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# برآورد بافت های سرطان پستان توسط تصویربرداری تراهرتز با استفاده از ضریب جذب

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[۱و۳]مرکز طب هسته ای گاما اسکن آذربایجان،[۲]شغل آزاد

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*چکیده – در این مقاله تمرکز بر روی تشخیص و تصویربرداری سرطان پستان است. تلاش بر این است که یک روش نوین تصویر برداری تشخیصی، که پرتوهایی با انرژی فوتون کمتر دارند معرفی شود. همچنین نتایج بدست آمده نشان می دهد که این روش در مقایسه با روش های دیگر از دقت بالاتری برخوردار است. تصویر برداری تراهرتز نقش مهمی در ارائه تصاویر دقیق در کمترین زمان با ریسک پائین برای بیمار ایفا می کند. در این روش نیازی به رنگ آمیزی نمونه های گرفته شده از بیمار مانند ایمونوهیستوشیمی یا H&E یا روش های مشابه نمی باشد. دراین مقاله اثبات شده است که با در نظر گرفتن عدم سوختگی و آسیب در تصویربرداری تراهرتز به دلیل افزایش دمایی ناچیز برای پستان توسط پرتوهای تراهرتز، با استفاده از ضرایب جذب بافتهای تشکیل دهنده نمونه مورد نظر، نواحی چربی، فیبر و تومور تشخیص داده شده است و بادقت به این که بیشتر قسمتهای پستان را چربی و فیبر تشکیل می دهد نواحی سالم از سرطانی تمییز داده می شود. در ادامه با استفاده از روش های پردازش تصویر، نوع بافت مورد بررسی قرار گرفته و همچنین درصد نسبی آنها نیز اندازه گیری می گردد.*

**کلید واژه– *تصویربرداری تراهرتز، سرطان پستان، ضریب جذب.***

# The Breast Cancer Measurement with Terahertz Imaging by Using Absorption Coefficient

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Abstract-*In this paper the focus is on breast cancer detection and imaging methods and we want to present a method that has low photon energy radiations. In addition, the results present the high accuracy of this method in comparison with other methods. In this way, THz imaging plays an important role on giving detailed outputs very fast with low risk for patient. Also we do not need to stain the specimen for example in IHC or H & E methods. In this paper it is proved that with no damage and burn in T-ray imaging due to low temperature gain in breast tissue, by using the tissue absorption coefficients, various areas of adipose, fiber and tumor is distinguished in breast specimen. Then normal and cancerous borders in tissue will be recognized because normal tissue contains high amount of adipose and fiber. In addition, by using image processing methods the type of tissues are determined and the mean percentage of them are calculated.*

Keywords: *absorption coefficient, breast cancer, THz imaging.*

## 1. Introduction

ACS, the American cancer society, have shown that breast cancer is second most common cancer among women and obviously the third leading cause of death after lung and colon cancers. [1, 2] Its chance of developing invasive breast cancer in a woman's life is almost 12 percent. Also, the chance that breast cancer would be responsible for a woman's death is almost 3 percent. Early high sensitivity detection and therefore diagnoses and treatments can play critical role in a patient's life that is suffering from breast cancer. In clinical practice, the possible methods to detect the breast cancer are physical examination, breast ultrasound, X-ray mammography and breast MRI. Approximately 70 percent of women diagnosed will undergo breast conserving surgery, which leads to removing the cancer with a clearance of at least 2 mm to save as healthy tissue as possible. [2] By X-ray mammography, the changes of density of breast tissues can be identified that usually cause increase fibro-glandular tissue or tumour. [1] One of the problems of mammography is using ionizing X-ray that may induce malignancy. Recently, some studies have reported on the early detection of breast cancer but in most cases it may faces some problems such as X-ray ionizing or need for second or third surgery to remove the cancerous tissue and other problems. All of them may cause delay in giving adjurant therapy, a risk of wound infection, a risk of malignancy or cost more for healthcare system. Therefore, a new diagnostic method is needed to show a detailed early detection of cancer.

