Image Scan line Conversion For Portable Ultrasound Machine

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***Abstract* - Ultrasound is one of the fastest-growing medical imaging modalities due its relative simplicity, low cost, and radiation-free operation .Portable ultrasound machines are typically used in situations where space is limited, mobility is important, or the scanning must be done in the field. Currently portable ultrasound machines are used in Cardiac, Vascular, Radiology, Endocrinology, and OB/GYN applications. The problem in this portable ultrasound machine is the power consumption, performance and quality of display .To reduce the power consumption and to increase the quality of display highly efficient scan conversion algorithm is developed on DSP. This algorithm helps to improve the quality of an image and to reduce the power consumption of the machine. The purpose of scan conversion in digital ultrasound machine is to translate the input data that are captured in different polar coordinate in to Cartesian coordinate, which will improve the quality of the display**

Keywords - Ultrasound, Scanconversion,Interpolation

I. INTRODUCTION

Ultrasound is cyclic sound pressure with a frequency greater than the upper limit of human hearing. Although this limit varies from person to person, it is approximately 20 kilohertz (20,000 hertz) in healthy, young adults and thus, 20 kHz serves as a useful lower limit in describing ultrasound. Ultrasound diagnostic scanners emit ultrasound (roughly 2-15 MHz) into the body, and use the signals from the sound waves that bounce back from the interface between tissues (referred to here as "echo") to obtain images and blood flow speed information. Research into the use of ultrasound in medical diagnosis began in the 1940s with research conducted by K.T. Dussik et al. At that time, a method called the A mode (amplitude mode) was used to observe echo as a wave, but the scope of applications was limited. In the late 1950s, a technology was developed to create images by converting echo waves into intensity, and in the 1970s, an electronic scanning ultrasound scanner was released, in which multiple ultrasound transducers were arranged in an array, and these elements were switched electronically to achieve scanning. This ultrasound scanner came to be used in a wide range of diagnostic fields, including abdominal, obstetrics and gynecology, and cardiac diagnostics, because it is safe, non-invasive, and provides real-time images [1]. In ultrasound there are three different mode of operation .In A-mode echo signal are applied on the Y-deflection plate of the CRT so that they are displayed as vertical blips as a beam swept across CRT .The height of the vertical blips corresponds to the strength of the echo. In B-mode is brightness mode in which reflected echos are depicted as dots on the screen. Brightness of the dot depends on intensity of the echo. Third one is M-mode is used to study moving object like the valves and walls of the heart.

The digital ultrasound diagnostic scanner is divided into front end and back end segments [1].In the front end segment, a group of pulses with a time difference is generated to achieve ultrasound transmission focus; these pulses are supplied to the transducer array via the transmission circuit. The sound waves that are reflected back from the body are received by the transducer array, and then pass through the pre amplifier; they are converted into digital signals by the A/D converter, and reception focus processing is executed. The segment that executes this transmission focus and reception focus is called the beam former. The back-end segment, meanwhile, executes processing to create images and detect blood flow information in response to the signals after reception focus processing, and creates image data to be displayed on the monitor. The ASIC was developed jointly with Hitachi, Ltd. because a filter with sharp cutoff characteristics is needed to eliminate frequency components that are not required for harmonic imaging. After eliminating the unnecessary band using this ASIC, log compression (dynamic range control) and enhancement are executed to enable effective display on the monitor.

A. Basic Principles

When a high-voltage pulse is applied to a piezoelectric crystal, [2] the crystal generates a short burst of ultrasonic energy in response to this excitation. The disk-shaped crystalis mounted on one end of a small cylindrical tube to form an ultrasonic transducer. The transducer is typically 1 to **2** cm in diameter with a 1- to 20-MHz resonant frequency. Since resolution is limited by the ultrasonic wavelength, better resolution can be expected at higher frequencies. However, ultrasound undergoes attenuation as it travels through biological material due to scattering and absorption. Such attenuation becomes more severe at higher frequencies. The transducer is acoustically coupled to the patient by a thin layer of mineral oil on the skin. The ultrasonic pulse travels through the patient in a relatively well-defined beam. During its propagation, the ultrasonic pulse encounters interfaces between different tissue structures. A portion of the ultrasonic energy, which depends on the degree of mismatch between tissues, is reflected as an echo. Echoes reflected toward the transducer are converted to electrical signals which are detected by a sensitive receiver, and may be displayed in A-mode, B-mode, or M-mode presentations.

