Visualization of The Breast Cancer through Raw Data of Temperature on Thermal Imaging (Rat Model Animals)

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***Abstract*— Infrared (IR) camera can capture a surface temperature and visualized the temperature into a visual form. The camera provides a processed image of the temperature and a raw data of the temperature. One of the potential application of the camera is for a non-contact diagnostic tool for breast cancer. However, the used of the generated thermal image from the camera could lead to a fake nodule. In fact, in breast cancer screening, visualization of the size and locations of the nodule of the cancer is a very important factor for further action. In order to achieve a better result of visualizing, we analyze thermal imaging of breast cancer through raw data of the temperature. The lowest and highest temperature was identified from the raw data of temperature. The data was then indexed and transformed into many space colors to produce a better visualization of the nodules size or cancer location. This research using wistar rat by injecting DMBA to the rat model. Data was taken from the rat model once every week for two months. The data showed that thermal imaging through a raw data of the temperature resulted in a better image and color space changing compare to the associated data from the processed image by the camera. We found that the visualization of the size cancer nodules and location was best in 5 color space .**

Keywords— visualization, raw data, location, nodule, breast cancer, temperature

I. INTRODUCTION

Many measurement method were developed for identification and detection of the existence, position and size of breast cancer. Non invasive measurement were developed to visually represent the human body part under examination. MRI, mammography and USG were well known gold standard method for breast cancer examination. However those mentioned methods has been known having negative impact to the patient [1] [2]. Therefore several approached has been done to get the method which provide adequate information with less or zero impact to the patient. A non invasive method based on the thermal tradiation fo the human body has been developed using an infrared camera.

With its technological development, the infrared camera could provide a good surface temperature values. Which can be developed for breast cancer examination. The infrared camera which produces a thermal image can be processed and analyzed to give maximum information with good precision [3] [4] [5].

Identification process and breast cancer screening can be done by measuring the temperature around the targetted area of the breasts. In breast cancer, nodules below the skin produce more heat than its surrounding. Heat conductivity proves that there is a temperature changing in the breast that release some heat [6] or hotspot [7] [8]. A report in 2009-2013 by using medical data from 948 medical patients showed that the released heat from the breast differed between the normal breast and abnormal breast [9]. Based on this finding, one can used the temperature distribution and value as a basis for identifying abnormality of the breast due to a cancer.

Infrared (IR) camera is a camera that has a temperature sensor, that IR camera can visualize heat from an object. IR camera can export the outcome into 2 form, which is an image with bitmap, jpeg, tiff, gif or png extension or in raw data temperature. Image outcome is a file that has many distortions so that it can produce false information. In previous research, many researcher processing breast cancer images using image

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outcome, it visualizes bad space color changing and has a fake nodule.

In this research, we using raw data of temperature as a method to collect data. It will read from lowest to highest temperature then indexing the heat. Heat indexing will change the color space, thus the size of cancer nodule and it location can be seen clearly.

This research using wistar rat as a model. It inducted with DMBA for 2 months. We hope this research will improve the screening where it can be done several times without side effect and produce a better visualization that can be seen clearly in some color space.

II. THERMAL IMAGING

A. *Thermal Imaging for breast cancer*

The human body metabolism process produces a heat energy which is represented by human body temperature. In addition to the result of the metabolism process, the human body temperature can also related specifically to a specific tissue or organ activity and condition. An abnormal condition of the tissue or organ will also result in a rasing or decreasing temperature of the tissue or organ. Increasing temperature was on around breast cancer because of the chemical and blood vessel acitivity [8]. Angiogenesis process as a cancer growth nutrition leaded to an elevated temperature around the breast and the skin surface [6].

The human body temperature can be measured using a contact and non contact temperature sensor. Human body temperature has its maximum intensity in the infrared region. Therefore the non contact temperature measurement can be done by utilizing an infrared temperature sensor. The used of the infrared camera has an advantage of simultaneous measurement of the surface temperature. The measurement data can be taken in an area in the same time. Therefore the surface heat distribution can be taken, the captured surface temperature was then further processed using one of many several image processing techniques.

Thermal Imaging from the infrared camera is a multiresolution image that can be used to increase the object feasibility in dark conditions with detecting heat radiation and creating a picture based on the signal [10]. The increase temperature of the breast indicated an abnormal condition of the breast. Therefore using the thermal imaging method, every patient under examination will have their breast heat map. A regular check will produce a set of heat map picture that shows the abnormality. This method could be done for several time safely [11].

