizes a finite difference scheme for the direct solution of the Pennes bioheat equation. It was determined that a genetic algorithm based approach is well suited for the estimation problem since both the depth and the heat generation rate of the heat source were accurately predicted.

Publication Types, MeSH Terms

PMID: 17227096 [PubMed - indexed for MEDLINE]

[THE DESIGN OF NEAR INFRARED MAMMOGRAPHY COMPUTER-AIDED DIAGNOSIS SYSTEM].

Zhan CA, Feng HQ.
Department of Electronic Science and Technology, University of Science and Technology of China.

ABSTRACT

Near infrared mammography is a new method for breast imaging for popular examination. Its merits are no radiation, without the necessaries of darkroom, etc. Based on the digital image processing and analysis system, the doctor can get informations more conveniently and with higher diagnosis reliability. In this paper, the near infrared image acquisition, processing and analysis system and its implementation are presented.

Publication Types, MeSH Terms

PMID: 12583262 [PubMed - indexed for MEDLINE]

A REAPPRAISAL OF THE USE OF INFRARED THERMAL IMAGE ANALYSIS IN MEDICINE.

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ABSTRACT

Infrared thermal imaging of the skin has been used for several decades to monitor the temperature distribution of human skin. Abnormalities such as malignancies, inflammation, and infection cause localized increases in temperature which show as hot spots or as asymmetrical patterns in an infrared thermogram. Even though it is nonspecific, infrared thermology is a powerful detector of problems that affect a patient's physiology. While the use of infrared imaging is increasing in many industrial and security applications, it has declined in medicine probably because of the continued reliance on first generation cameras. The transfer of military technology for medical use has prompted this reappraisal of infrared thermology in medicine. Digital infrared cameras have much improved spatial and thermal resolutions, and libraries of image processing routines are available to analyze images captured both statically and dynamically. If thermographs are captured under controlled conditions, they may be interpreted readily to diagnose certain conditions and to monitor the reaction of a patient's physiology to thermal and other stresses. Some of the major areas where infrared thermography is being used successfully are neurology, vascular disorders, rheumatic diseases, tissue viability, oncology (especially breast cancer), dermatological disorders, neonatal, ophthalmology, and surgery.

PMID: 10048859 [PubMed - indexed for MEDLINE]
PARAMETRIC DATA MINING AND DIAGNOSTIC RULES FOR DIGITAL THERMOGRAPHS IN BREAST CANCER.
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ABSTRACT

In this study, a novel data mining algorithm and parametric analysis protocol were utilized for generating knowledge-based diagnostic rules for infrared thermographs. First, Beier-Neely field morphing and linear affine transformation algorithms were used in geometric standardization for the whole body and partial region respectively. Gray levels of thermal images at same anatomical coordinates in the abnormal regions were then analyzed to determine upper and lower limits for diagnosis. Twenty-five parameters were extracted from each abnormal region for parametric analysis, and decision trees were used to generate the knowledge-based diagnostic rules. A total of 71 and 131 female patients with and without breast cancer respectively were both analyzed in this study. Experimental results indicated that a total of 1750 abnormal regions (703 positive and 1047 negative) were detected. Sixty one positive abnormal regions (61/703=8.6%) from 44 cancer patients (42/71=59.2%) can be found in the abovementioned 14 branches.

PMID: 19162603 [PubMed - indexed for MEDLINE]

ADVANCED INTEGRATED TECHNIQUE IN BREAST CANCER THERMOGRAPHY.
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ABSTRACT

Thermography is a passive and non-contact imaging technique used extensively in the medical arena, but in relation to breast care, it has not been accepted as being on a par with mammography. This paper proposes the analysis of thermograms with the use of artificial neural networks (ANN) and bio-statistical methods, including regression and receiver operating characteristics (ROC). It is desired that through these approaches, highly accurate diagnosis using thermography techniques can be achieved. The suggested method is a multi-pronged approach comprising of linear regression, radial basis function network (RBFN) and ROC analysis. It is a novel, integrative and powerful technique that can be used to analyse large amounts of complicated measured data such as temperature values extracted from abnormal and healthy breast thermograms. The use of regression allows the correlation between the variables and the actual health status of the subject, which is decided by other traditional means such as the gold standard of mammography for breast cancer detection. This is important as it helps to select the appropriate variables to be used as inputs for building the neural network. RBFN is next trained to produce the desired outcome that is either positive or negative. When this is done, the RBFN possess the ability to predict the outcome when there are new input variables. The advantages of using RBFN include fast training of superior classification and decision-making abilities as compared to other networks such as backpropagation. Lastly, ROC is applied to evaluate the sensitivity, specificity and accuracy of the outcome for the RBFN test files. The proposed technique has an accuracy rate of 80.95%, with 100% sensitivity and 70.6% specificity in identifying breast cancer. The results are promising as compared to clinical examination by experienced radiologists, which has an accuracy rate of approximately 60-70%. To sum up, technological advances in the field of infrared thermography over the last 20 years warrant a re-
evaluation of the use of high-resolution digital thermographic camera systems in the diagnosis and management of breast cancer. Thermography seeks to identify the presence of a tumour by the elevated temperature associated with increase blood flow and cellular activity. Of particular interest would be investigation in younger women and men, for whom mammography is either unsuitable or of limited effectiveness. The paper evaluated the high-definition digital infrared thermographic technology and knowledge base; and supports the development of future diagnostic and therapeutic services in breast cancer imaging. Through the use of integrative ANN and bio-statistical methods, advances are made in thermography application with regard to achieving a higher level of consistency. For breast cancer care, it has become possible to use thermography as a powerful adjunct and biomarker tool, together with mammography for diagnosis purposes.

