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Clinical Setup of Microwave Mammography :Phase 2

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Abstract

The microwave mammography for the clinical test to the patients has been prepared. 3 types of the sensor have been manufactured for several sizes of the breast. Also, the control equipment has been modified and miniaturized. Phantoms made of the diacetin solution were successfully imaged.
Keywords : UWB radar, Mammography, Clinical Test

1. Introduction

The breast cancer has the highest attack-rate in the cancer of the woman and early detection and treatment are important. Though the X-ray mammography is widely used, it has drawbacks of (1) X ray exposition, (2) fail of detection due to the low contrast, (3) pain at the inspection. An echography is known as the alternatives. However, the inspection quality depends on the skill of the inspector and the reproducibility of the result is poor [1].

In the recent, the diagnosis image by a multistatic UWB radar is demonstrated and attracts attention [2][3]. Also, we are studying detection of the early breast cancer. Our study is featured by MS (Multistatic)-MIST(Microwave Imaging via Space Time) algorithm which extended MIST to the multistatic radar [4], and a conformal array that fixes a breast on the shape of the cup by suction [5]. It was confirmed by numerical simulation and experiments using the phantom that the MS-MIST had high resolution and low artifacts compared to the mono-static MIST and calculation load is low compared to MAMI. Also, through the clinical-evaluation with healthy women, it was confirmed that there was no problems in use of the sensor featured by the suction fixation [6].

In this article, we present equipments modified for the clinical test to the patients and the experimental results using phantom.

2. Equipment

The schematic diagram of the developed microwave mammography is shown in figure 1. It is composed of sensor, aspirator, antenna switch, network analyzer, PC for control, and work station (WS) for the data processing.

2.1 Sensor

As shown in figure 2, we have prepared 3 types of sensor for varieties of the breast size: diameters of 13cm and depth of 5.4cm with 30 elements, diameters of 10cm and depth of 4cm with 18 elements, and diameters of 8cm depth of 2cm with 6 elements. The element is the stack patch antennas, and is designed so as to match over the bandwidth in the condition that it touches skin. Since the pressure in the cup is decreased by the aspirator, the breast fixes to the inside of the sensor. Therefore, we need not to know shape of the breast for imaging process.

The element number and positions have been determined by numerical simulation. Figure 3 shows the model of the breast consisted of skin, adipose tissue, fibro glandular tissue, chest wall, and malignant tissue (tumor). The volume rate of fibro glandular tissue adipose tissue is set to 10%. The electromagnetic properties of the tissues were modelled by 1-pole Debye model. The constants are shown in Table 1. For the small sensor is 6 elements are arranged on the circumference while for the large sensor, 2 sets of 12 elements and 6 elements are arranged on 3 circumference. Examples of imaging for small (6 elements) and large (30 elements) sensor are shown in Fig.4. We can successfully image the breast model for small and large sensor.