B. *Color Space*

Color is a perception result from light in space spectrum that seen by eyes and has a wavelength around 400 nm to 700 nm. Color space is a mathematical model that explains how color is represented in a set of number. The repesentation of image in a monitor, for example, is presented using RGB (red green blue) color space. The data which reperesent each point of the image (pixel) was recorded in an integer number code represented in red, green and blue color.

Therefore the color space was an importance in the presentation of image and also how the image would be analyzed. Understanding the color space algorithm was a must for object visualization, image classification, object detection in an image, image compression and many other image processing aspect. The object visualization, creation and adjustment was done using a color space model. One should used an appropriate color space model which depend on the equipment characterize which acted as a primary data source for producing image. Some equipment has a restiction on the size and type of color space due to the technological limitation.

An infrared camera was basically made from a miniaturized two dimentional array of thermal sensor which has a sensitivity in a certain temperature range. With the advanced of the microelectronic technology, the camera has two different ouputs to represent the temperature of the object, i.e. visual image of the temperature and the raw data of the temperature. These can be used as a basis for processing image in case of breast cancer nodule, where in thermal imaging processing still found the fake information [5] [12] [13].

Image quality improvement can be done by applying the segmentation process using edge detection method, holding extraction and histogram[3]. The application of color segmentation uses a Gaussian combined model and iterative maximization algorithm, where gaussian components are matched with pixel values in the RGB color space [11].

III. EXPERIMENTAL METHOD

The visualization of the nodule size and location of the breast cancer depend on the data processing and model which was used. To achive the best visualization, the research performed three steps as depicted in Fig. 1

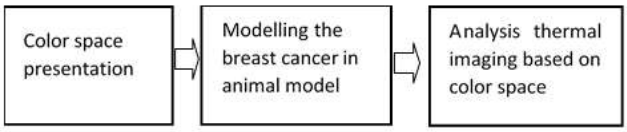

Fig. 1. Steps to achieve best visualization

The color space presentation was the step to visualize the thermal data of the breast cancer nodule into a visible image. Fig. 2 shows the process of producing visible image. The first process was capturing the temperature of the object using the IR camera. The raw value of the temperature data was then indexed. Then the indexed temperature value was converted into a color space representation. The resulted visible image visualizing the location, size and number of the nodule.

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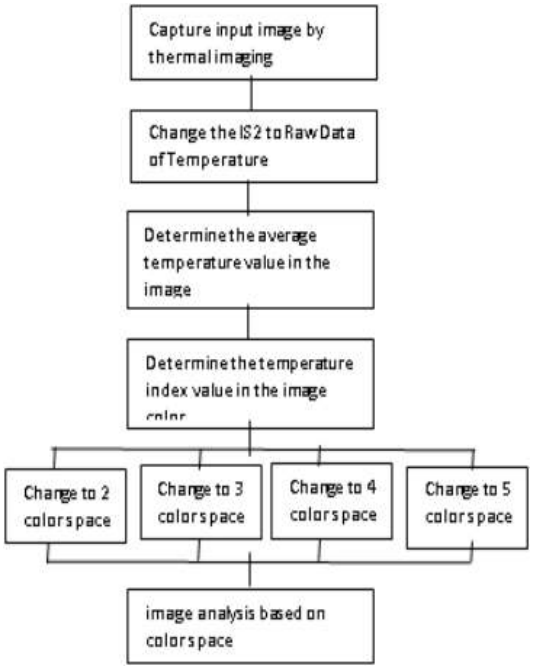

Fig. 2. Color space presentation steps

The breast cancer model was made using a mouse animal model. The animal model was treated to generate a cancer on its breast. The mouse was female Wistar mouse aged around 1.5 months. The breast cancer of the mouse was made by treated the mouse with DMBA (7.12 dimenthyl benz (α) anthracene) [14]

The stages for animal attacked by cancer is follow:

1. Scaling the weight from each mouse and measuring the heat temperature around the breast.
2. Preparing the carcinogen :

   Dissolving amount of DMBA powder into the corn oil solution with a specific volume to produce the required concentration.
3. Inducting carcinogen on rat

   Model animal inducted with DMBA. The amount of the DMBA was 20 mg/kg weight to weight ratio. Induction was done 10 times in 48 hours. The induction was done at the subcutane of the breast position no 2.