PMID: 17852648 [PubMed - indexed for MEDLINE]

CURRENT IMAGING MODALITIES FOR THE DIAGNOSIS OF BREAST CANCER.
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ABSTRACT
Although mammography still remains the gold standard for breast cancer screening and diagnosis, it typically cannot differentiate benign from malignant disease and is less accurate in patients with dense glandular breasts. This article is an overview of imaging modalities that have emerged to augment mammography and improve the accuracy of non-invasive breast cancer diagnosis. Ultrasound is currently used to differentiate breast masses and guide aspirations and biopsies. Magnetic resonance imaging has excellent sensitivity in demonstrating breast cancer but a low specificity. Nuclear medicine studies have recently emerged that detect the increased metabolic rate and vascularity of breast cancers. Other modalities, such as thermography and computed tomography, have a more limited utility for breast cancer diagnosis. Digital mammography is among other emerging technological advancements that will continue to develop and improve the accuracy of breast cancer diagnosis in the future.

PMID: 10584437 [PubMed - indexed for MEDLINE]

COMPARATIVE STUDY ON THE USE OF ANALYTICAL SOFTWARE TO IDENTIFY THE DIFFERENT STAGES OF BREAST CANCER USING DISCRETE TEMPERATURE DATA.
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ABSTRACT
Breast cancer is the second leading cause of death in women. It occurs when cells in the breast begin to grow out of control and invade nearby tissues or spread throughout the body. The limitations of mammography as a screening modality, especially in young women with denser breasts, necessitated the development of novel and more effective screening strategies with acceptable sensitivity and specificity. The aim of this study was to develop a feasible interpretive software system which was able to detect and classify breast cancer patients by employing techniques of different analytical software. The protocol described uses 6,000 pieces of thermal data collected from 16-sensors, eight placed on the surface of each breast. Data was collected every 5 min for the duration of the test period. Placement of sensors was accomplished with the use of a template design from information provided by the national tumor registry to insure that the information was collected in areas of the breast where most breast cancers develop. Data in this study was collected from 90 individuals exhibiting four different breast conditions, namely: normal,
benign, cancer and suspected-cancer. The temperature data collected from these 16 sensors placed on the surface of each breast were fed as inputs to the classifiers. Comparisons were made on five different kinds of classifiers: back-propagation algorithm, probabilistic neural network, fuzzy (Sugeno-type), Gaussian mixture model and support vector machine. These classifiers were able to attain approximately 80% accuracy in classifying the four different diagnoses (normal, benign, cancer and suspected-cancer). Gaussian mixture model was the most sensitive classifier, achieving the highest sensitivity of 94.8%. Support vector machine was considered the best classifier as it was able to produce the most specific and accurate results. Based on these evaluations, this current effort shows the feasibility of applying analytical software techniques together with the real-time functional thermal analysis to develop a potential tool for the detection and classification of breast cancer.

PMID: 19397099 [PubMed - indexed for MEDLINE]

[DYNAMIC TELETHERMOGRAPHY IN MAMMARY CARCINOMA].
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ABSTRACT
Dynamic telethermography, a still new technique, enables to obtain original data on the behaviour of mammary carcinomas both in space and time. It deserves to be used in conjunction with the other clinical and paraclinical methods in the "non bloody combined diagnosis" of such tumors. In spite of 5 per cent of false positive and 8 to 16 per cent false negative results, it helps to correct over one half of erroneous radioclinical diagnosis. It often brings accurate data on extension, multifocality and topography of these carcinomas and plays an efficient part in post-therapeutical systematic periodical surveillance, more especially when the breast has been preserved. Capable of detecting small non-palpable adenocarcinomas, it could be used as a trustworthy screening procedure. Finally, it demonstrates "cold" cancers and too "hot" cancers, the former of probably slow development, the latter developing rapidly. Beyond a simple positive diagnosis, it is contributory to the first steps of clinical physiology of breast carcinomas, which is all the more remarkable because it is a true non-traumatic tele-measurement.

PMID: 17474649 [PubMed - indexed for MEDLINE]

ENHANCEMENT OF THERMAL DIAGNOSTICS ON TUMORS UNDERNEATH THE SKIN BY INDUCED EVAPORATION.

