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Two-Dimensional Vibration Scanning Method for Puncture Needle-Type Ultrasonography

穿刺型超音波顕微鏡用二次元振動走査法

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1. Introduction

In order to establish tissue diagnosis by the endoscopic ultrasonography into, we have been developing puncture needle-type ultrasonography.[1-4] For realization of a low-cost, fast scanning rate, and high resolution system, we developed a vibration scanning method using an audio speaker and the equivalent-time sampling method. Previously, we demonstrated the perfprmance of the vibration scanning method.[4] However, in that experiment, the vibration method was used for only one directional scannig, and an automatic stage was used for the two dimensional scanning. Use of the stage hinders to make real-time imaging possible.

In this experiment, we demonstrated a two-dimentional vibration scanning method using two audio speakers and confirmed the effectiveness of the method.

2. Principle

2.1 Puncture needle-type ultrasonography

Figure 1 shows the schematic of the equipment for the puncture needle-type ultrasonography. The measurement principle of the method was previously reported.[1)]

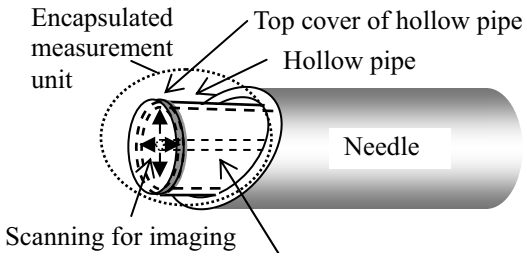

Fig. 1. Basic concept for puncture needle-type ultrasonography.

2.1 Two-dimensional vibration scanning method

The principle of the scanning method is based on the movements of the end point of a lever[2)].

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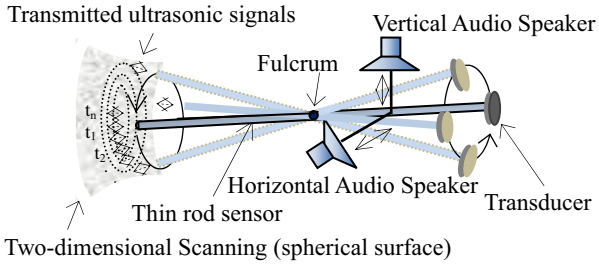
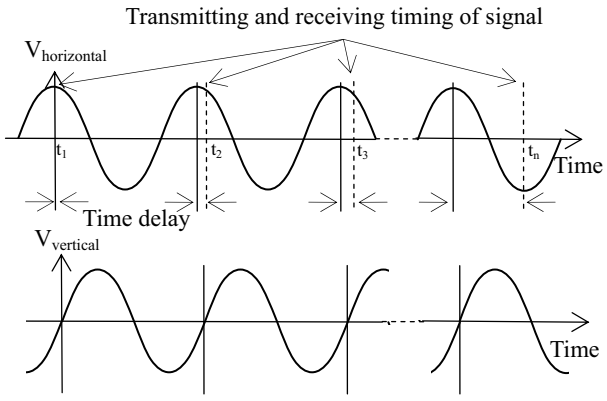


(a) Two-dimensional scanning mechanism by speakers



(b) Driving voltages of speakers

Fig. 2. Schematic illustration of vibration scanning method

Figure 2 (a) shows that the vibration generated by two speakers makes two-dimensional scanning possible. When the endpoint of the lever is at a point, an ultrasonic signal is transmitted and received, and the ultrasonic measurement at the point is conducted. Those speakers are driven by the sinusoidal voltage signals, as shown in Fig. 2 (b). During vibration of the thin rod sensor, the ultrasonic signals are transmitted and received at the timing which delayed at a small increment from the maximum point of the sinusoidal signal, respectively, as shown in Fig. 2 (b). Since the sinusoidal signal corresponds with the spatial position of the sample, two-dimensional data are

obtained. If the voltage of those signals is changed, the imaged circle is changed, and then the spherical image is obtained, as shown in Fig. 2 (a).