B. A-Mode Presentation

The amplitude of echo signals may be presented against their depth and displayed on a CRT. The A-mode representation has limited **use,** because it lacks anatomical information, i.e., it is difficult to identify the anatomical sources of the echoes with any certainty.

C. B-Mode Presentation

The echoes are presented as bright dots along a horizontal linear trace **on** a CRT. The brightness of the dots is proportional to the amplitude of the echoes. The distance along the linear trace is proportional to echo depth. **This** mode forms the basis for the B-scan

D. M-Mode Presentation

The echoes are displayeads in the B-mode, and thel inear CRT trace is also swept vertically. The resultant display is a family of curves depicting the position of reflecting interfaces versus time. This mode is used to examine the motion of heart valves and other internal structures.

II. DIGITAL ULTRASOUND

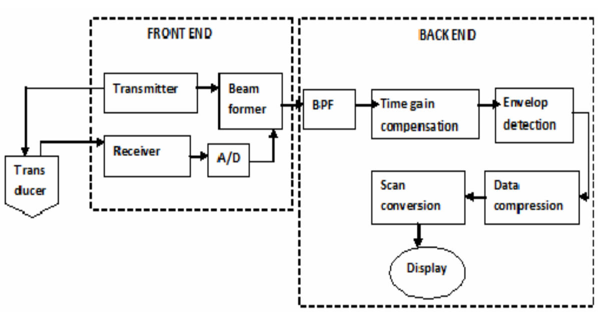

Fig. 1 Digital ultrasound

In fig.1 the front end segment, a group of pulses with a time difference is generated to achieve ultrasound transmission focus; these pulses are supplied to the transducer array via the transmission circuit. The sound waves that are reflected back from the body are received by the transducer array, and then pass through the receiver and they are converted into digital signals by the A/D converter, and reception focus processing is executed. The segment that executes this transmission focus and reception focus is called the beam former. In back end the signal processing stage in which the signal is filtered with a band pass filter to eliminate frequency components that are not required for harmonic imaging. After eliminating the frequency component , data compression (dynamic range control) and enhancement are executed to enable effective display on the monitor used to observe echo signals for which the dynamic range is 90 dB or more. These signals are then converted into scanning lines by scan conversion and sent to the display circuit. Envelop detection id done before the data compression part to get I and Q component [3] of the RF signal.

III. PRE PROCESSING STEPS

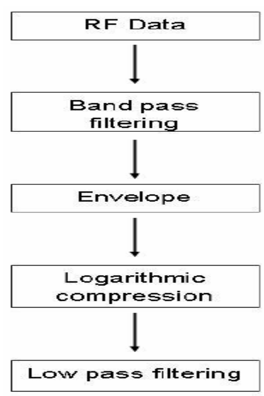

Fig.2 Preprocessing step

The scanner performs some signal processing to make the data fit the human eye perception and distinguish tissues with close properties. Typically, a band-pass filter, a rectification, a logarithmic compression and a low pass filter are applied to the samples. The Fig.2 represents post processing steps for a single line gives the RF data issued from the beam former without any post processing. As no detail is obtained in block before post processing .Then by filtering the RF signals in the bandwidth of the probe (2 to 9 MHz), removing the noise induced by the reception block and digitalization. Next step is detecting the envelope of the filtered RF signal. This operation removes the frequential information from the RF signal and makes it useless to many algorithms .Last is log compression step. This step is required to visualize both weak and strong backscattered echoes.

IV. SCAN CONVERSION

The purpose of scan conversion in a digital ultrasound application is to translate input data that are captured in different coordinates into Cartesian coordinates, which are more suitable for display. In an ultrasound system, the input to the scan converter is the scanned echo data or color flow data (velocity and turbulence). The output is typically data that needs to be displayed on a monitor, such as an LCD screen.

V. INTERPOLATION

Different Types Of Algorithm used in the Scan Conversion .

A. Nearest-neighbor interpolation

Nearest-neighbor interpolation is a simple method of multivariate interpolation in 1 or more dimensions. Interpolation is the problem of approximating the value for a non-given point in some space, when given some values of points *around* that point. The nearest neighbor algorithm simply selects the value of the nearest point, and does not consider the values of other neighboring points at all, yielding a piecewise-constant interpolation.