ABSTRACT
Infrared imaging has frequently been used in clinics to detect changes in skin surface temperature associated with some superficial tumors. In order to accurately detect and diagnose tumors (especially in their early stages) using infrared thermography, enhancement of thermal expression on the skin over the tumor is desired. This study proposed a novel approach to effectively enhance the skin thermal expression of tumor by induced evaporation on skin surface. To illustrate its feasibility, numerical calculation was first applied to simulate the corresponding heat transfer process, from which the three-dimensional transient temperatures of the biological bodies subjected to induced evaporation were theoretically predicted. Further, preliminary infrared imaging experiments on human forearm were also performed, in which water and 75% (V/V) medical ethanol were particularly chosen to be respectively sprayed on the skin surface. Both the numerical and experimental results indicate that the induced evaporation can significantly enhance the sensitivity of temperature mapping on skin surface over the tumor. The results also suggest that the induced evaporation method can be used to improve the diagnostic accuracy of infrared thermography, especially for tumors at early stages and/or deeply embedded.

PMID: 17282022 [PubMed - in process]
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Geshelin SA, Noskin AL, Kravchenko VA.

**ABSTRACT**

Contact thermography was performed in 87 patients with benign and in 75 with cancerous tumors of the breast. Hyperthermia over the tumor is characterized by a 2.2 degrees C and higher increase of the temperature and was registered only in cancer of the breast. Anisothermy of the breast was characterized by a +/- 0.5 degrees C and higher and may be considered as a supplementary diagnostic sign distinguishing cancer of the breast from benign tumors.

PMID: 2588501 [PubMed - indexed for MEDLINE]

[CONTACT THERMOGRAPHY IN THE DIFFERENTIAL DIAGNOSIS OF BENIGN TUMORS AND CANCER OF THE BREAST].

Moiseenko MD, Kitsai TA, Mukhina MV.

**ABSTRACT**

One hundred of women with diseases of the mammary gland were examined. Breast cancer was found in 31 patients, 65 patients had various benign tumors, 4 women had chronic mastitis. Breast cancer was manifested by pronounced focal elevation of temperature over the tumor, temperature asymmetry of mammary glands, uneven boundaries of hyperthermia focus with "pathways" of hyperthermia running from the tumor to regional lymph nodes (in 75% of cases) even when no metastases are found histologically. Patients with alterations in the mammary glands referred to as precancerous, are thermographically characterized by focal hyperthermia with distinct boundaries. Nonproliferating forms of fibroadenoma, as a rule, do not manifest themselves by focal pictures without changes in the general background of the thermogram.

PMID: 7189619 [PubMed - indexed for MEDLINE]

[COLOR CONTACT THERMOGRAPHY IN THE DIAGNOSIS OF BREAST DISEASES].

Ng EY, Chen Y, Ung LN.

**ABSTRACT**

Breast cancer is a common and dreadful disease in women. The surface temperature and the vascularization pattern of the breast could indicate breast diseases. Establishing the surface isotherm pattern of the breast and the normal range of cyclic variations of temperature distribution can assist in identifying the abnormal infrared images of diseased breasts. This paper investigates the cyclic variation of temperature and vascularization of the normal breast thermograms under a controlled environment. More than 50 Asian women, were examined and some of them have been examined continuously for two month. All together, not less than 800 thermograms were obtained. Before these thermograms can be analysed objectively via a computer algorithm, they must be digitized and segmented. The authors present a method to segment thermograms and extract the useful region from the background. After the image processing, these thermograms can be analysed and then the best time to perform an examination can be chosen. All

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these results are important for establishing a data bank of normal breast thermography, to choose the best time for an examination and as a systematic methodology for evaluating and analysing the abnormal breast thermography in the future.

MOTION ARTIFACT REDUCTION IN BREAST DYNAMIC INFRARED IMAGING.
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ABSTRACT
Dynamic infrared imaging is a promising technique in breast oncology. In this paper, a quantum well infrared photodetector infrared camera is used to acquire a sequence of consecutive thermal images of the patient's breast for 10 s. Information on the local blood perfusion is obtained from the spectral analysis of the time series at each image pixel. Due to respiratory and motion artifacts, the direct comparison of the temperature values that a pixel assumes along the sequence becomes difficult. In fact, the small temperature changes due to blood perfusion, of the order of 10-50 mK, which constitute the signal of interest in the time domain, are superimposed onto large temperature fluctuations due to the subject's motion, which represent noise. To improve the time series S/N, and as a consequence, enhance the specificity and sensitivity of the dynamic infrared examination, it is important to realign the thermal images of the acquisition sequence, thus reducing motion artifacts. In a previous study, we demonstrated that a registration algorithm based on fiducial points is suitable to both clinical applications and research, when associated with a proper set of skin markers. In this paper, we quantitatively evaluate the performance of different marker sets by means of a model that allows for estimating the S/N increment due to registration, and we conclude that a 12-marker set is a good compromise between motion artifact reduction and the time required to prepare the patient.

