Chapter I

Introduction

Medical science make use of ultrasound as a diagnostic tool along with the traditional tools like X-rays and Nuclear medicines, the X-ray image recognises the interface where a considerable molecular weight difference is encountered. The ultrasound image,on the other hand, is capable of recognising the soft-tissue interface. Additionally the ultrasound is free from possibly hazardous consequences of high frequency electromagnetic radiations. Probably the non electromagnetic nature of ultrasound has made the imaging a utilitarian and popular art. Owing to this fact sustained efforts are being made on the development of real time ultrasound imaging systems.

A broad range of ultrasound imaging systems are commercially available.

Sector and linear scanning systems are for the examination of general abdomen, gynacology and cardiac abnormalities. This happens to be an area where still more efforts are needed to make the imaging system a true tomographic tool. The need aggravates because of the fact that investigations of these regions with X-ray are tedious and one needs additonal infusion of radio opage materials in the body.

Despite of the achievements in real-time ultrasound imaging techniques and instrumentation, it suffers from various inconsistencies because of non uniform velocity profile of ultlrasound through the human body. Therefore, in sector scan systems, quantitative estimates about the dimensions of the abnormal mass could be effected, only if the object is correctly identified. The identification is ievitable to determine the average velocity of ultrasound through that mass.

The sectional views are many a times decisive to provide correct information about the mass, it's location, density etc. This ambiguity could be removed if three dimensional view of the object is simultaneously imaged.

The task is not a easy one. The average velocity of ultrasound, at 3 MHz, is so low that at the most 60 frames of a section in the human body could be acquised in a second. Probably because of this reason, efforts of instrumentalists are not intense on devicing 3-D ultrasound imaging systems.

Stanford Electronic Laboratory, USA has prototyped a system, the ULISYS, to image the cardial anamolies. This type of system results to be a costlier one and 3-D pictures of the complete pyramidal volume are rather unwanted. On contrary, one wishes to visualise 3-D picture of the target alone.

The project proposes a way to achieve this goal.

The Department of Physics, Shivaji University, centre for Post-Graduate Studies, has proposed a project "Developement of Three Dimensional Ultrasound Imaging System and Establishment of Infrastructure For Instrument Prototyping". The contents of the dissertation form a part of this total endeavor.

The project is meant to develop the complete product. It is evident that to develop a complete product, various infrastructural facilities are must. Once these facilities are established, a series of products could be developed with lesser investments per product. The Instrumentation Facility could be defined nicely, if the product range is specific. The range thought over at present includes the medical instruments and the sophisticated analytical instruments. These happen to be import alternative products and 'The Instrumentation Facility' includes the following laboratories.

1. Laboratory to develop integrated transducer.
2. Laboratory to design and develop electronic circuits.
3. A software, Hard ware integration station.
4. A single crystal Growth set up
5. A polymer synthesis, characterisation (Accoustic Properties). Laboratory

The project is yet to receive the financial assistance. But the task of the design of "Three Dimensional Imaging" could be continued independent of establishment of these 'Instrumentation Facilities' The dissertation undertakes this task of 'The Interface Design'.

The design part includes understanding basic principles of transmission of ultrasound in human body. Further all possible consequences of the transmission and reflection of ultrasound, their numeric values, and the errors limits were to be checked manually for a few sample examples. The methodology of the imaging was to be proposed, with reconcilation to the technology of transducer making. The discussion here concerned form chapter 2 of the dissertation. Facilities of the system programming through 'TURBO C', IBM PC BUS and Numeric approximations relavant to the project are high-lighted in this chapter.

The chapter 3 is devoted to discuss the Hard-ware component of 'The Interface'. This includes establishment of transducer specifications, ultra-sound beam steering, receiption of echo-information and transmission of this information to the interfaced microcomputer (The PC/XT). The discussion is related to the PC-Addon designed. The corresponding IC specifications and address maps are included in the dissertation.

The soft—ware component is the heart of 'Three Dimensional' simulation. The hard-ware interface acquises information about one horizontal and two vertical sections of the object to be viewed. Using this echo-information the numeric elegance should establish the surface of the object under observation. The soft ware component unfolds this method in a step wise manner. The discussion is included in the chapter 4.

The task of the dissertation being design of 'The Interface', the conclusions are bit obvious. Therefore these are included with each subsection itself, without making any separate head for it. The efforts are made to present the complicated design procedure, in a transparant way to the reader.