IV. Result and Discussion

Breast cancer thermal data of the mouse model was taken after 2 months of DMBA induction The surface temperature around the mouse breast was taken using the IR camera. The data from the IR camera, both the raw data of temperature and image of temperature then transferred to the computer for further processing.

Fig. 3 shows the visual image of the mouse (rat) model captured with the IR Camera. The position of the object (mouse model) can be identified easily. The resulted image can be used for referencing the thermal image of the rat model.

Fig. 3. Visual the temperature location of the rat image

The IR camera can provides 2 information, a image of the temperature and a raw data of the temperature (fiq 4)

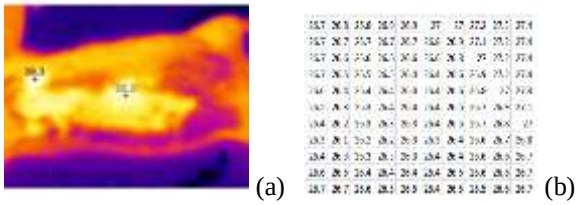

Fig. 4. (a) image of temperature; (b) raw data of temperature

Fig. 4a showed the JPEG image format produced by the IR camera which represent the image temperature value at each pixel location. We can identify the highest temperature location of the image object. JPEG (Joint Photographic Expert Group) is a file compression standard developed by the Joint Photographic Group Experts; using a combination of DCT and Huffman coding to compress an image file. JPEG is a lossy compression algorithm, (which means the image quality is rather poor). This file format is capable of storing images with RGB, CMYK, and Grayscale color modes. So if JPEG images are used as input in image processing for temperature-based breast cancer detection, it can provide images with false information.

Fig. 4b shows temperature information from IR cameras that are represented in the raw data of temperature at each pixel. The use of thermal imaging in the form of raw data of temperature as input for detecting breast cancer, this can provide more accurate information and better image visualization. By the way, change the raw data of temperature to an image that achieves the temperature in each pixel.

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Table 1. Comparison of visualization between image of temperature and raw data of temperature

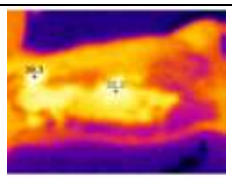
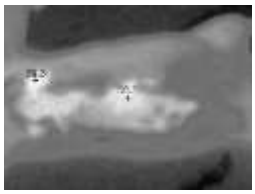
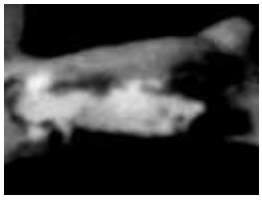
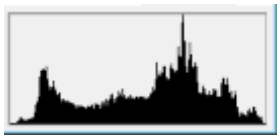
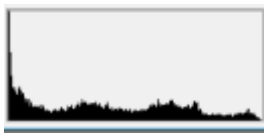
	Input in image of temperature	Input in raw data of temperature
Original image		
Gray scale image		
Black, gray, white color of distribution Chart	 In the graph above shows the highest color composition in gray areas. So that the heat target (white color) is not clearly visible. Where the position and size of the nodule are not clearly visible.	 In the graph above shows the composition of black is more dominant. So that the heat target (white color) looks more focused. Where this shows the position and size of the nodule is more visible

Table 1, shows that when input from image of temperature and raw data of temperature is changed to grayscale image, it can be seen that the difference in black and white degradation in both images. Sharp degradation between black, white and gray in the image, will focus more on the target area. So that the process of segmentation between target objects with a background can be distinguished. It can be seen that the process of the normalization value of the temperature data before it was converted into image grayscale affect the contrast of the resulted image. We can see the grayscale color ranging from black to white. It made the identification of nodule number and breast cancer location becoming easier. In contrast the same image resulted from the grayscale convertion in image of temperature has lower contrast from the darkest to the brightest.