SUBCUTANEOUS TEMPERATURES: A METHOD OF NONINVASIVE SENSING.
Barrett AH, Myers PC.

ABSTRACT
A new method of noninvasive sensing of the subsurface temperature distribution in human and animal tissue is described. Thermal radiation emitted from subsurface depths of several centimeters can be detected with microwave receivers. Temperature sensitivity of order 0.1 degree C and spatial resolution of approximately 1 by 2 centimeters have been obtained. Measurements demonstrating the technique, with feline and human tissue, are reported. A potential medical application is the detection of subsurface thermal anomalies such as malignant tumors and regions of vascular insufficiency.
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CIRCADIAN RHYTHM CHAOS: A NEW BREAST CANCER MARKER.
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CIRCADIAN RHYTHM AND ITS ROLE IN MALIGNANCY.
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Abstract:
The most disappointing aspect of breast cancer treatment as a public health issue has been the failure of screening to improve mortality figures. Since treatment of late-stage cancer has indeed advanced, mortality can only be decreased by improving the rate of early diagnosis. From the mid-1950s to the mid-1970s, it was expected that thermography would hold the key to breast cancer detection, as surface temperature increases overlying malignant tumors had been demonstrated by thermographic imaging. Unfortunately, detection of the 1-3 degrees C thermal differences failed to bear out its promise in early identification of cancer. In the intervening two-and-a-half decades, three new factors have emerged: it is now apparent that breast cancer has a lengthy genes; a long-established tumor—even one of a certain minimum size—induces increased arterial/capillary vascularity in its vicinity; and thermal variations that characterize tissue metabolism are circadian ("about 24 hours") in periodicity. This paper reviews the evidence for a connection between disturbances of circadian rhythms and breast cancer. Furthermore, a scheme is proposed in which circadian rhythm "chaos" is taken as a signal of high risk for breast cancer even in the absence of mammographic evidence of neoplasm or a palpable tumor. Recent studies along this line suggest that an abnormal thermal sign, in the light of our present knowledge of breast cancer, is ten times as important an indication as is family history data.

Abstract:
Circadian rhythms are daily oscillations of multiple biological processes directed by endogenous clocks. The circadian timing system comprises peripheral oscillators located in most tissues of the body and a central pacemaker located in the suprachiasmatic nucleus (SCN) of the hypothalamus. Circadian genes and the proteins produced by these genes constitute the molecular components of the circadian oscillator which form positive/negative feedback loops and generate circadian rhythms. The circadian regulation extends beyond clock genes to involve various clock-controlled genes (CCGs) including various cell cycle genes. Aberrant expression of circadian clock genes could have important consequences on the transactivation of downstream targets that control the cell cycle and on the ability of cells to undergo apoptosis. This may lead to genomic instability and accelerated cellular proliferation potentially promoting carcinogenesis. Different lines of evidence in mice and humans suggest that cancer may be a circadian-related disorder. The genetic or functional disruption of the molecular circadian clock has been found in various cancers including breast, ovarian, endometrial, prostate and hematological cancers. The acquisition of current data in circadian clock mechanism may help chronotherapy, which
takes into consideration the biological time to improve treatments by devising new therapeutic approaches for treating circadian-related disorders, especially cancer.


THERMAL MODELING OF THE NORMAL WOMAN'S BREAST.
Osman MM, Afify EM.

ABSTRACT
A comprehensive thermal model of the normal woman's breast is presented. The model is developed taking into consideration metabolic heat production, tissue perfusion with capillary blood, arterial and venous blood thermal interaction and change of arterial blood temperature with position. A series of computer programs are written using a 3-dimensional finite-element technique to evaluate the surface temperature distribution of the breast. Comparison between the results obtained for the model and those from thermograms of a woman's breast are in good agreement.

PMID: 6738016 [PubMed - indexed for MEDLINE]

Prog Clin Biol Res. 1982;107:133-54.

Simpson HW, Wilson D, Griffiths K, Match F, Halberg F, Gautherie M.

ABSTRACT
Publication Types, MeSH Terms

[PLATE THERMOGRAPHY OF THE BREAST. PRELIMINARY RESULTS OF A NEW METHOD OF THERMOGRAPHIC EXAMINATION (AUTHOR'S TRANSL)].
Müller R, Barth V, Heuck F.

ABSTRACT
Publication Types, MeSH Terms

BREAST THERMOGRAPHY AS A SCREENING TECHNIQUE. AN EVALUATION OF PERFORMANCE DATA.
Revesz G, Lapayowker MS.

ABSTRACT
The concepts of relative operating characteristics (ROC-curves) and detectability index (d') are introduced for the purpose of evaluating performance in breast thermography. In assessing published information on the subject we have found that much of it is anecdotal and lacks sufficient data to determine performance. We have also found that for those published findings which had sufficient data it was possible to reconcile conflicting conclusions as to the efficacy of thermography, and that performance could be quantitated with the use of the detectability index. Conclusions for optimizing available clinical thermographic techniques are given together with ways for future improvement.

