Resolution Enhancement Compression (REC)-Synthetic Aperture Focusing (SAF)

Functional Requirements Lists and Performance Specifications

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Introduction

Ultrasound imaging is an indispensable technology in medicine. Its most important application in medicine is nondestructive scanning wherein a transducer is used outside bodies of patients to scan some particular regions inside the bodies. The data from the ultrasound scanning will be used to construct an image of those regions. Using these images, doctors can quickly identify if there is any anomalous feature, such as a tumor inside the body. The ability to see the inside of the body will enable doctors to decide if medical treatments are needed to eliminate anomalous features, thereby saving people's lives.

Ultrasound imaging involves exciting the transducer and forming ultrasound beams to gather data on the targeted object. Transducer excitation and beam-formation procedures have been the subject of interests since they affect the resolution of ultrasound images. The goal of this project is to investigate and demonstrate the effectiveness of resolution enhancement compression (REC) and synthetic aperture focused technique (SAFT) techniques in enhancing the resolution of ultrasound images. The project entails literature research on REC and SAFT and simulation of these two concepts through MATLAB R2012a and general purpose graphics processing unit (GPGPU).

System Block Diagram

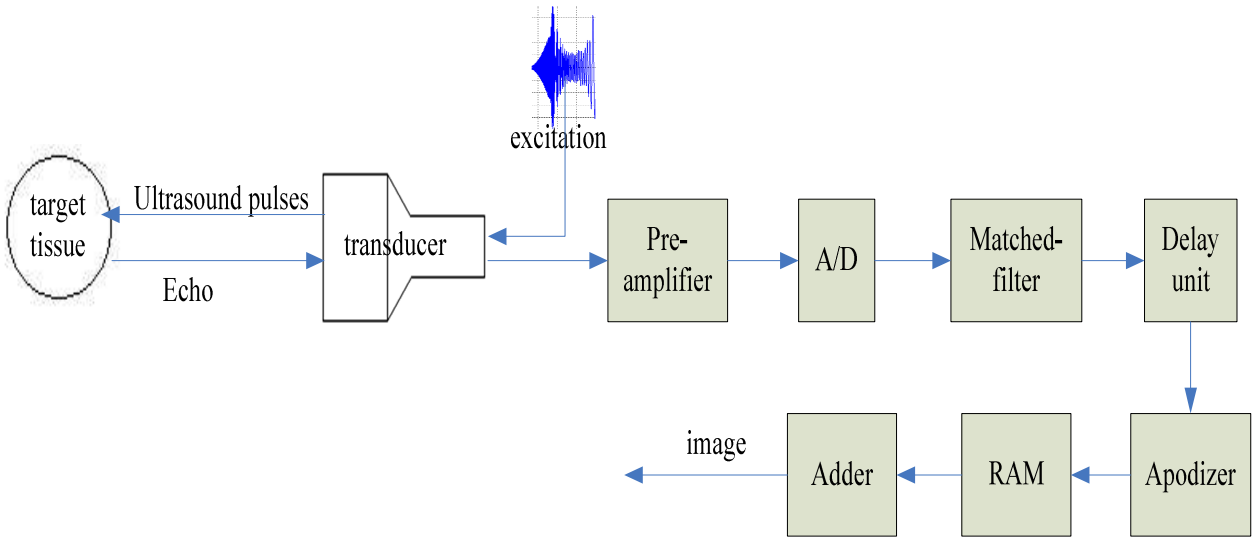

Figure 1: System Block Diagram

Functional Requirements

Synthetic Aperture Focus (SAF)

- The transducer shall consist of an array of elements arranged linearly.
- The ultrasound simulations shall be performed using the MATLAB add-on Field II.
- The synthetic aperture system shall store the received signals from the transducer elements in RAM.
- The total memory usage shall not exceed 2 gigabytes.

- The delay and sum calculations shall be performed on a GPGPU.
- The total synthetic aperture processing time shall be less than 1 second.
- The SNR of the output images shall be at least 50 dB.
- The simulated transducer shall have these specifications:

Parameters	Values
Center frequency (denoted as f_0)	2 MHz
Sampling Frequency (denoted as f_s)	400 MHz
Number of elements in the transducer array	128
Element's width	200 μm
Element's kerf	40 μm
Element's height	5 mm
Focus of ultrasound beam	40 mm

Table 1: Requirements for REC-SAFT simulation

Resolution Enhancement Compression (REC)

- The actual impulse response of the transducer (denoted as $h_1(t)$) shall have a center frequency f_0 of 2 MHz.
- $h_1(t)$ shall have a bandwidth of about 83% (Here, percent bandwidth = 6dB bandwidth of the spectrum of $h_1(t)$ divided by f_0)
- The sampling frequency f_s shall be 400 MHz.
- The desired impulse response (denoted as $h_2(t)$) shall have a bandwidth about 1.5 times the bandwidth of $h_1(t)$.
- The linear chirp (denoted as $V_{\text{lin chirp}}(t)$) shall have a bandwidth that is about 1.14 times the bandwidth of $h_2(t)$
- The side lobes of $V_{\text{lin chirp}}(t)$ shall be reduced below 40 dB.

References

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