Imaging and quantification of fatty liver by terahertz wave

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Abstract

Recently, quantifying the progress of fatty liver disease has been recognized as an important practice in medical science. Such quantification is performed to enable the treatment and diagnosis of fatty liver disease.

1. Introduction

In our experiment, we examine differences between a fatty liver and a normal one using terahertz electromagnetic waves. Using terahertz electromagnetic waves, one can analyze differences between normal tissue and fatty tissue to obtain a difference in refractive index, which is an optical characteristic that allows quantification of the fat in a fatty liver and thereby enables diagnosis and evaluation of the progress of fatty liver disease. This diagnosis method is a good alternative to the painful method of directly removing sample tissue. The primary purpose of our experiment is to develop a method of diagnosis based on objective data rather than subjective observations, which can lead to opinion-based diagnosis. Furthermore, we aim to develop a method of imaging and analyzing the differences between fatty livers and normal ones using terahertz waves. Such a method will enable the quantification and detection of fatty liver disease so that appropriate remedial steps can be taken.

2. Experimental Method

Terahertz waves can be get by a semiconductor antenna and we can be generated by using the surge-current phenomenon by exposing a 10-fs of a sample by moving the sample on a two-dimensional plane, as shown in Figure 1.[1]

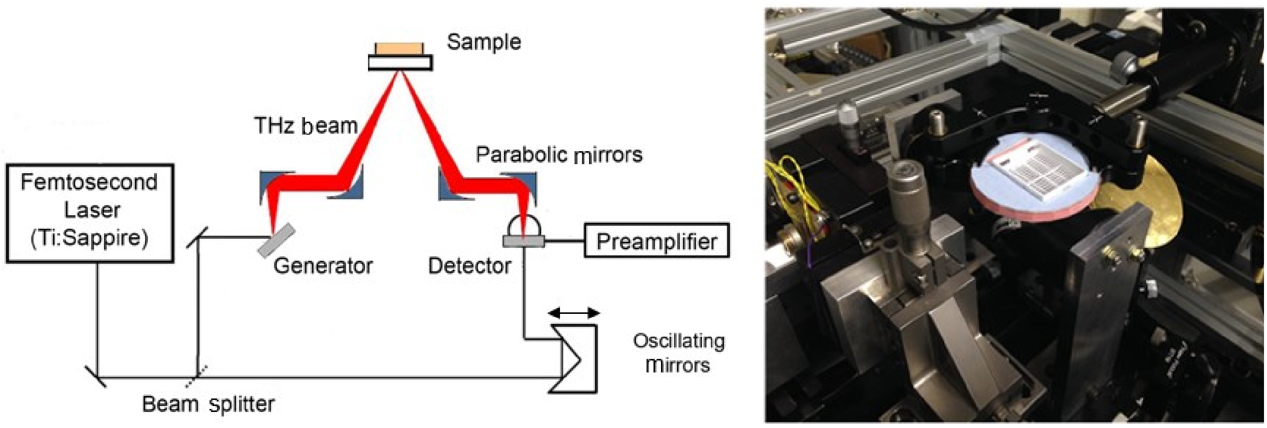

Figure 1. Terahertz imaging system and an experiment in progress

In this experiment, we use a sample of rabbit liver fixed on paraffin. We employed a program that can calculate the refractive index for each pixel of imaging data and applied this program to a normal liver and fatty liver fixed on paraffin blocks.[2] We can detect the distinction between tissue and paraffin and divide sections according to the refractive index of each material. Figures 2 and 3 show quantifications of the refractive index of tissue and terahertz refractive index images taken of normal liver and fatty liver, respectively (normal state: 11%, fatty state: 92%). We find that the value of the refractive index for the normal liver is higher than that for the fatty liver; we compare these two cases using a relative standard.[3]

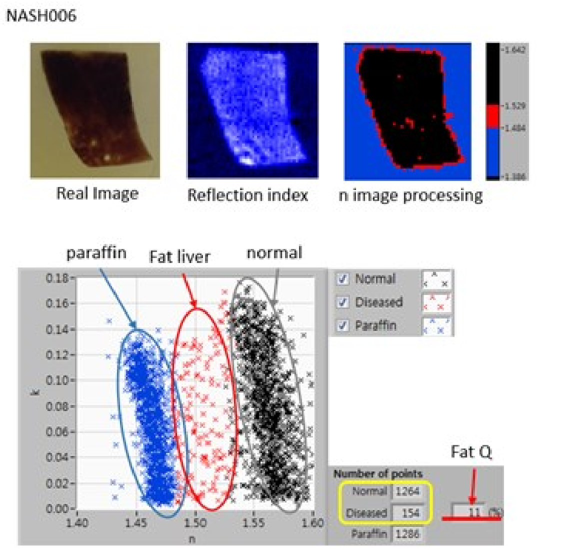

Figure 2. Refractive index of normal liver image and quantification of refractive index for each pixel

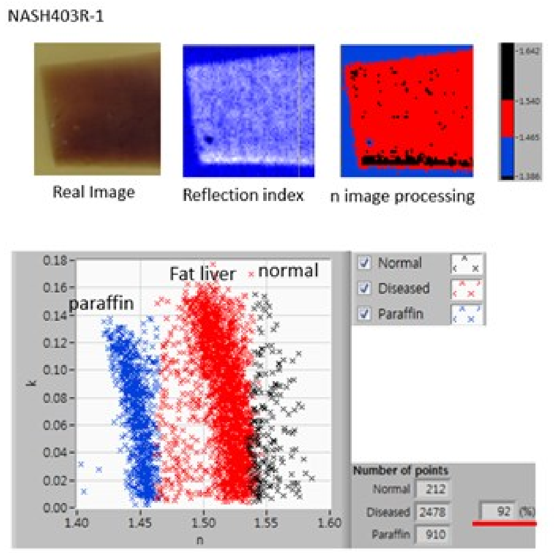

Figure 3. Refractive index of fatty liver image and quantification of refractive index for each pixel

Thus, we analyzed normal tissue and fatty tissue by quantifying the refractive index, and we performed this quantification using direct comparison and data distribution.

3. Results and Conclusion

In this experiment, we demonstrated that it is possible to quantify and image pathological fatty liver. However, further statistical analysis is required in order to obtain more exact measurements of the refractive indices of normal liver and fatty liver, and we must develop a program for calculating and processing to acquire quantification data. In the future, we will quantify and compare samples fatty liver using terahertz waves.

4. References

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