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RESEARCH ARTICLE

THERMAL IMAGE ANALYSIS USING WAVELET METHOD AND STATISTICS IN ANN STRUCTURE ON BREAST CANCER IDENTIFICATION (ANIMAL MODEL: RAT)

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Abstract

Breast cancer identification based on imaging system is developed until now. One of the modalities to identifying breast cancer using thermal imaging through energy heat intensity that emitted by cancer nodule. The difference of heat temperature on cancer nodule compare with other area shows that there is an abnormality in it. Thermal imaging is a heat image which is has no clear edge (multiresolusi). In this research, we using ANN (Algorithm Aritificial Network) to analyse thermal imaging on breast cancer where ANN input structure optimized by implementing wavelet and statistic method. The purpose is to generate information that inform about breast abnormal and size of cancer nodule. This research was done using 12 rats as a model and divided by 2 groups. 5 rats have no treatment, while the rest inducted with 10 times of 20 mg/BB of DMBA (7.12 dimenthyl benz (α) anthracene). Treatment is carried out for 2 month and checked for the cancer nodule every week. Testing as a gold standard is done by palpamasi and Patologis Anatomi (PA). The result shows 87.5% sensitivity with 57% specivity. In group 2 shows that all subjects 100% infected by cancer with 70% cancer potential and 30% has a high temperature (neoplasma). The smallest size of cancer nodules that can be detected is 1.5 mm x 5.85 mm.

Introduction:-

Cancer is a disease which can cause the death. Based on annual data from Indonesia Ministry of Health, until 2013 early breast cancer detection program has been done 7.8% and still in development stage. The temperature on surface skin can indicate of abnormality. Like breast cancer patient, the temperature around the breast will higher than others. Metabolic activity and vascular circulation in cancer area will higher than normal system. From that information, through thermal imaging process that taken with infrared camera can identify breast cancer [1][2].

Research in identifying breast cancer through heat temperature which it produced around the cancer area allow the clinical practical visualizing and quantifying heat temperature changing in the surface. In breast cancer identifying research concluding the different between healthy breast and abnormal breast [3][4][1]. Thus, there is still a subjectivity that can cause inconsistency in detecting breast cancer.

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Heat visualization will be mapping in graphic and known as thermal imaging. It is multiresolution image, which means image has an unclear edge. In image processing, when pre-processing and processing need to modelling that can increase the pixel value intensity. Taking thermal image resource from raw data of temperature instead from image of temperature could give a better result of reading cancer nodule [5]. Implementation of colour space transformation to YUV in processing and wavelet transformation while in processing could increase the pixel intensity in thermal image.

In this research, use Artificial Neural Network in thermal imaging post processing to identifying a breast cancer nodule or not. Before post processing, use wavelet method and choosing the best pixel using statistic. Improving input with wavelet and statistical method in ANN structure will identifying breast cancer and informing the size of identified nodule.

This research using female wistar rat around 1.5-month-old. Around 15 rats divided into 2 groups, 5 without treatment and the rest inducted by 20 mg/KgBB DMBA in 10 times [6]. After 2 weeks treatment, it will continue treating and monitoring for next 8 weeks. Taking heat temperature using infrared camera TiS20 type. In pre-processing step is changing colour space with wavelet and statistic method and using ANN algorithm in identifying breast cancer in post processing.

Identification breast cancer through thermal imaging analysis could give maximum information [7][2] and without side effects after test also could been done in several time [8]

Thermal Imaging

Thermal Imaging is a technique to improve the visibility an object in dark condition with detecting object infrared radiation and creating an image based on it. Measurement of an object temperature has a good impact, which is not damaging and safe to do it in several times directly.