B. Linear interpolation

This is the method of finding unknown point from the two known point. If the two known points are given by the coordinates $(x_0,y_0)$and (x_1,y_1), the linear interpolant is the straight line between these points. For a value *x* in the interval (x_0,x_1), the value *y* along the straight line is given from the equation

$$\frac{y-y_0}{x-x_0}=\frac{y_1-y_0}{x_1-x_0}$$

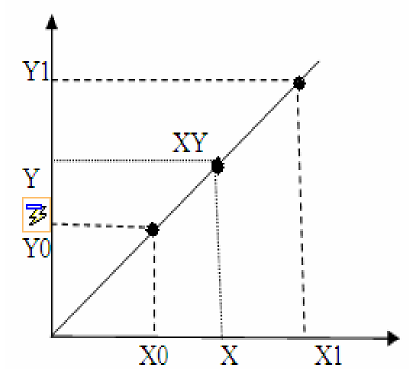

Fig.2 Linear Interpolation

Solving this equation for *y*, which is the unknown value at *x*, gives

$$y=y_0+(x-x_0)\frac{y_1-y_0}{x_1-x_0}=\frac{(x-x_0)y_1+(x_1-x)y_0}{x_1-x_0}$$

C. Bilinear Interpolation

Bilinear interpolation is an extension of linear interpolation for interpolating functions of two variables (e.g, *x* and *y*) on a regular grid. The key idea is to perform linear interpolation first in one direction, and then again in the other direction. Although each step is linear in the sampled values and in the position, the interpolation as a whole is not linear but rather quadratic in the sample location.

VI. RESULT

All ultrasound data is stored in beam space format Fig. 3, which is another word for polar coordinate .Every row in the beam space image has depth sample. To convert the image from beam space to Cartesian space the image must be scan converted.

Thus the scan conversion is performed for the cardiac image. The result shows the beam space, logarithmic compression Fig. 4 and scan conversion of cardiac image Fig.5 with the frequency of 1.67MHz.

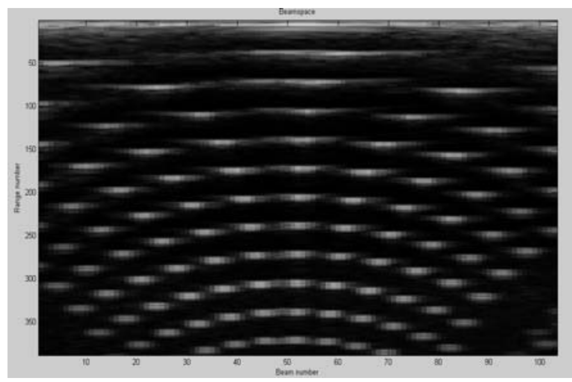

Fig 3 Beam space image

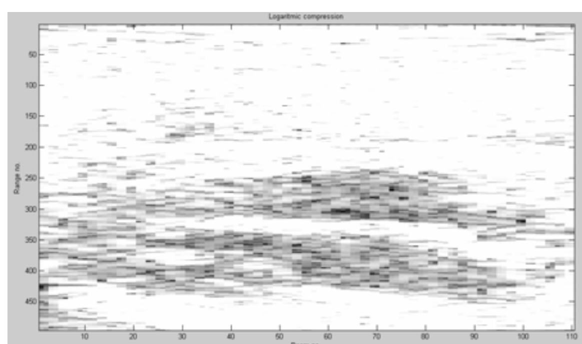

Fig.4 Logarithmic compression

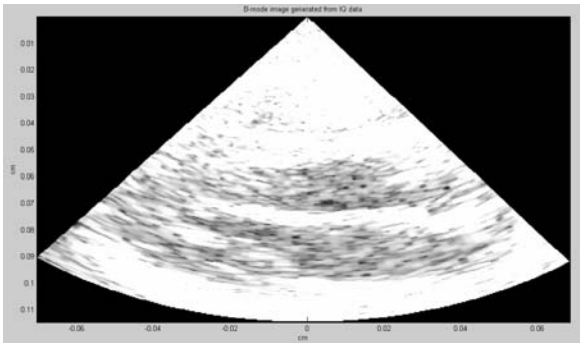

Fig. 5 Scan converted Image

VII. CONCLUSION

To perform the scan conversion the tissue data is filtered, amplitude detected and logarithmic compressed .Then this logarithmic compressed data is used for scan conversion. The output shows the scan conversion of cardiac image. To improve the quality of image display the different types of interpolation such as linear, bilinear and cubic can be done.

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