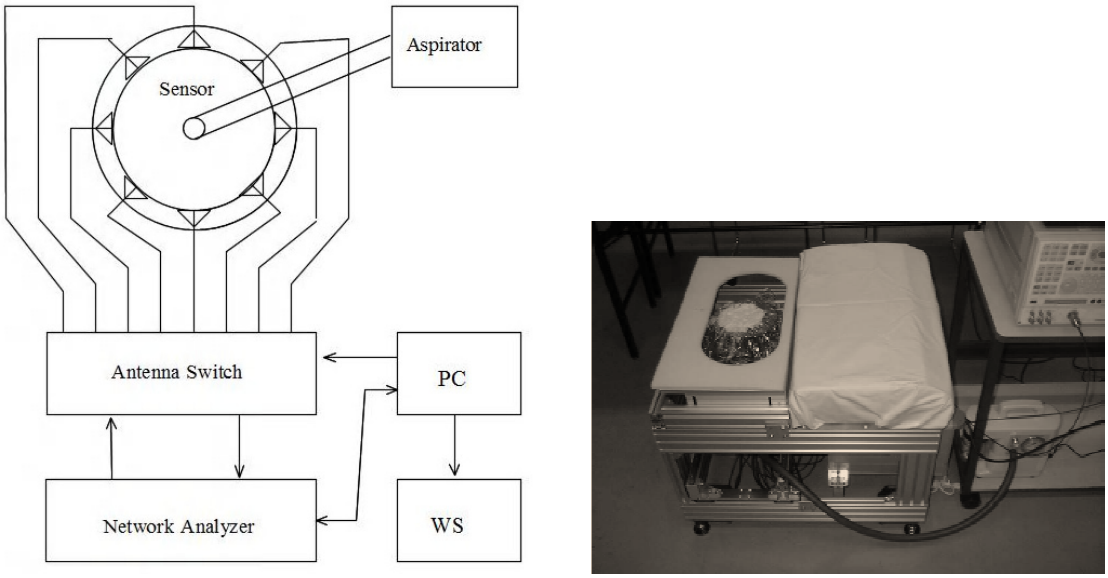
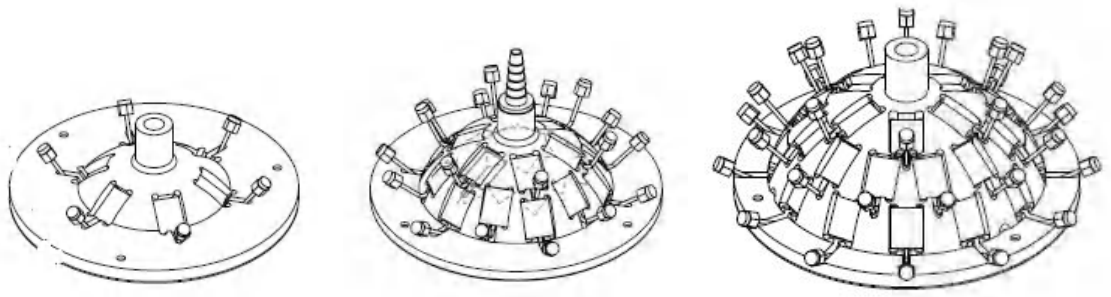


Fig.1 Modified Equipment



Small(6elements) middle(18elements) large(30 elements)

Fig.2 3 types of the sensor

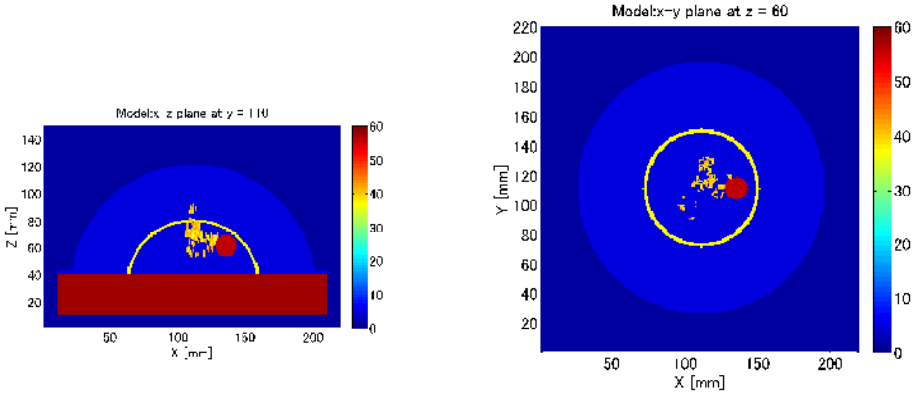


Fig.3 Breast Model for simulation

Table1 The electromagnetic properties of the tissues

	ε_s	ε_∞	σ_s(S/m)	τ(ps)
Adipose tissue	4.9	3.3	0.037	17
Fibro glandular tissue	49	21	0.72	17
Malignant tissue	56	23	0.8	17
Skin	37	4	1.1	7.23
Chest wall	58	4	0.7	7