Due to some properties of THz radiation (T-ray) in biomedicine, it can be a trustworthy and useful method for medical imaging including distinguishing between muscle and fat as well as benign and malignant tissues. In fact, this radiation is a kind of electromagnetic spectrum that lies between infrared and microwave and covers frequencies of 0.1-10 THz (1 THz =10^12 Hz). [3, 4] Using terahertz for medical imaging is a viable technique because of a few reasons. First of all, terahertz wavelengths are longer than infrared and optical radiation so scattering in biological tissue is less in comparison. T-ray is non-ionizing so the power levels does not cause any detrimental effects. The broadband frequency content can be used for spectroscopic investigations to probe biomolecules and specify DNA and proteins. THz imaging has been used for Basal cell carcinoma (a kind of skin cancer). And now in breast cancer the aim is to excise the tumour with a safe minimized localization area. The purpose of this paper is to study the detailed result of cancerous amount in breast cancer and besides, the increased temperature and optical coefficients while using terahertz radiation in breast to reduce the load of extensive and time consuming pathological examination procedure. With this method we expect to adjust the use of hospital and human resource in better economized way. [4]

## 2. Material and method

Through a few past years, researchers studied THz absorption contrast of breast cancer tissues. They have proved that this absorption contrast varies from water and cancer induced tissues. [5, 6] Most of the tissue samples are not homogeneous and contain a mixture of tissue types. To extract and observe the tissue types and their information, there are a few factors to focus on like absorption coefficient and increased temperature in different tissues. [5, 7] In the used THz images in this paper fig1 and fig2 [9], the breast tissue sections are shown according to their different absorption coefficients ($\alpha$). These absorption coefficients are calculated according to Bear-Lambert low [7].

Totally the average absorption coefficient of breast tumour tissues at 320 GHz (=0.3 THz that is chose as working frequency because of the most difference of coefficients) is higher than normal tissues (including fibrous and adipose tissues). [5,8] The mediocre absorption coefficient of adipose tissues, fibrous tissues and tumours are 2-4.5 $mm^{-1}$, 7.5-9 $mm^{-1}$ and 9-12 $mm^{-1}$, respectively.[5,8,9] And the refractive index is n=1.50 for breast tissue. [10]

It has shown THz near field microscope images of cancerous breast tissue specimens in fig.1 and fig.2.

They are related to papillary tumour and ductal carcinoma cancers. [9]

The default thickness of the slice by an optical microscope is about 15μm. As fig.1 and fig.2 illustrate, the colour bar defines in the following way:

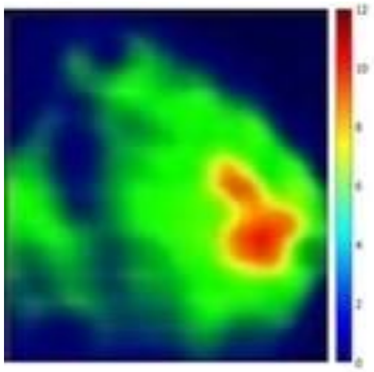

**Figure 1: papillary tumor breast THz image**

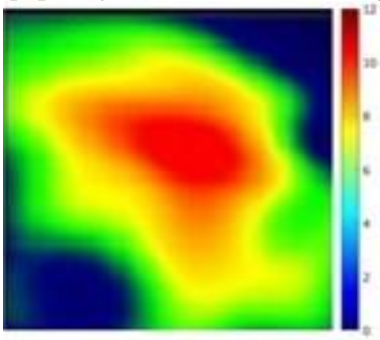

**Figure 2:ductal carcinoma breast cancer THz image**

If the absorption coefficient inside a certain region of the terahertz image was greater than $9mm^{-1}$ , it is marked as tumour and shown in red (9-$12mm^{-1}$), fat is shown in blue (2-4.5$mm^{-1}$) and fibrous in green (7.5-9$mm^{-1}$). [5, 8] Due to the various absorption coefficients in these samples, the regions are shown in different colours.
We can see the absorption and refractive indexes diagrams in THz frequency spectrum in fig.3 and fig.4 that are experimental indexes of breast tissues that are obtained from mentioned data interpolation. [2] Referring to different reactions of various wavelengths in these indexes we can extract the properties of the image and therefore tissues.

