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Proceedings of Symposium on Ultrasonic Electronics, Vol. 34 (2013) pp. 323-324
20-22 November, 2013

Compact module transducer for HIFU therapy
HIFU 用モジュールトランスデューサーの開発

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1. Introduction

High-intensity focused ultrasound (HIFU) is widely used for therapeutic applications because it is an attractive and non-invasive tool by which to provide thermal therapy [1]. The sound pressure at the focal point reaches hundreds of megapascals, resulting in an increase in temperature, which necrotizes cells. Although HIFU treatment has been applied to limited rigions. It is difficult to treat targets that lie behind bone (e.g., brain tumors) or that lie deep inside the body (e.g., liver tumors), because the ultrasound beam is reflected, refracted, and attenuated by the intervening tissue and/or bone [2-3]. In order to resolve this problem, phased array HIFU has been developed [4]. Focus position control of HIFU by multi-elements phase control is very popular in clinical application. However, multi-elements driving amplifier is very large size like a large refrigerator. So, we adopted a direct drive amplifier system for the multi-elements transducer [5]. This system has an advantage of reduce the energy loss at the connecting cable between the transducer element and the amplifier. So, we make the very compact multi-elements transducer system combined with multi-elements amplifier. Figure 1 shows an image of multi-elements module transducer.

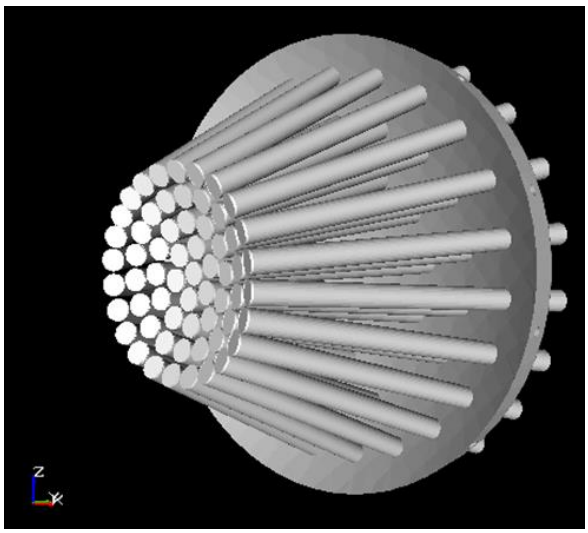

Fig.1 Schema of multi-elements module transducer

2. Method

In this study, we evaluated the specification and system design of the first prototype module transducer. We discussed the requirement of the specification as follows.

- Number of elements: 64 (8 x 8)
- Pattern: square
- Pitch : 2 mm
- 0.1 Watt per element during the ON time
- Mechanical focusing: None (flat active area)

Figure 2 shows the schematic view of the module system. Also, we simulated focus intensity with phase delay. Focus positions are normal focusing (100mm distance from the transducer surface) and right shift focusing (5mm).

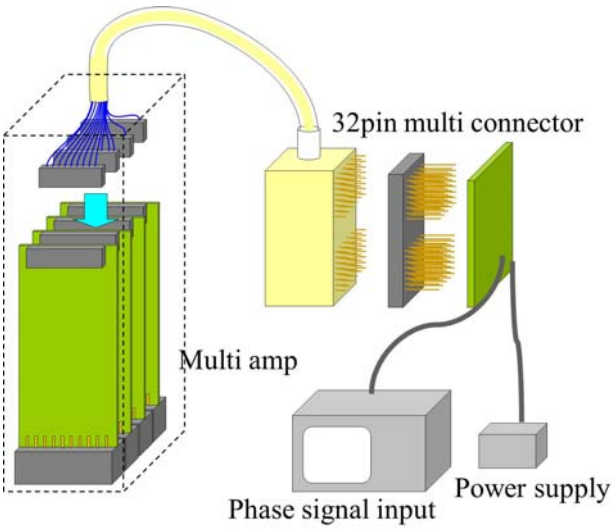

Fig.2 Schematic view of the module system

3. Results

Figure 3 and figure 4 showed simulation results of focus region control using phased array system. Our module has 8*8 matrix array elements and placed

