Development of multi-purpose Switching MUX for the ultrasound measurement

Hyo-jin Lee[1,1], Yong-tae Kim, Sun-Hyung Kim[1]

Department of Information & Communication Engineering, Soonchunhyang University, Asan, Chungnam 336-745, Republic of Korea, Information & Communication ineering, SoonChunYang University, 22, Soonchunhyang-ro, Sinchang-myeon, Asan-si, Chungcheongnam-do 336-745, korea, Korea Research Institute of Standards ans Science, 1 Doryong-Dong, Yuseong-gu, Daejeon, Korea.
dkid33@naver.com, ytkim@kriss.re.kr, shkim@sch.ac.kr

Abstract. In this thesis, it is presented the proposed development of the Switching MUX with the array transducer by use of Delay-And-Sum Beam-forming technology for a more accurate measurement. Among the several measurement methods, it is studied two ways, i.e. Pulse-Echo method and the radiation conductance measurement. In this paper, we propose to the multi-purpose Switching MUX all interfacing the two methods mentioned earlier. And it is verified that beam-forming control of the proposed equipment is smoothly implemented through simulation. And multi-purpose Switching MUX proposed in this thesis is modularized by 64ports in order to reduce the hardware size.

Keywords: Ultrasound, Array Transducer, Beam-forming, Switching MUX

1   Introduction

Ultrasound is the sound of more than 20,000Hz frequency. Frequency represents how many times the vibration wave in one second. And unit uses Hz (hertz)[1]. Ultrasound of frequency higher than 1MHz has directivity. In other words, it is emitted in a certain direction as the light. There are four properties of the ultrasound, i.e. attenuation, reflection, refraction and scattering. Ultrasound transducer is generated ultrasound by the piezoelectric element. And it is made from Crystal, tourmaline, ceramic, etc. Electricity generated by ultrasound is applied to the surface [7]. When an electrical signal is applied to piezoelectric element, it vibrates. Ultrasound measuring device generates ultrasound wave by adding electrical signal to the transducer. And detects the electrical signals generated by the reflected wave coming back. This paper proposes multi-purpose Switching MUX which is capable of interfacing with various measurement methods using ultrasound. In this paper, it is suggested the Structure of the Switching MUX so that it may have a variety of

---

[1] Corresponding author : Tel.: +82-41-530-1344; Fax:+82-041-530-1548

measurement methods using the ultrasound. And designed to be able to control beam-forming of the proposed equipment is smoothly implemented through simulation. And it makes the modularization in order to reduce the hardware size and to change easily the port control. This thesis is comprised of following chapters. Chapter 1: introduction, Chapter 2: proposed Switching MUX, Chapter 3: simulation of Switching MUX, Chapter 4: simulation result and is finalized with chapter 5.

2 Proposed Switching MUX

2.1 Array transducer

Ultrasound transducer is generally formed of a single piezoelectric element [2]. Therefore the shape of the ultrasound beam is always constant [3][5]. In order to make variable shape of the ultrasound beam, it needs the Switching MUX. Therefore it is possible to adjust the ultrasound delay of an array transducer. So we can change the shape of the beam. Each element of the Array transducers is able to vary the release time of the ultrasound wave[4]. Thus, the change the shape of the ultrasound beam means the beam-forming. The type of the beam-forming is various things. In this paper, the Delay-And-Sum beam-forming is used.
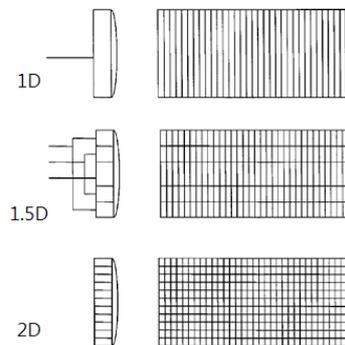

Fig. 1. Kind of array transducer element.

2.2 Delay-And-Sum Beam-forming

Principle of ultrasound beam is described in fig. 2. First, ultrasound waves are emitted with a different delay. Emitted ultrasound waves will be subjected to interference with each other. Thus, ultrasound is amplified together, attenuation or offset. Because of this phenomenon, it is possible to focus the ultrasound beam to the desired point.

Delay-And-Sum Beam-forming is a beam-forming method using the delay. This method has two types. It is the Tx Beam-forming and Rx Beam-forming. Tx Beam-forming is a beam-forming method for delaying at the transmitting end. On the other hand, Rx Beam-forming is a method that delaying the received signal. In this paper, discuss only the Tx Beam-forming. As mentioned earlier, all elements have each different delay. This makes it possible to change the ultrasound beam into a desired shape[8].
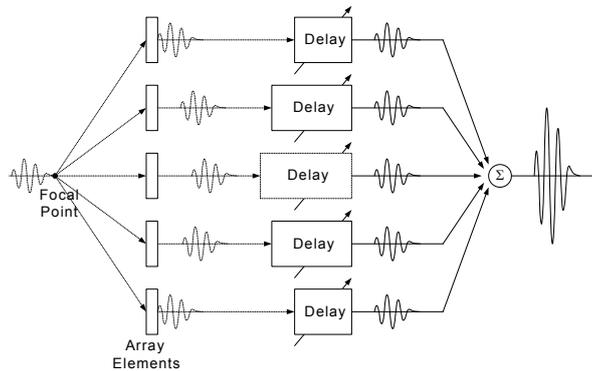
Fig. 2. Principle of Delay-And-Sum Beam-forming.
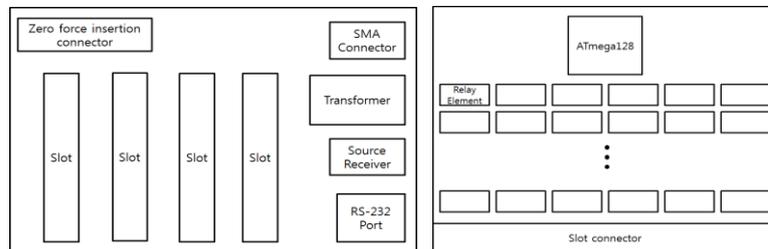
Fig. 3. A block diagram of Switching MUX with 4* 64 port module.