PMID: 1106837 [PubMed - indexed for MEDLINE]
[THE IMPORTANCE OF THE THERMOGRAPHIC STUDY METHOD IN ONCOLOGY].

Bilyns'kyj BT, Novak OP.

ABSTRACT

Results of the study give reason to consider distant thermography a method for detection of a tumor and differential diagnosis of tumorous and inflammatory pathology. Registering changes of temperature in tumorous lesion, that is assessment of functional condition of pathological focus, may be helpful in solving diagnostic problems and provides possibility for monitoring of the process in the course of radiation therapy.

PMID: 8209469 [PubMed - indexed for MEDLINE]

THE DIAGNOSIS OF BREAST PRE-CANCER BY THE CHRONOBCRA--II. THE BREAST PRE-CANCER TEST.
Simpson HW, Griffiths K.
University Department of Pathology, Royal Infirmary, Glasgow, U.K.

PMID: 2627722 [PubMed - indexed for MEDLINE]

THERMOGRAPHIC EVALUATION OF THE BENIGN DISEASES AND REACTIVE CHANGES OF THE SKIN.
Stüttgen G.

ABSTRACT

White Erythema is combined with an augmentation of heat radiation only if the convection of heat is increased, reflectoric flush phenomenon is detected more reliably by thermography than reflex photometrics. Urticarial exanthema shows an increased heat radiation if the edema derives from the deeper layers of the skin vessels, whereas a cooling effect results from an edema affecting the superficial layers of the skin. Papular lesions with inflammation are characterized by increased heat radiation. Most of the benign skin tumors are not characterized by an increased convection of heat and show approximately the same temperature as the surrounding skin. Diminished heat isolation by atrophy of the subcutaneous fat is followed by an increase of heat radiation by the conduction of heat from the warm inside of the core. The blood storage capacity of the deeper venous plexus and varicose veins of the lower legs maintain a raised skin temperature which can be decreased by pharmacological vasoconstriction of these veins by catecholamines and serotonin. Finally, the pharmacological effectiveness of topically applied drugs can change the blood flow through the skin vessels and alter the heat radiation of the skin surface.

PMID: 7167494 [PubMed - indexed for MEDLINE]
THE CORRELATIVE VALUE OF THERMOMETRY AND THE GLUCOSE TOLERANCE TEST IN CANCER OF THE BREAST.

Chiricu?? I, Bucur M, Opri? I, Bologa S.
PMID: 5116409 [PubMed - indexed for MEDLINE]

[HEAT FIELD OF THE BREASTS OF HEALTHY WOMEN (ACCORDING TO THERMOGRAPHIC DATA)].

Karochkin BB, Kisenishcki? AM, Ginzburg LI, Zhukovski? VD, Shekhter AI.
PMID: 853884 [PubMed - indexed for MEDLINE]

DEEPLY COOLED FAR-INFRARED THERMAL IMAGING STRATEGY FOR EARLY TUMOR DIAGNOSTICS.

Zhang H, Liu J, Deng ZS, Zhou YX.
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ABSTRACT

This paper is dedicated to evaluate the thermal behavior of skin surface embedded with tumor tissue through construction of three-dimensional heat transfer model of the human body. It was found that the far-infrared imaging equipment could not yet get the accurate results for diagnosis of tumors developed in early stage or located deeply in the human body, because of limited resolution and accuracy in the current system. Conceptual experiments with a thermal imaging system under various cooling levels were performed to confirm this issue. A dual cooling cavity was proposed to realize ultra-low-temperature so as to improve the cooling of the current infrared equipment and thereby to enhance its image precision and accuracy. This study is expected to be of significant reference value for realizing an early diagnosis of cancers through medical image.

PMID: 19565794 [PubMed - in process]

[ THERMOGENIC CAPACITY OF BREAST CARCINOMAS. II. VARIATION DURING HORMONAL TESTS ].

Gautherie M, Gros C, Bourjat P, Quenneville Y.
PMID: 4752707 [PubMed - indexed for MEDLINE]

HEAT-SEEKING PADS MAY HELP FIND EARLY BREAST CANCERS.