Implementation of thermal imaging analysis in several skin disease diagnosis, bone break and breast cancer are still developed. Classification of normal or abnormal breast was done by Serrano, where first data is in JPEG format and then transforming into grayscale color space. In figure 1, can be seen the visual difference between normal and abnormal breast

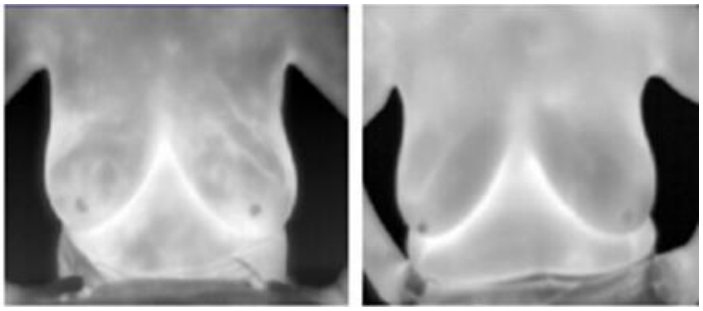

Figure 1:-The difference between normal and abnormal breast[3]

Abnormal breast classification through thermal imaging analysis is fit in every age including pregnant woman with 97% sensitivity, 44% specificity and 82% negative prediction value [9]. While [1][10] gives 83% sensitivity in classifying abnormal breast with showing the cancer area (Figure 2).

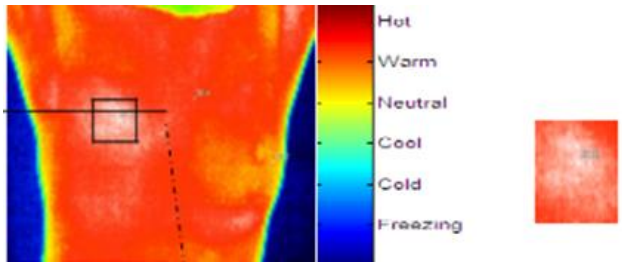

Figure 2:-Cancer detection using infrared camera. This figure shows that cancer area is pointed with white spot[1]

Structure of Artificial Neural Network (ANN)

A quality image is shown with high intensity pixel values and deleting the low frequency in an image. In analyzing the image of breast cancer using a series or stages in the study. Starting from the preprocessing stage, input data from the IR camera in the form of raw of temperature then indexed will be the degree of temperature per pixel. Change to level 5 color space (Black, Blue, Green, Red and White). The purpose of the pre-processing stage is to get the visualization of the location of the highest heat area or that describes the location of the growth of cancer nodules. The next stage is the cutting process (cropping) at the location of the cancer growth site with a size of 64x64.

Next is the wavelet transformation in the cropping area. Wavelet transformation is a technique to deleting the low frequency in a multiresolution image. It works in a digital image with divided into 2 parts, which is: Forward Wavelet Transformation (FWT) and Inverse Wavelet Transformation (IWT). FWT decompose an image so that energy in it will concentrate into particular pixels which is it called blurred image. While IWT reconstruct the image that produced by FWT. Either FWT or IWT are transforming in image line then image column [11]

Artificial Artificial Neural Network (ANN) is a technique or information processing approach that is inspired by the workings of the biological nervous system, especially in the cells of the human brain in processing information. A key element of this technique is the structure of an information processing system that is unique and diverse for each application. Neural networks consist of a large number of information processing elements (neurons) that are connected to each other and work together to solve a particular problem, which is generally a problem of classification or prediction. One application of ANN is to predict breast cancer. Thermal imaging in identifying breast cancer nodule in this research is using ANN backpropagation Algorithm as a decision support. Improvements in the ANN structure can be applied with the wavelet method and statistical data processing.

In processing stage, statistic processing is necessary after implementation of wavelet method, before the data processed as an input process in post processing. Thermal image is a multiresolution image which it has no clear edge. With implementing statistic concept will improve the data structure, so that enhance data training process in ANN processing. The intensity values from each pixel will get max and min value, average, modus, standard deviation, skewness and kurtosis

Methodology:-

The development of software by implementing an ANN algorithm with wavelet and statistic method. The purpose is to improve the thermal imaging process and consistency of thermal image reading. The development of apps is used to read the thermal intensity value in cancer area. Where higher thermal intensity will show the size of the cancer.

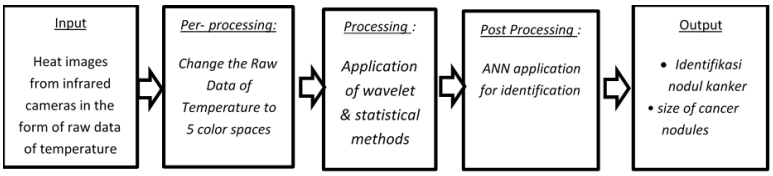

Figure 3:-Implementing of ANN Algorithm

Result and Discussion:-

There are three steps of data testing. First test is difference histogram between normal and abnormal rat's breast. Second is gold standard test to showing the existence of cancer nodule. The last is software testing.