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on a flat surface. When we input same phase wave, this module generate a plane wave. We set the focal position on the center of axial direction. Focal position distance from the element surface is 100mm. (Fig.3) Figure 4 showed that focal position was moved to right direction (steering angle: 2.862 degree. It means that focal position moves to right side 5mm.) by phase delay. Peak intensity was little bit reduced by focal position moving and second peak value was still very small. This result indicated that our module design (e.g. element pitch) was able to use phase delay control for focal position control. Figure 5 shows the first prototype 64 channel matrix array module. This module connected to array amplifier modules directly. One amplifier module has 16ch driving circuit. This amplifier module size was 70mm height, 20mm width and 5mm thickness. Four amplifier modules were set on the backside of array elements with direct connection.

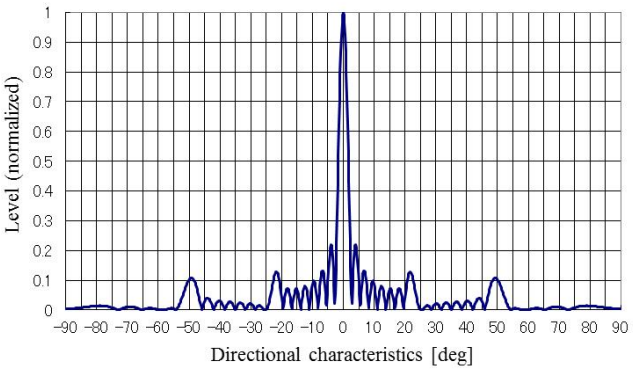

Fig. 3 Focal position control with phase delay simulation (steering angle 0 degree focus point 100mm from module element surface)

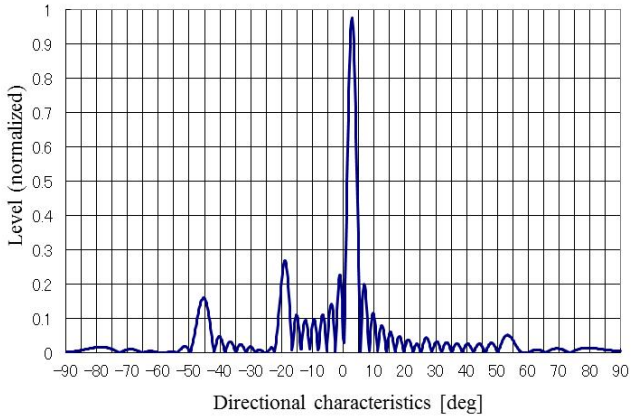

Fig. 4 Focal position control with phase delay simulation (steering angle 2.862 degree focus point 100mm from module element surface)

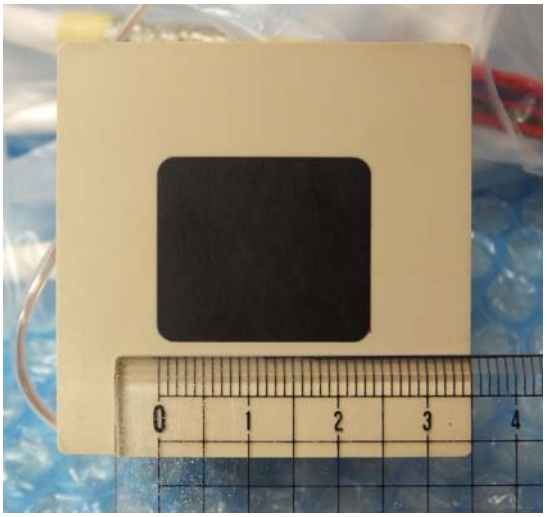

Fig.5 1st prototype matrix array module

4. Conclusion

In this study, we developed first prototype module transducer for HIFU therapy. We believe that this module can be used for many types of ultrasound therapy researches.

Acknowledgment

The present study was partially supported by a Grant for Translational Systems Biology and Medicine Initiative (TSBMI) and Scientific Research (A)2012, 24246035 from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

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