Randal J.
PMID: 9326909 [PubMed - indexed for MEDLINE]
**Abstract**

In this study, a computer-assisted entropy-based feature extraction and decision tree induction protocol for breast cancer diagnosis using thermograph images was proposed. First, Beier-Neely field morphing and linear affine transformation were applied in geometric standardization for whole body and partial region respectively. Gray levels of pixel population at the same anatomical position were statistically analyzed for abnormal region classification. Morphological closing and opening operations were used to identify unified abnormal regions. Three types of 25 feature parameters (i.e. 10 geometric, 7 topological and 8 thermal) were extracted for parametric factor analysis. Positive and negative abnormal regions were further reclassified by decision trees to induce the case-based diagnostic rules. Finally, anatomical organ matching was utilized to identify the corresponding organ with the positive abnormal regions. To verify the validity of the proposed case-based diagnostic protocol, 71 and 131 female patients with and without breast cancer were analyzed. Experimental results indicated that 1750 abnormal regions (703 positive and 1047 negative) were detected and 822 branches were broken down into the decision space. Fourteen branches were found to have more than 4 positive abnormal regions. These critical diagnostic paths with less than 10% of positive abnormal regions (61/703=8.6%) can effectively classify more than half of the cancer patients (42/71=59.2%) in the abovementioned 14 branches.

**APPLICATION OF K- AND FUZZY C-MEANS FOR COLOR SEGMENTATION OF THERMAL INFRARED BREAST IMAGES.**

Etehad Tavakol M, Sadri S, Ng EY.

Electrical and Computer Engineering Department, Isfahan University of Technology, Isfahan, Iran.

**Abstract**

Color segmentation of infrared thermal images is an important factor in detecting the tumor region. The cancerous tissue with angiogenesis and inflammation emits temperature pattern different from the healthy one. In this paper, two color segmentation techniques, K-means and fuzzy c-means for color segmentation of infrared (IR) breast images are modeled and compared. Using the K-means algorithm in Matlab, some empty clusters may appear in the results. Fuzzy c-means is preferred because the fuzzy nature of IR breast images helps the fuzzy c-means segmentation to provide more accurate results with no empty cluster. Since breasts with malignant tumors have higher temperature than healthy breasts and even breasts with benign tumors, in this study, we look for detecting the hottest regions of abnormal breasts which are the suspected regions. The effect of IR camera sensitivity on the number of clusters in segmentation is also investigated. When the camera is ultra sensitive the number of clusters being considered may be increased.

MeSH Terms

PMID: 20192053 [PubMed - indexed for MEDLINE]
THE ACCURACY OF DIGITAL INFRARED IMAGING FOR BREAST CANCER DETECTION IN WOMEN UNDERGOING BREAST BIOPSY.

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COMMENT IN:

ABSTRACT

BACKGROUND: Mammography has a lower sensitivity for breast cancer detection in younger women and those with dense breasts. Recent improvements in digital infrared breast imaging suggest there may be a role for this technology and we have studied its performance in 100 women prior to breast needle core biopsy (CB).

METHODS: All patients were imaged using a digital infrared breast (DIB) scan (Sentinel BreastScan) prior to breast biopsy. Analysis of the infrared scans was performed, blinded to biopsy results, in four different ways: Sentinel screening report, Sentinel artificial intelligence (neural network), expert manual review and NoTouch BreastScan a novel artificial intelligence programme.

RESULTS: Of 106 biopsies performed in 100 women, 65 were malignant and 41 were benign. Sensitivity of Sentinel screening (53%) and Sentinel neural network (48%) was low but analysis with NoTouch software (70%) was much closer to expert manual review (78%). Sensitivity (78%) and specificity (75%) using NoTouch BreastScan were higher in women under 50 and the combination of mammography and DIB, with NoTouch interpretation, in this age group resulted in a sensitivity of 89%.

CONCLUSION: DIB using NoTouch is an effective adjunctive test for breast cancer detection in women under 70 and appears to be particularly effective in women under 50 where maximal sensitivity (78%) and specificity (75%) were observed. The combined sensitivity of NoTouch BreastScan and mammography in women under 50 was encouraging at 89%, suggesting a potential way forward for a dual imaging approach in this younger age group.

PMID: 20452740 [PubMed - indexed for MEDLINE]

Guang Pu Xue Yu Guang Pu Fen Xi. 2009 Mar;29(3):611-5.

[PSEUDO COLOR METHOD FOR THE INFRARED THERMOGRAM DISPLAY OF LOCAL BREAST FOCUS TISSUE].

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ABSTRACT

An infrared thermogram which reflects the human body surface temperature distribution can be obtained through detecting the infrared thermal radiation from each point on the human body surface. When a malignant tumor occurs in a breast, it will cause an increase in the prominent temperature in the breast surface focus region due to the abnormal blood transmission state of local focus tissue. Breast cancer can be detected through the visual analysis of the focus regions by physicians. In order to help physicians better find these focus regions, the present paper improved the traditional pseudo color display method by introducing visual effect factor and made the focus regions have a better display effect. The efficacy of this method was verified in the breast infrared thermograms of 47 breast cancer patients. The result from visual analysis of the focus region in infrared thermogram by this method can also be compared with the
tissue blood transmission state from near infrared spectroscopy (NIRS) and other methods. It will be helpful to obtain more accurate diagnostic information.