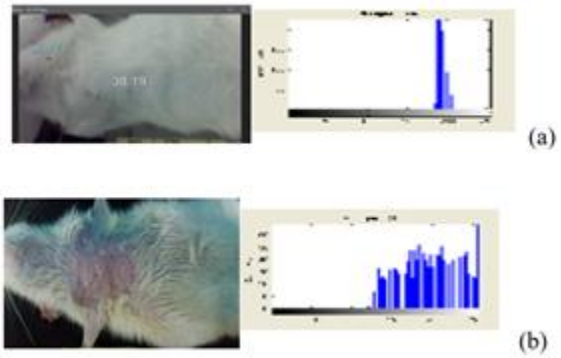

Figure 4 :-Histogram of Thermal Image with normal condition (a), infected cancer (b)

According from the data above, it shows that histogram of normal rat tends to low, while the infected rat, it shows a variable result. Where the temperature around the cancer nodule is quite high compared with the others.

Implementation of wavelet method in processing is used to edge detection. Then we calculate the heat area, the size of nodule is calculated from edge area. Nodule size can't be predicted due the multiresolution image. Amount 10 treated mousses with growing time around 2 months can be identified the lowest nodule, which is 1.5 mm and 5.85. mm in object number 7 (attachment 1 table 2). While the highest is object number 5, which is 7.5 mm x 7.5 mm. The implementation of wavelet and statistical method in ANN structure to helps determining the potential of cancer nodule in thermal intensity. In this research, group 2 shows the 70% abnormality result(a cancer), while 30% shows a higher temperature(a neuplasma). These phenomena inline with palpamasi testing shows that all the subjcts containing cancer nodule in group 2.

In group 1, there are 5 objects as healthy controlled, after being treated shows that all objects are clean in rat breasts by thermal imaging system. As visual result from edge detection is none. But in object number 22 is still has a heat intensity. Probably because a side effect of induction (attachment 1 table). Either group 1 or 2 shows 87.5% sensitivity level and 57% specificity while overall accuracy is 73%.

Conclusion:-

1. Implementation of wavelet and statistic method in ANN structure of identifying breast cancer nodule in group 2 is 70% abnormal potential (show a cancer) and 30% is higher temperature detected (show a neuplasma). This result is inline with palpamasi testing that all the subjects are infected with breast cancer.
2. The result of the research either group 1 or 2 has 87.5% sensitivity, 57% specificity and 73% overall accuracy.
3. The smallest nodule is 1.5 mm x 5.85 mm in subject/rat number 7

Further Research

This research was carried out by one picture. This creates a new problem if taking the position of nodule data between pixels is also one of the causes of thermal image counting nodules. Further research is needed where taking multiple position data, where each data specified is right, left, up or down, it will find the right nodule position.

