# Potential of Automatic Control of Frequency, Image Contrast and Received Bandwidth for Image Characterization of Solid Breast Masses

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The primary purpose of this study is to evaluate the use of bi-plane, multiple frequency, tunable receiver techniques for ultrasound mammography. Emphasis is placed on use of frequency manipulation for control of image contrast, improved visualization in highly attenuating regions of the breast and observation of qualitative differences in the image scattering characteristics of benign and malignant breast masses. Using a broad bandwidth, co-polymer PVDF transducer, in combination with specific transducer pulsing conditions, it was found that the center frequency output of a single ultrasound transducer could be varied over a wide frequency range. This control of frequency and, thus, the wavelength of the incident beam, provides image information not available by single frequency scanning. Confirmation of the frequency values were determined by spectral analysis techniques.

Using this new technique, an ultrasound imaging breast instrument (Labsonics, Inc.) which provides for the emission of 3.5, 4.5, 6.5, and 8 MHz ultrasound frequencies from the same co-polymer transducer was fabricated. With the patient in a supine position and the ultrasound coupled to the breast by means of a water bag system which allows control over applied compression, this automatic control, B-mode, linear scan unit produces static images of the breast. An additional feature of this instrument is provision for automatic scanning (using any of the available frequencies) at two mutually perpendicular tissue planes, by a bi-plane scanning technique. Thus, the structure of masses may be evaluated from images obtained by automatic scans of both transverse and longitudinal planes of the mass. Additionally, the ratio of the longitudinal and transverse diameter of the mass, (a parameter which may have diagnostic significance) can be readily obtained without errors sometimes associated with the techniques commonly used for such measurements.

Ten and 15 MHz co-polymer PVDF transducers have also been used with this breast unit. The receiver system initially used was designed for a bandpass response that is appropriate for each of the four previously mentioned frequencies and their associated bandwidths. A tunable receiver system which allows selection of bandwidth, from wide to narrow, has been added.

It has been confirmed that control of frequency, when scanning tissues deep in the nipple-areolar area, can, in some cases, improve detection of masses located within this region. Additionally, bi-plane, multiple frequency scanning can provide information on tissue structure which is not revealed by routine, single frequency scanning. Bi-plane scanning at frequencies above 10 MHz, using sharply focused transducers, may be a significant factor in achieving maximum potential from the outlined technique.

Data on the L/T ratio, obtained from bi-plane scanning of benign and malignant solid masses, will be presented.

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Variation of Transducer Frequency Output and Receiver Band-Pass Characteristics for Improved Detection and Image Characterization of Solid Breast Masses