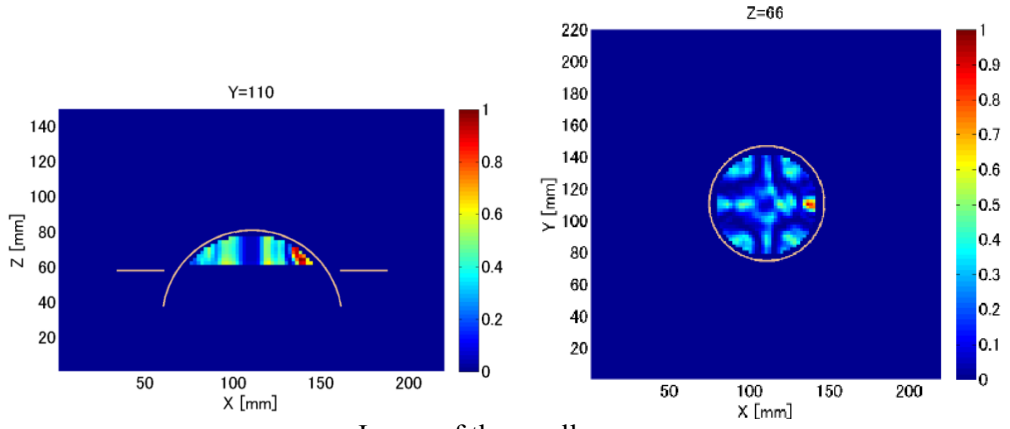


Image of the small sensor

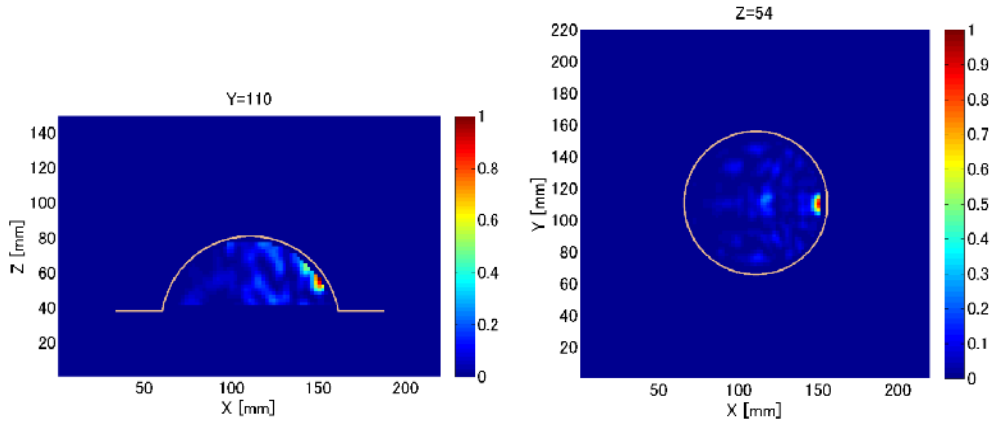


Image of the large sensor

Fig.4. Examples of simulation results

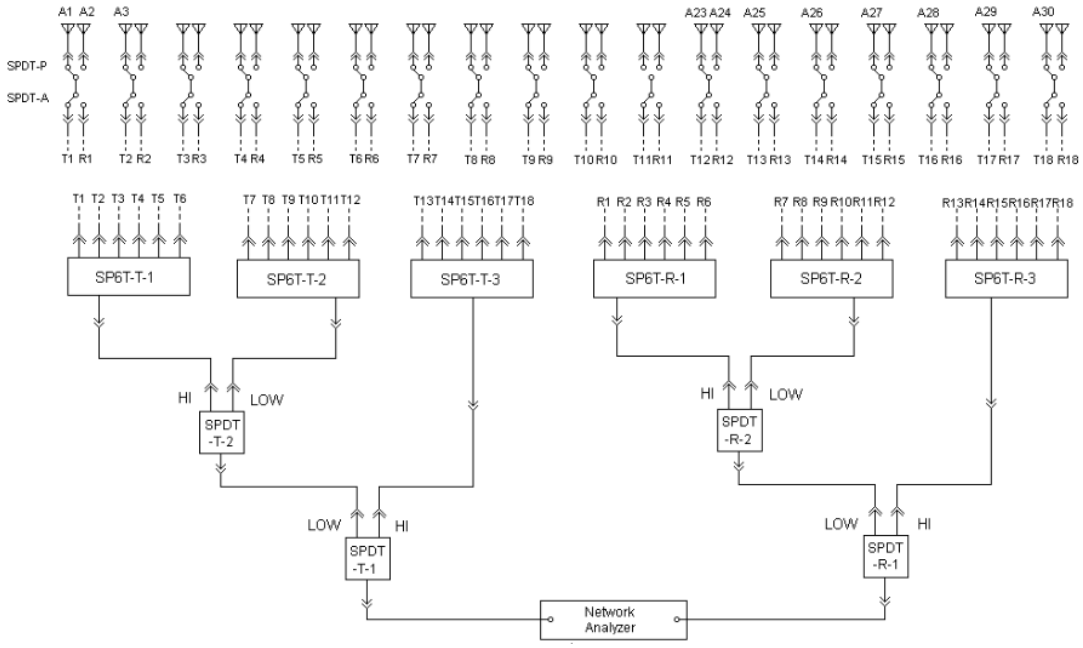


Fig.5 Antenna switch

2.2 Antenna Switch and Control

The antenna switch chooses the 2 antenna connected with the input/output port of the network analyzer. The modified antenna switch can be applied to sensor with 6, 18, and 30 elements. The configuration of the antenna switch is shown in Fig.5. It consists of 40 SPDTs and 6 SP6Ts. The

insertion loss is less than 5dB(@6.5GHz) and amplitude and phase deviation is less than 0.2dB and 10degs, respectively.

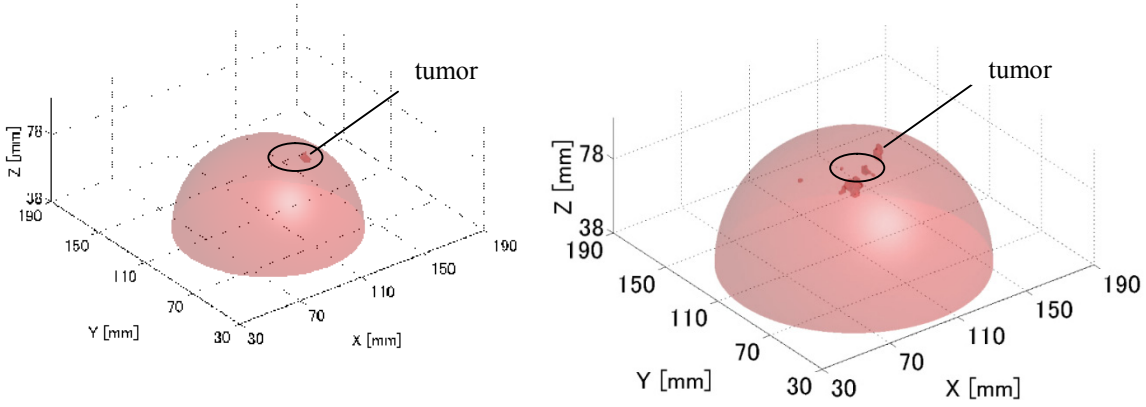
3. Phantom Imaging

3.1 Phantom

The operation of this equipment was confirmed using a phantom. Two pieces of different diacetin solution (ε_r=7, ε_r=48@6GHz) of the permittivity were used as the material of the phantom. Sensor for imaging was filled with the solution of ε_r=7 (adipose tissue), the solution of ε_r=48 (tumor) was enclosed with the tube of 6×10 mm and was put in the sensor.

3.2 Imaging Results

We have imaged the tumor using small and large sensor. Figure 6 is imaging result. The area where the scattered peak power declines by 20 % is shown. The position of the tumour and the strong electric power agrees.



Small sensor Large sensor

Fig.6 Imaging Results

4. Conclusions

The microwave mammography which is used for the clinical test to the patients was manufactured and a experiment using the phantom was carried out. Tumor phantom made of diacetin solution can be detected for each of 3 sensors.

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Acknowledgments

This work is supported by Grants-in-Aid for Scientific Research (Contract No. 23300187).