3   Simulation of Switching MUX

As mentioned earlier, there is necessary for a device in order to make the delay for beam-forming of the array transducer. This thesis provides a device that will create a delay. Thus, this paper proposes the variable channel Switching MUX that can be used in Pulse-Echo method and Radiation conductance measurement [10]. The basic operation of the Switching MUX would make generate the delay [9]. Using a delay device in Switching MUX, it switches connection port and generates a delay. And a

slot type mux module is made by the LabVIEW Software. Therefore, it is possible to use selectively only the required channels.
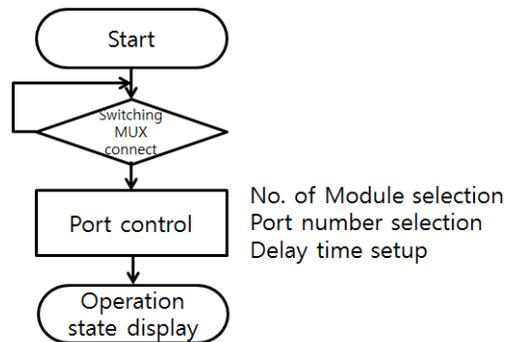

Fig. 4. Software flowchart of Switching MUX.
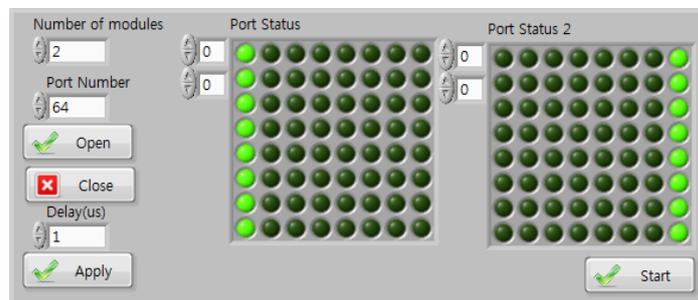
4   Simulation result

Fig. 5. Simulation of additional modules

The proposed Switching MUX consists of ports so that it may selected necessary port in channel. Each slot is modularized by 64 channels. Therefore, I will simulate a 64 channel. The figure. 6. shows the basic operation of the channel control. Enter the number of ports that control to when you click the [Open] button, the port is open. And come into the in to a Boolean. When you click the [Close] button, Closed the port, Turned off the Boolean. To use the beam-formed ultrasound, it is necessary to delay a short time of each element in array transducer. To the Beam-forming, use LabVIEW to add a function that can provide a delay in short. If the number of [Number of module] to enter the number of modules of the more users use, it is

possible to control the module just entered. Number of port of added modules to start from 65 If you enter the three, the third module, starting from 129.

5 Conclusions

This paper provides an interface device which can be used to two ultrasound measurement method. The name of the device is defined Switching MUX is to add a ultrasound delay to each element of the array transducer. And it makes the modularization in order to reduce the hardware size and to change easily the port control. It consists of a programming that can control the 256 ports using the LabVIEW software. It Programming up to four modules. In addition, it was made to be able to provide a delay for each element. Simulation results, it each is possible to provide a delay for each port, it was confirmed that up to four modules can be used. And it is verified that beam-forming control of the proposed equipment is smoothly implemented through simulation. And multi-purpose Switching MUX proposed in this thesis is modularized by 64ports in order to reduce the hardware size. In the future, it is planned to implement the interface device for the 256 channels by constructing the hardware and to measure the thickness and intensity by using the ultrasound beam-forming with a delay.

References

1. Peter D. Edmonds, Ultrasonic, Academic Press, INC.(1981)
2. Frederick W, Kremkau, Diagnostic Ultrasound Principles and Instruments Six edition, W.B. Sauunders Company(2002)
3. Thomas L. Szabo, Diagnostic ultrasound imaging: inside out, Elselvier academic press, San Diego (2004)
4. Erikson, K., Hairston, A., Nicoli, A., Stockwell, J., 123 × 123K (16K) ultrasonic transducer hybrid array. Acoust. Imaging. Vol. 23.(1997) New York
5. J. A. Jensen, "Simulating arbitrary-geometry ultrasound transducers using triangles", Proc. IEEE Ultrason. Symp., vol. 2, pp. 885-888, (1996)
6. D., and C.R. Johnson, Methods for procedures related to the electrophysiology of the heart. U.S. Patent 5,529,067, Jun 25 (1995).
7. M. H. Bae, Focusing delay calculation method for real-time digital focusing and apparatus adopting the same. U.S. Patent 5,836,881, Nov. 17 (1998).
8. D. Lipschutz, Time multiplexed digital ultrasound beamformer, U. S. Patent 5,469,851, Jul 17(1998).
9. D. Y. Yun, M. J. Jho, Y. T. Kim, J. K. Kim, and M. H. Lee, "Design of the electro-acoustic radiation conductance measurement system for medical ultrasonic array probe", IEICE Electronics Express, Vol.8, No.12, pp. 978-983(2011).