At the local spot of highest temperature point, the zoomed image showed better contrast and also detailed different between the points. This result showed that grayscale presentation from raw data of the temperature provided a better image, as further step for nodule identification (fiq 5)

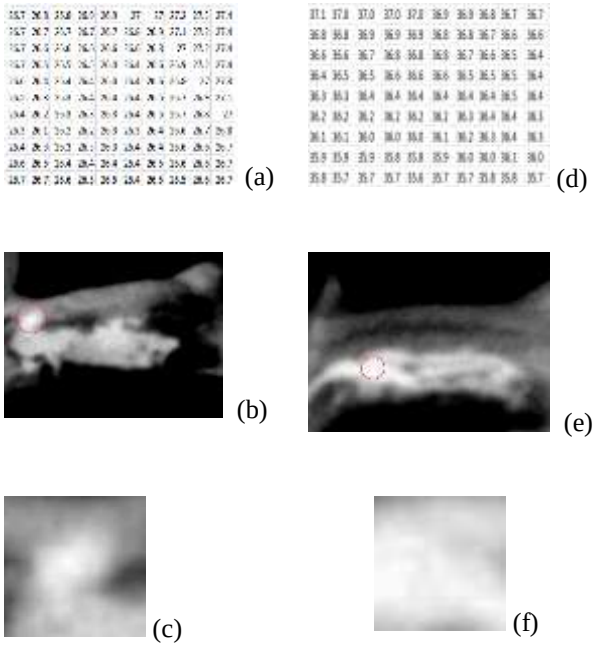
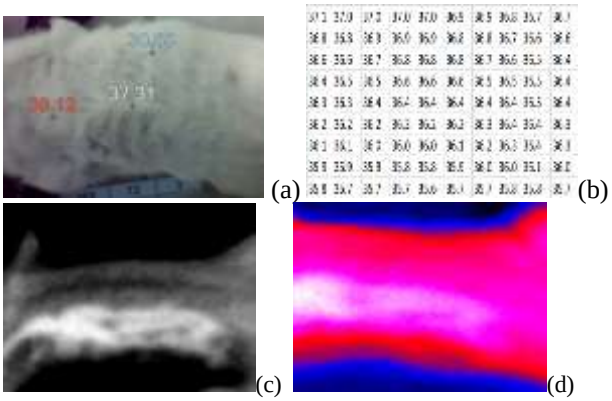


Fig. 5. image processing from temperature data converted into grayscale, (c) and (f) the highest heat center

In the background, looking at location and size of the nodule, object visualization is very important to note. Improvements not only on input (image of temperature or raw data of temperature), but also in image processing. Presentation of images in color space will affect visualization. In Figure 5, the degradation of black and white is quite clear. but the white color that represents the highest temperature still appears in some locations. So as to detect the location of breast cancer, it cannot only look at 2 color space (grayscale) but must be seen from the level of other color spaces. The following are the results of changing the image color space in various levels.

Further data processing was done using the raw data to be presented in different color space to get the best color space for nodule identification. Fig. 6 and Fig. 7 showed the image generated from the raw data of the temperature in different color space.



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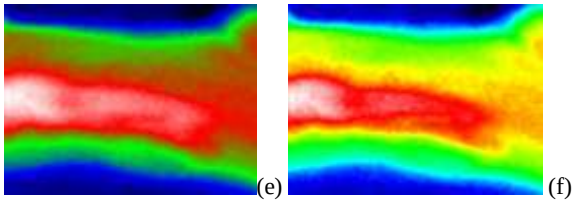


Fig. 6. (a) real image of rat number 1 (b) IR outcome in raw data of temperature . (c) conversion into 2 color space (d) conversion into 3 color space (e) conversion into 4 color space (f) conversion into 5 color space.

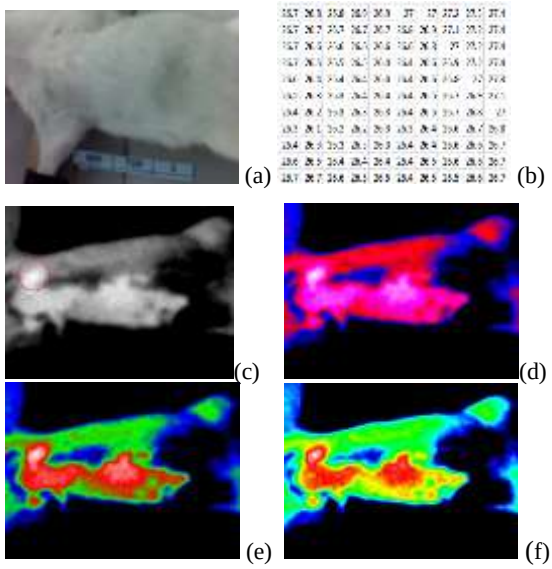


Fig. 7. (a) real image of rat number 2 (b) IR outcome in raw data of temperature . (c) conversion into 2 color space (d) conversion into 3 color space (e) conversion into 4 color space (f) conversion into 5 color space

Color space transformation is to change the raw data of temperature value to several color levels.