PMID: 19455784 [PubMed - indexed for MEDLINE]

THERMOGRAPHY BASED BREAST CANCER DETECTION USING TEXTURE FEATURES AND SUPPORT VECTOR MACHINE.
Acharya UR, Ng EY, Tan JH, Sree SV.
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ABSTRACT
Breast cancer is a leading cause of death nowadays in women throughout the world. In developed countries, it is the most common type of cancer in women, and it is the second or third most common malignancy in developing countries. The cancer incidence is gradually increasing and remains a significant public health concern. The limitations of mammography as a screening and diagnostic modality, especially in young women with dense breasts, necessitated the development of novel and more effective strategies with high sensitivity and specificity. Thermal imaging (thermography) is a noninvasive imaging procedure used to record the thermal patterns using Infrared (IR) camera. The aim of this study is to evaluate the feasibility of using thermal imaging as a potential tool for detecting breast cancer. In this work, we have used 50 IR breast images (25 normal and 25 cancerous) collected from Singapore General Hospital, Singapore. Texture features were extracted from co-occurrence matrix and run length matrix. Subsequently, these features were fed to the Support Vector Machine (SVM) classifier for automatic classification of normal and malignant breast conditions. Our proposed system gave an accuracy of 88.10%, sensitivity and specificity of 85.71% and 90.48% respectively.

PMID: 20957511 [PubMed - as supplied by publisher]

THE POTENTIAL ROLE OF DYNAMIC THERMAL ANALYSIS IN BREAST CANCER DETECTION.
Salhab M, Keith LG, Laguens M, Reeves W, Mokbel K.
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ABSTRACT
BACKGROUND: It is presently well accepted that the breast exhibits a circadian rhythm reflective of its physiology. There is increasing evidence that rhythms associated with malignant cells proliferation are largely non-circadian. Cancer development appears to generate its own thermal signatures and the complexity of these signatures may be a reflection of its degree of development. The limitations of mammography as a screening modality especially in young women with dense breasts necessitated the development of novel and more effective screening strategies with a high sensitivity and specificity. The aim of this prospective study was to evaluate the feasibility of dynamic thermal analysis (DTA) as a potential breast cancer screening tool.

METHODS: 173 women undergoing mammography as part of clinical assessment of their breast symptoms were recruited prior to having a biopsy. Thermal data from the breast surface were collected every five minutes for a period of 48 hours using eight thermal sensors placed on each breast surface [First Warning System (FWS), Lifeline Biotechnologies, Florida, USA]. Thermal data were recorded by microprocessors during the test period and analysed using specially developed statistical software. Temperature points from each contra-lateral sensor are plotted against each other to form a thermal motion picture of a lesion's physiological activity. DTA interpretations [positive (abnormal thermal signature) and negative (normal thermal signature)] were compared with mammography and final histology findings.
RESULTS: 118 (68%) of participating patients, were found to have breast cancer on final histology. Mammography was diagnostic of malignancy (M5) in 55 (47%), indeterminate (M3, M4) in 54 (46%) and normal/benign (M1, M2) in 9 (8%) patients. DTA data was available on 160 (92.5%) participants. Using our initial algorithm, DTA was interpreted as positive in 113 patients and negative in 47 patients. Abnormal thermal signatures were found in 76 (72%) out of 105 breast cancer patients and 37 of the 55 benign cases. Then we developed a new algorithm using multiple-layer perception and SoftMax output artificial neural networks (ANN) on a subgroup (n = 38) of recorded files. The sensitivity improved to 76% (16/21) and false positives decreased to 26% (7/27).

CONCLUSION: DTA of the breast is a feasible, non-invasive approach that seems to be sensitive for the detection of breast cancer. However, the test has a limited specificity that can be improved further using ANN. Prospective multi-centre trials are required to validate this promising modality as an adjunct to screening mammography especially in young women with dense breasts.

NEAR-INFRARED TOMOGRAPHY OF BREAST CANCER HEMOGLOBIN, WATER, LIPID, AND SCATTERING USING COMBINED FREQUENCY DOMAIN AND CW MEASUREMENT.
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ABSTRACT
In this study, near-IR tomography was implemented in the wavelength range from 661 to 948 nm to characterize breast tumors in vivo. Frequency-domain measurements provide amplitude and phase transmitted at wavelengths below 850 nm, where photomultiplier tube detection is efficient. Continuous-wave detection at additional longer wavelengths (903, 912, and 948 nm) was collected using a CCD-based spectrometer. Phantom validation experiments showed improved accuracy in hemoglobin and water concentrations using this technique. Three women with malignant breast tumors were studied. The addition of cw data at longer wavelengths increased the recovered contrast of water in the tumor region relative to surrounding tissue and allowed quantification of lipid.

