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A Comparitive study in detection of Abnormality of human Medical Thermographs using color image segmentation

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Abstract: Infrared thermography, non-contact, non-invasive technique is widely accepted as a medical diagnostic tool. An IR camera captures heat variations from the skin and maps into thermographs. Thermographs are acquired for the whole body or the region of interest. Thermographs either gray scale or pseudo color are processed for abnormality detection and quantification. However temperature variations are not normally visible to naked eye. Hence it is necessary to develop and analyze the feature extraction algorithms for abnormality detection. This paper gives a comparative study in the analysis of color image segmentation in detection of abnormality of human medical thermographs .Three feature extraction algorithms(Euclidean distance,Manhattan,Minkowski) are compared and the optimal one is predicted. Here, the cases considered are Stress fracture and Arthritis.

Keywords: Thermograph, Arthritis, and Stress fracture, Manhattan, minkowski.

I. INTRODUCTION

Medical imaging is the technique and process used to create images of the human body (or parts and function thereof) for clinical purposes (medical procedures seeking to reveal, diagnose or examine disease) or medical science (including the study of normalanatomy and physiology). Infrared thermography, a successful Non Destructive Testing (NDT) Technique is recently accepted as a successful medical diagnostic procedure. It is based on a careful analysis of skin surface temperatures as a reflection of normal or abnormal human physiology. Infrared or thermal images are produced with Infrared camera. Based on these thermal images, accurate temperature measurements can be made to detect even the smallest temperature differences when looking at human bodies.

Thermal images, or thermograms, are actually visual displays of the amount of infrared energy emitted, transmitted, and reflected by an object. Thermal imaging cameras detect radiation in the infrared range of the electromagnetic spectrum and produce images of that radiation, called thermograms. Since infrared radiation is emitted by all objects near room temperature, according to the black body radiation law, thermography makes it possible to see one's environment with or without visible illumination.

The rest of the paper is organized as follows: In Section 2, we review some project related work. In Section 3, we present the problem statement of the paper. In Section 4, we present experiment results of the paper. We give conclusion and future work in Section 5.

II. RELATED WORK

Thermal imaging cameras_detect radiation in the infrared range of the electromagnetic spectrum and produce images of that radiation, called **thermograms**. Since infrared radiation is emitted by all objects near room temperature, according to the black body radiation law, thermography makes it possible to see one's environment with or without visible illumination.Precision thermal imaging can give valuable physiological information which is not obtainable by any other means. It is particularly useful for follow up because it is painless and noninvasive [1]. There was a good relationship between changes in pain intensity and changes in symmetry of heat patterns for most of the disorders examined. Thermography had mixed usefulness in differentiating pain-free from pained subjects reporting knee pain (test efficiency, 98%), leg pain, and back pain (efficiency, 56%) [2]. Thermal imaging is not only effective for differentiating the presence or absence of abnormality but also for determining the pain severity, fake patients, and pain recovery [3]. There are two practical ways of using the automated color image segmentation in the medical field: for content-based region query and for tracking the time evolution of the disease in patients following a certain treatment [4]. Basically, segmentation techniques attempt to subdivide an image into regions based on a specified criterion [5].

III. THE PROBLEM STATEMENT

Most of the techniques at present give an approximation in the deduction of abnormality. Thermography presents a new way of noninvasive and painless method of imaging technique. We propose the analysis of abnormality in human medical thermographs by three algorithms. The cases taken here are arthritis and Stress fracture.

A. Prediction of hotspot from the Thermal Image:

In arthritis thermograph, the abnormality exhibits itself as hotspot... The abnormal region in the thermograph shows the color variation from the other regions because of heat variation in the abnormal region. Any pixel from the region is selected as hotspot. Any pixel from the hotspot region can be chosen as the average pixel.

B. Abnormality detection and Feature Extraction:

Quantification is the process of mapping a large set of input values to a smaller set – such as rounding values to some unit of precision. Here the algorithms used to quantify the hot spot.