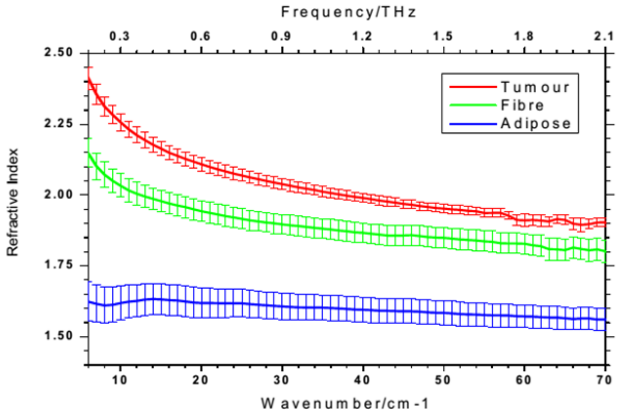


**Figure 3: refractive index of breast tissue**

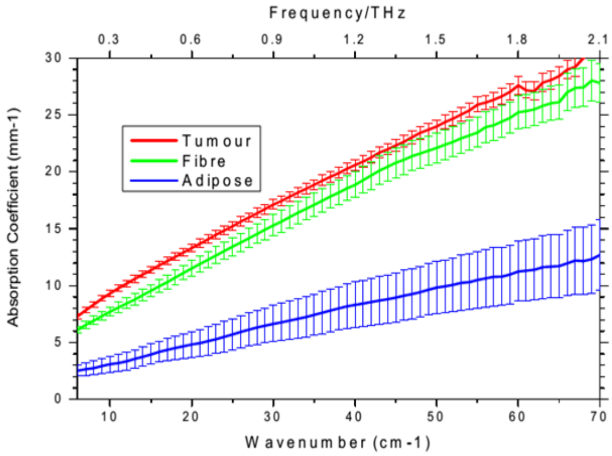


**Figure 4:absorption coefficient of breast tissue**

## 3. Results

We have previously studied on THz radiation modelling on human body tissues. It is proved that T-ray will increase the tissue temperature just a little that goes just up to safe and secure edge and does not damage tissue. So we can use the different absorption coefficients for illustrating the possible increasing temperature in three tissues of cancer, fibrous and adipose: (fig 5)

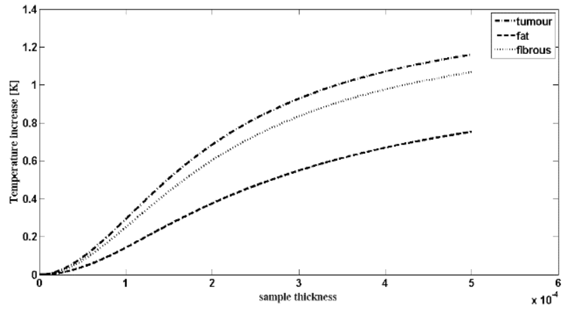


**Figure 5: temperature increase of tissue by THz radiation**

Afterward, the cancerous area of THz images can be calculated with a simple algorithm that gives us a percentage of cancer in comparison with the whole image. The terahertz images and the result of algorithm running for diagnosing the tissue parts are illustrated in figure (6) and (7). So the cancerous tissue, fibrous tissue and normal tissues beside the original THz image of specimen can be observed for two samples.
As it can be observed from the results in table (1), the percentages of breast cancer specimens show the high-sensitivity borders of tissues and disease progression.

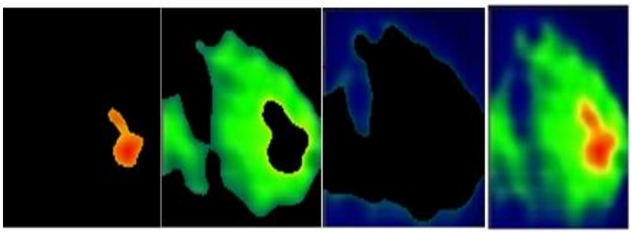

**Figure 6: different tissue areas of fig.1**

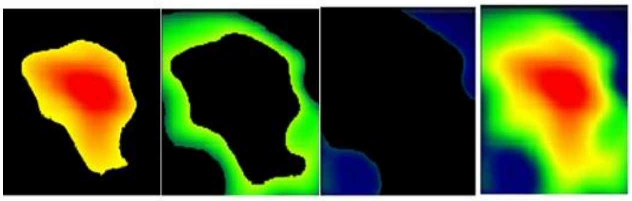

**Figure 7: different tissue areas of fig.2**

**Table 1: percentage of breast cancer specimens**

| Tissue | COLOR | Fig(4)% | Fig(5)% |
|---|---|---|---|
| **Normal** | Blue | 44.5 | 21.4 |
| **Fibrous** | Green | 50.3 | 42.2 |
| **Tumour** | Red & Yellow | 5.2 | 36.4 |

As you can catch from the previous parts, THz images and the temperature measurement algorithm by using optical coefficient like absorption and refractive indexes, we can see approximately high-sensitive outputs to use in pathology and cancerous diseases.

## 4. Conclusion

Generally, early and fast detection, detailed observations to realize the probability of cancer disease and its step of malignancy and benign is the main purpose of each detection and treatment method. As it was mentioned previously, radiations in medical detections and imaging may contain some hazardous effect on tissues. This issue is very low in THz detection and imaging (fig5). The THz imaging method for detection, provides the high resolution images with low risk for patients that gives the chance for doctors to choose this method. Also other parts of cancer can be studied in the future with this method. It is a new way to diagnose abnormal region of tissue in image processing medicine that experts did not paid enough attention to it. There may be huge improvements and deep studies in this field (THz imaging and detection) in the near future.

## 5. Acknowledgement

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