A Survey on Ultrasound Beamforming Strategies

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Abstract - *Medical imaging is the process of creation of visual representation of the interior of human body for diagnosis purpose. There are many different medical imaging techniques are available such as CT, MRI,US etc. Among these US is most commonly used because of its features like noninvasive nature, low cost and real time imaging. The most fundamental step of ultrasound imaging is the beamforming. There are different strategies available for this beamforming where the strategies are differed in their amount of region of imaging, type of signal used, time and computational cost etc.*

***Key Words*: Beamformer, Ultrasound imaging, Soundwaves, pulse-echo data, moving aperture**

1. INTRODUCTION

The working of Ultrasound imaging can be explained as, initially we transmit a high frequency sound wave which is ranging from 1-5 MHz in to human body. This wave moves into the body and hit some boundary between tissues like bones and then the wave bounce and echo back the signal. The bounced signal is also received by the same transducer which transmits the signals. Then the received sound wave converts to electrical signal and imaging is performed. The beamforming is the crucial step in ultrasound imaging and here we discuss some strategies for the beamforming.

This paper is organized as follows. In Section II, we briefly summarize the different techniques used for beamformation. Finally, we summarize and draw some conclusion in Section III.

2. LITERATURE SURVEY

In [1] introduces a method for ultrasound beamforming with plane wave echo signals in the Fourier domain. The advantage of this method is, it provides quick and high resolution image reconstruction. We use non uniform fast Fourier transform (NUFFT) for further image processing. The proposed method has advantages like feasible signal-to-noise ratio and computational cost.

Nowadays software-based beamformers for ultrasound array imaging are available. Data transmission from the analog front end to the software back end at a high rates of about few gigabits per second is the main challenge to implement the fully software based system. The paper present data compression as a solution which reduces the data transfer requirements. For that here JPEG and JPEG2000 compression techniques were used. The proposed system provides high image quality. These are described in [2].

In [3] a modular digital ultrasound beamforming which is based on field programmable gate array (FPGA) is presented. The Virtex-5 FPGA is implemented with digital beamforming. The objective of this work is to develop a digital ultrasound imaging with modular low-cost PC-based system that has almost all of its processing steps done on the PC side. Two 8 channels block and reconstructed line block constitute the proposed system. The hardware architecture of the design provided flexibility for beamforming.

The received pulse-echo data for beamforming with an aperture generally involves the compression of signals from multiple channels. And more importantly the performed compression is irreversible, which may cause loss of information relevant for performing a diagnostic task. The paper[4] performs an evaluation of information transfer in beamforming along with a previously developed ideal observer model. This model is used to simply quantify diagnostic information relevant to performing a task. Here describe an elaborated statistical model of image formation within a moving aperture, which have fixed-focus transmission and single-channel reception. This one is mainly used for breast sonography .The advantage of the method is that it optimize the transfer of information because of the single channel. And also acquisition noise is well described.

The image quality in biomedical ultrasound can be significantly improved by reducing the clutter due to interfering signals arriving from undesired directions. In [5] along with the consideration to conventional linearly constrained minimum variance (LCMV) adaptive beamformer here propose an alternative based on the well-known generalized side lobe canceller (GSC). The GSC, combined with iterative optimization methods, to achieve low computational complexity of beam forming and high image quality. This was the first time a GSC-based gradient-driven approach has been applied and evaluated in the context of ultrasound beam forming.

A strict timing-coherent digital signal processing architecture is presented in [6]. Within predictable time intervals with tight accuracies the programmable events should be produced and this is the most basic requirement. Ultrasound beamforming is one of the main application field of this criteria.. The followed approach defines a modular and scalable architecture (AMPLIA), configured as a multi-branch pipeline. This arrangement guarantees timing coherence along all the system, independently of the number of processing modules. The latency introduced by every module is automatically compensated and clock synchronization is achieved by Digital Clock Managers inside FPGAs.

3. CONCLUSIONS

The most fundamental step for ultrasound imaging is the beamforming. And there are different methods available for beamforming. These strategies are differ in their domain, type of wave used, area that can be covered, computational cost, resolution of reconstructed image etc. For every method the working of ultrasound imaging is same. The survey performs an analysis among these strategies along with the advantages and drawbacks of each strategy.

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BIOGRAPHIES

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