C. Euclidean Distance Algorithm:

In Cartesian coordinates, if p = (p1, p2,..., pn) and q = (q1, q2,..., qn) are two points in Euclidean n-space, then the distance from p to q, or from q to p is given by:

$$d(\mathbf{p},\mathbf{q}) = d(\mathbf{q},\mathbf{p}) = \sqrt{(q_1-p_1)^2 + (q_2-p_2)^2 + \cdots + (q_n-p_n)^2} = \sqrt{\sum_{i=1}^{n}(q_i-p_i)^2}.$$

D. Manhattan Distance Measure:

The formula for this distance between a point X=(X1, X2, etc.) and a point Y= (Y1, Y2, etc.) is:

$$d = \sum_{i=1}^{n} |x_i - y_i|$$

Where n is the number of variables, and Xi and Yi are the values of the itch variable, at points X and Y respectively.

E. Murkowski Method:

The Minkowski distance of order p between two points

$P=(X_1,X_2,\ldots..X_n)$ **and** $Q=(Y_1,Y_2\ldots..Y_n)\epsilon R^n$

is defined as:

$$\left(\sum_{i=1}^{n} |x_i - y_i|^p\right)^{1/p}.$$

F. Analysis of the Abnormality Detection Methods:

Here we set a hypothesis that the method which shows the minimal area of abnormality as well as minimal major and minor axis is the best to predict the abnormal condition in arthritis. There is a medical truth that pain will spread in and around the affected regions. This may cause the medical images to be inaccurate in showing the exact abnormality. So the algorithm which best finds the abnormal region will give the smallest area covering the exact points within the distance from the hotspot and it can be well used for predicting the arthritis in the patient.

IV. EXPERIMENTAL RESULT

In original image, every pixel intensity is represented as unsigned integer with 8 bits. This data type is converted into double (fraction) for easier computation. Red, Blue and Green domain intensities of the average pixel are 0.9725, 0.9725 and 0.9725 respectively. The threshold chosen is 0.09. The original image and the output image consisting of hotspots are as shown.

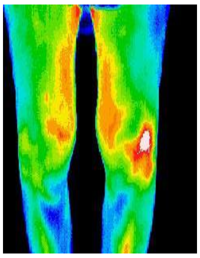


Figure 1-Arthritis

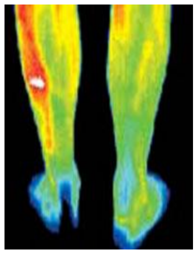
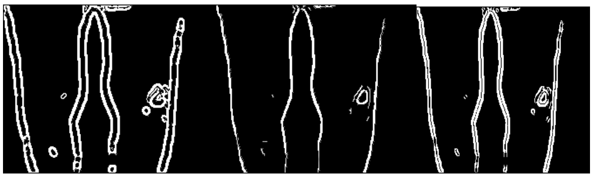


Figure 2-Stress fracture

The original images are shown in fig1 and fig2.The extracted features of the above cases are



Mikowski Euclidean Manhattan

Figure 3 Extracted features of abnormal region-Arthritis

Mikowski Euclidean Manhattan

Figure 4 Extracted features of abnormal region-Stressfracture

The result that is reported here shows the optimal solution for finding the abnormality in human medical thermographs. The extracted abnormal regions are shown in the output for the three methods. The tables showing the area, major and minor axis is also included.

Table-1 Comparison of various distance measures

Abnormality	Method	Area in cm^2	Major axis length in cm	Minor axis length in cm
Stress fracture	Euclidean Distance	0.0154	0.1695	0.2065
	Manhattan	0.0189	0.1244	0.2636
	Minkowski	0.0197	0.0857	0.1338
Arthritis	Euclidean Distance	0.0181	0.1989	0.1038
	Manhattan	0.0182	0.1101	0.1935
	Minkowski	0.0168	0.0980	0.08255

V. CONCLUSION

As a result of the analysis of three methods, the algorithm called minkowski performs well on detection of abnormality in human medical thermograms. Among the three it shows the minimum area of abnormality and minimal major and minor axis length. The optimal solution is given by minkowski method and it can replace the usual Euclidean distance method.

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