TOWARD THE DESIGN OF A WEARABLE SYSTEM FOR CONTACT THERMOGRAPHY IN TELEMEDICINE.
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ABSTRACT
Thermal imaging of the skin has been used for several decades for monitoring of temperature distribution of human skin for the detection of thermal abnormalities indicating pathologies (malignancies, inflammation, infection, and vascular, dermatological, and rheumatic disorders). Literature has shown that to detect and monitor the thermal abnormalities related to pathologic conditions, there is a need to extend acquisition over 8, 12, 16, or 24 hours. A wearable device is strongly needed in contact thermography to reach the objective of long-term monitoring of contact thermography, especially in telemedicine applications. A wearable system has been designed and constructed that allows the continuous thermographic monitoring of a skin region at the point of affixation. Measurement allowed by this system is direct and not hampered by the influence of the environment--as with IR thermography--nor by the
The validation of the system embedded in a pilot preliminary telemedicine application was successful. The next step will be the wide focusing and adaptation to telemedicine clinical applications to assess the response to the chemotherapy and tune the therapy at home of the breast cancer or the response to the inflammation care.

PMID: 19382868 [PubMed - indexed for MEDLINE]

**IMPROVED INFRARED THERMOGRAPHY BASED IMAGE CONSTRUCTION FOR BIOMEDICAL APPLICATIONS USING MARKOV CHAIN MONTE CARLO METHOD.**

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**ABSTRACT**

Breast thermography is one of the scanning techniques used for breast cancer detection. Looking at breast thermal image it is difficult to interpret parameters or tumor such as depth, size and location which are useful for diagnosis and treatment of breast cancer. In our previous work (ITBIC) we proposed a framework for estimation of tumor size using clever algorithms and the radiative heat transfer model. In this paper, we expand it to incorporate the more realistic Pennes bio-heat transfer model and Markov Chain Monte Carlo (MCMC) method, and analyze its performance in terms of computational speed, accuracy, robustness against noisy inputs, ability to make use of prior information and ability to estimate multiple parameters simultaneously. We discuss the influence of various parameters used in its implementation. We apply this method on clinical data and extract reliable results for the first time using breast thermography.

PMID: 20198744 [PubMed - indexed for MEDLINE]

**EVALUATION OF FEATURE-BASED REGISTRATION IN DYNAMIC INFRARED IMAGING FOR BREAST CANCER DIAGNOSIS.**

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**ABSTRACT**

Dynamic infrared imaging has been proposed in literature as an interesting adjunctive technique to mammography in breast cancer diagnosis. For a correct analysis of the infrared image sequences, however, a preprocessing registration step may be fundamental. In this paper, we provide a first quantitative evaluation of the performances of registration on dynamic infrared images for this specific application. We propose an algorithm for the automatic control point localization and employ a feature-based piecewise linear registration approach. The quality of the image alignment is evaluated on a small sample of subjects, considering both alignment and localization errors. Results show that subject movement of up to five pixels is compensated, obtaining a subpixel error correction.

PMID: 17946428 [PubMed - indexed for MEDLINE]
NONDESTRUCTIVE TESTING OF THE HUMAN BREAST: THE VALIDITY OF DYNAMIC STRESS TESTING IN MEDICAL INFRARED BREAST IMAGING.
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ABSTRACT
The validity of the autonomic cold challenge for use in screening breast thermography is reviewed. A review of the literature is discussed along with reasoning for the choice of the cold stress method used. Breast thermogram results from 23 patients with histologically confirmed breast cancers are presented demonstrating positive and negative responses to the challenge. Cold challenge responses from 500 patients without breast cancer and with normal and persistent abnormal thermograms are also discussed. The question is posed, should the use of the cold challenge be continued considering that a negative response does not rule out the possibility of neoplasm nor does a positive response guarantee its existence? Conclusions are drawn from the available data that suggest that the use of the cold challenge be left up to the discretion of the interpreting thermologist and not mandated with every breast thermogram. Until further studies are performed and ample evidence can be presented, a review of the available data indicates that infrared imaging of the breast can be performed excluding the cold challenge without any known loss of sensitivity or specificity in the detection of breast cancers.

PMID: 17271894 [PubMed]

ANALYSIS OF BREAST THERMOGRAPHY WITH AN ARTIFICIAL NEURAL NETWORK.
Koay J, Herry C, Frize M.

ABSTRACT
Thermal imaging has been used for early breast cancer detection and risk prediction since the sixties. Examining thermograms for abnormal hyperthermia and hyper-vasculartiy patterns related to tumor growth is done by comparing images of contralateral breasts. Analysis can be tedious and challenging if the differences are subtle. The advanced computer technology available today can be utilized to automate the analysis and assist in decision-making. In our study, computer routines were used to perform ROI identification and image segmentation of infrared images recorded from 19 patients. Asymmetry analysis between contralateral breasts was carried out to generate statistics that could be used as input parameters to a backpropagation ANN. A simple 1-1-1 network was trained and employed to predict clinical outcomes based on the difference statistics of mean temperature and standard deviation. Results comparing the ANN output with actual clinical diagnosis are presented. Future work will focus on including more patients and more input parameters in the analysis. Performance of ANN network can be studied to select a set of parameters that would best predict the presence of breast cancer.

PMID: 17271890 [PubMed]