Development of 1.5D Circular Array for Endoscopic Ultrasound

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Background, Motivation and Objective

Endoscopic Ultrasound (EUS) is a minimally invasive procedure to obtain the high-quality ultrasound images of internal organs and guide the fine need biopsy, which has served as the gold standard for the diagnosis of GI track malignant diseases such as pancreatic cancer. Traditional EUS transducer, operating at slightly higher frequencies 5-10MHz, is circular 1D array with a fixed cylindrical lens. Recent advances in transducer development have shown that the 1.5D array can achieve dynamic focusing and apodization in the elevation direction, and leads to a better detectability of small lesions over a large depth. However, the complicated processes of small radius circular pattern forming and high-density interconnection (HDI) make it difficult to fabricate a miniaturized 1.5D circular array for EUS. In this study, we design and manufacture a 425-element 1.5D circular array of which the radius is 5.35 mm to facilitate the electronic elevation focusing with improved image quality.

Statement of Contribution/Methods

Fig.1(A) shows the designed structure of the 1.5D circular array for EUS, with a designed center frequency of 5MHz. PZT composite materials are divided into 7 rows and 85 columns, as shown in Fig.1(B). The width of each column is 0.39 mm. The two outmost rows shown in gray are used for ground connection. The gaps between adjacent elements are filled with epoxy resins to reduce cross-talk noise. Each pair of two elements symmetric with respect to the central row are electrically connected. Thus the 5 elements of each column can realize dynamic focusing and apodization in the elevation direction. The elements are connected to the cable conductor by customized manufactured flexible printed circuits board (FPCB) with 255 individual channels. In order to keep the size and the electrical impedance of equivalent areas the same, the height of the central row is twice the height of outer rows. The thickness of the PZT layer and two matching layers are 0.26 mm, 0.142mm and 0.132 mm, respectively. The FPCB connected 1.5D array are circular formed by using a customized mould. **Results/Discussion**

The actual image of the composite material and fabricated 425-element 1.5D circular array are shown in Fig.1(B) and (C), respectively. And the electrical impedance curve of a single element is presented in Fig.1(D). Fig.1(E) and (F) show the pulse echo testing results for the single element at the central row and elements at two outer rows adjacent to the central row respectively in the time domain and frequency domain. The circular array has a measured center frequency of about 5.55 MHz and a measured bandwidth of about 43.6%. We have successfully designed and fabraicated 1.5D circular array first of its kind for EUS imaging with the electronic focusing capaliblity in the elevation direction.