3. Experiment

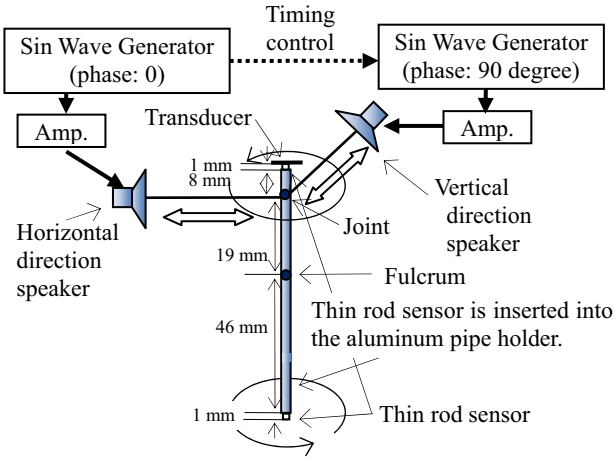


Fig. 3. Schematic diagram of experiment.

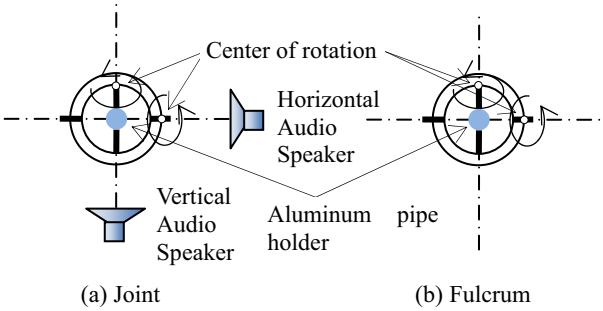


Fig. 4. Joint and fulcrum mechanism.

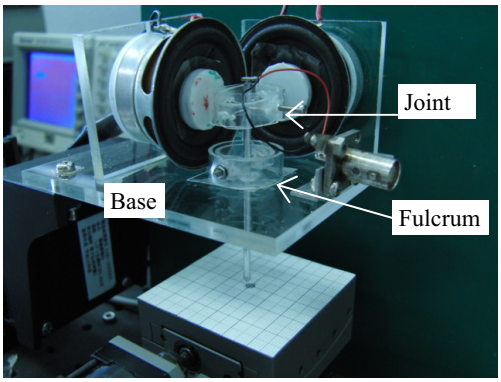


Fig. 5. Overview of the prototype vibration scanning mechanism.

Figure 3 shows the schematic diagram of the experiment. In this experiment, a fused quartz rod with a diameter of 1.2 mm and length of 75 mm was inserted into an aluminum holder with a diameter of 2.6 mm and length of 73 mm. The top side of the holder was connected to a speaker, as shown in Fig. 3. Sinusoidal waves having amplitudes of 2.5, 3.0, and 3.5 V_{PP} with a center frequency of 10 Hz was applied to the speakers. The phases of the sinusoidal waves differ by 90 degree each other. Figure 4 shows the mechanisms of the joint and the fulcrum. The joint was fixed to those speakers by aluminum pipes with a diameter of 2.6 mm, and the fulcrum was fixed to a base, as shown in Fig. 5.

4. Results and discussion

Figure 6 shows the amplitude of the motion as a function of the applied voltage to those speakers. This result shows that the effectiveness of the method. Figure 7 shows an example of the end motion when those speakers drove the sinusoidal wave having amplitudes of 3.5 V_{PP}. From this Figs, because of the joint was fixed to those speakers, the circle of the motion was seemed a little distorted. It is need to improve of the joint mechanism for aculeate circle motion.

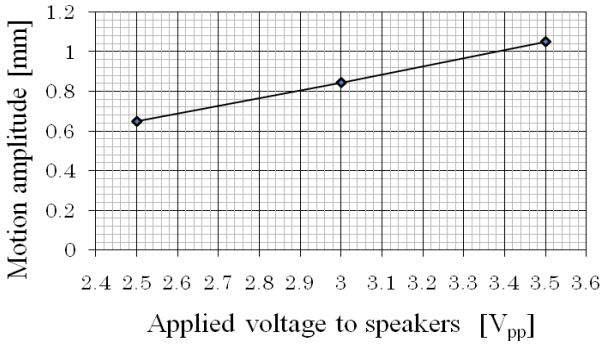


Fig. 6. Motion amplitude vs. applied voltage to speakers.

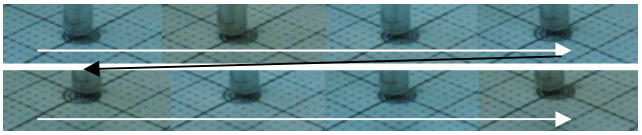


Fig. 7. Photographs of end motion (1/60 sec/frame)

5. Conclusion

We demonstrated the two-dimensional vibration scanning method using the audio speakers. We confirmed experimentally that the effectiveness of the scanning method.

References

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