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Table 1:-No Treatment

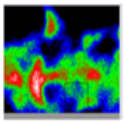
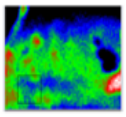
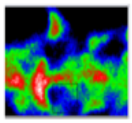
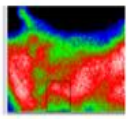
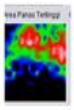
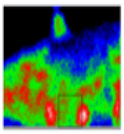
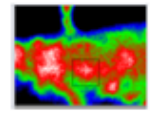
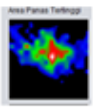
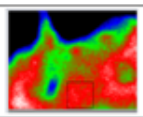
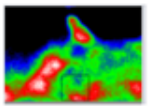
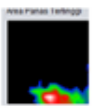
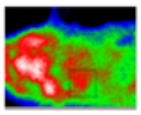
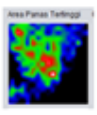
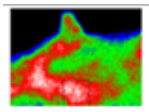
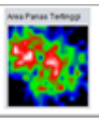
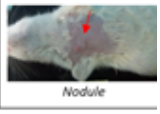
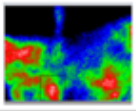
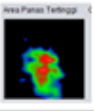
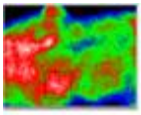
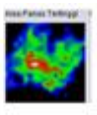
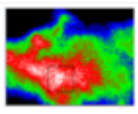
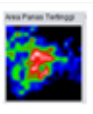
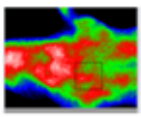
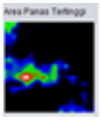
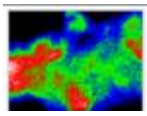
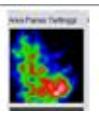
Code	Image	Image Location	Image Nodul	Palpamasi	Cancer Imaging System		Anaysis
Rat-1				 No Nodule	High temperature of Nodule Average temperature of Nodule Nodul Width (mm) Length of Nodules (mm) DSS	37.48 34 Not detected cancer	True Negatif
Rat-2				 No Nodule	High temperature of Nodules Average temperature of Nodule Nodul Width (mm) Length of Nodules (mm) DSS	37 35,49 7.50005 4.50004 Not detected cancer	True Negatif
Rat-21				 No Nodule	High temperature of Nodules Average temperature of Nodule Nodul Width (mm) Length of Nodules (mm) DSS	37 34.7 Not detected cancer	True Negatif
Rat-22				 No Nodule	High temperature of Nodules Average temperature of Nodule Nodul Width (mm) Length of Nodules (mm) DSS	38.58 36 6.50005 4.50004 Detected above normal temperature	False Negatif
Rat-23				 No Nodule	High temperature of Nodules Average temperature of Nodule Nodul Width (mm) Length of Nodules (mm) DSS	37.62 30.4 Not detected cancer	True Negatif

Table 2:-Treatment

Code	Image	Image Location	Image Nodul	Palpamasi	Cancer Imaging System		Anaysis
Rat-3					High temperature of Nodules	38.34	
					Average temperature of Nodule	36.02	
					Nodul Width (mm)	7.5	True
					Length of Nodules (mm)	5.8	Positif
					DSS Potential for abnormalities		
Rat-5					High temperature of Nodules	39.18	
					Average temperature of Nodule	37	True
					Nodul Width (mm)	7.5	Positif
					Length of Nodules (mm)	7.1	
					DSS Potential for abnormalities		
Rat-7					High temperature of Nodules	39.7	
					Average temperature of Nodule	37	
					Nodul Width (mm)	5.85	
					Length of Nodules (mm)	1.5	True
					DSS Potential for abnormalities		Positif
Rat-9					High temperature of Nodules	37.8	
					Average temperature of Nodule	36.4	
					Nodul Width (mm)	7.5	False
					Length of Nodules (mm)	7.5	Positif
					DSS **Detected above normal temperature**		
Rat-11					High temperature of Nodules	38.48	
					Average temperature of Nodule	35.74	
					Nodul Width (mm)	7.5	True
					Length of Nodules (mm)	7.5	Positif
					DSS Potential for abnormalities		
Rat-12					High temperature of Nodules	37	
					Average temperature of Nodule	34.8	
					Nodul Width (mm)	5.1	True
					Length of Nodules (mm)	5.1	Positif
					DSS Potential for abnormalities		
Rat-16					High temperature of Nodules	37.89	
					Average temperature of Nodule	36.23	
					Nodul Width (mm)	7.5	False
					Length of Nodules (mm)	7.5	Positif
					DSS Detected above normal temperature		
Rat-17					High temperature of Nodules	37.92	
					Average temperature of Nodule	35.8	
					Nodul Width (mm)	7.5	True
					Length of Nodules (mm)	7.5	Positif
					DSS Potential for abnormalities		
Rat-8					High temperature of Nodules	38.4	
					Average temperature of Nodule	36.7	
					Nodul Width (mm)	7.5	False
					Length of Nodules (mm)	7.5	Positif
					DSS Detected above normal temperature		
Rat-20					High temperature of Nodules	37.29	
					Average temperature of Nodule	35.5	
					Nodul Width (mm)	7.5	True
					Length of Nodules (mm)	7.5	Positif
					DSS Potential for abnormalities		

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