Color Space	Composistion	RGB (Red, Green,Blue)
2 Space	(0,0,0)	Black
	(1,1,1)	White
4 Space	(0,0,0)	Black
	(0,0,1)	Blue
	(1,0,0)	Red
	(1,1,1)	White
5 Space	(0,0,0)	Black
	(0,0,1)	Blue
	(0,1,0)	Green
	(1,0,0)	Red
	(1,1,1)	White
7 Space	(0,0,0)	Black
	(0,0,1)	Blue
	(0,1,1)	Yellow
	(0,1,0)	Green
	(1,1,0)	Violet
	(1,0,0)	Red
	(1,1,1)	White

Table 3. Visual Cancer Nodul in Color Space Rat 1

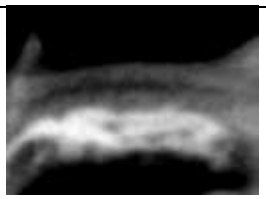
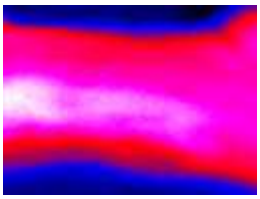
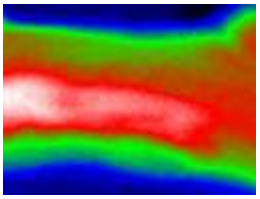
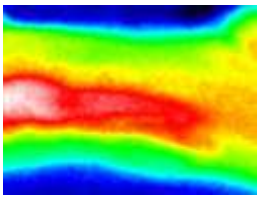
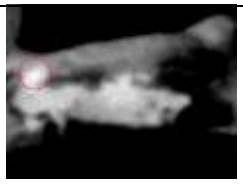
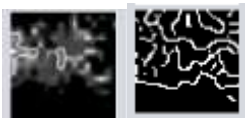
Color space	Image	Visual Cancer Nodul
2 space		
4 space		
5 space		
7 space		

Table 4. Visual Cancer Nodul in Color Space Rat 2

Color space	Image	Visual Cancer Nodul
2 space		

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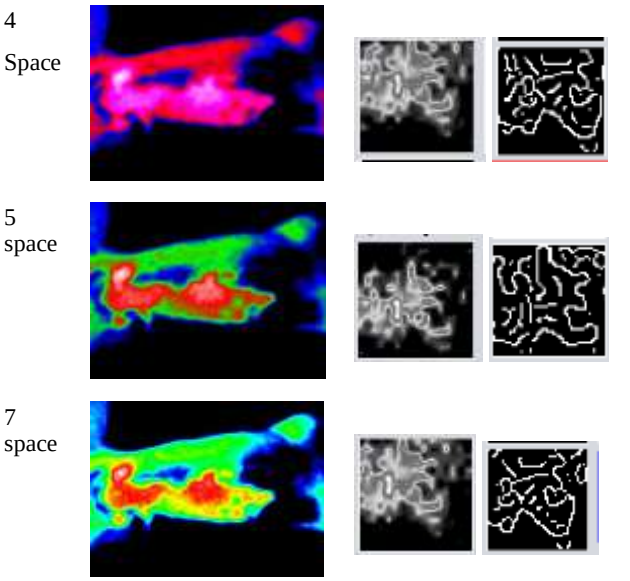

The location and size of the breast cancer nodule which is indicated by the highest elevated temperature of the mouse thermal image can be seen in all color space. However, we can see that the transformation of the raw temperature data was best identified in the 5 of color space. The location of the higherst temperature pixel of the thermal image can be seen clearly, heat distribution does not expand. Through edge detection, the size of cancer nodules in 5 color spaces is more focused. It can easily and quickly identified the location due to the highest color and intensity contrast (white color) of the image produced from the raw data of temperature. Therefore the result can also reduce fake visualization of the thermal image. In this study, 12 rats and repetition of data collection were 8 times, indicating that 87% of the best color space changes were 5 color spaces and showed the smallest size of nodules compared to other color spaces.

V. CONCLUSION

This research can conclude that :

1. The use of the raw data of temperature from the IR camera can resulted in a better identification on the breast cancer nodule compare to the using image of temperature from the IR camera.
2. The transformation 5 of color space resulted best image on visualization of the breast cancer nodule location and size, so it can is help to identify the location of the breast cancer nodule.

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