Chapter 1

Introduction

Computerized tomography (CT) is a technique of producing cross-sectional three-dimensional images from multiple views or projection data obtained with penetrating probe radiations or by other means such as magnetic field gradients, by processing those data using a computer and mathematical image reconstruction algorithms.

Nuclear magnetic resonance computerized tomography (NMR CT) is a 3-D imaging system that uses the NMR phenomenon as an imaging tool. Magnetic resonance is a phenomenon found in magnetic systems that posses both magnetic moment and angular momentum. The term *resonance* implies that we are in tune with a natural frequency of the magnetic system. In this case, it corresponds to the frequency of gyroscopic precession of the magnetic moment of nuclei in an external static magnetic field.

NMR imaging system can be divided into three parts: the NMR section, the electronics, and the computer. The NMR signal whose frequencies fall typically into the radio frequency (RF) range is amplified and demodulated with the RF reference signal. The result signal which falls in audio frequency (AF) range is then sent to data acquisition unit. In this step, signal averager is used to improve the signal-to-noise ratio of this signal and convert the signal into numerical data used by the computer for the reconstruction of the image.

Since the commercial signal averagers available in the markets are designed to serve wide range of applications, they lack many features required in NMR imaging system research. Those are post-processor for acquired signal, definable 2-dimensional memory-array structure, and etc.

The objective of this thesis is to build the signal averager specifically for NMR imaging system. For cost effective and flexible facilities purpose, the design is based on digital signal processor (DSP) which is a class of microprocessors. By using DSP, it is possible to have high performance and simplicity of operation, since most of operations are concentrated in software. Details will be given in following chapters. In brief, they are as follows:

Chapter 2 Basic Theory of NMR Imaging - introduces the basic theory of NMR, principles of NMR imaging, and imaging techniques. On imaging techniques, the discussion is relied on direct Fourier imaging which is in common use. Some parameter imaging methods are briefly discussed.

Chapter 3 NMR Imaging System Configuration - presents the whole NMR imaging system in detail. The basic parts of the NMR imaging system are described.'The follow sections discuss individual unit concerning its functions and features.

Chapter 4 The Mechanism of Signal Averager - discusses the roll and requirement of signal averager in NMR imaging system. The configuration of signal averager is described in order to understand its mechanism.

Chapter 5 Digital Signal Processor Architecture - presents an overview of signal processing and applications of digital signal processing. DSP is discussed using TMS32010 as an example. The information about its architecture, instruction set and methodology for application development are provided.

Chapter 6 Description of DSP-Based Signal Averager Hardware- presents the architecture of the constructed signal averager. The required specifications are provided as a fundamental resource of the design. The signal averager have been constructed from 5 parts: memory part, MCS32 part, TMS320 part, TMS320 IO part, and analog part. Each part is described in details about its function, configuration, and relation with other parts.

Chapter 7 Description of DSP-Based Signal Averager Software - presents the descriptions of the supporting software used in the design. A BASIC-language program and an assembly-language program have been developed for MCS32 part to control the operating procedures of the signal averager. The supporting software for TMS320 part is also introduced.

Chapter 8 Discussion and Summary - gives the discussion and summary of the whole work. Any problems in the design are introduced and some solving methods are suggested.

Appendix A Circuit Diagrams - presents all circuit diagrams of hardware section.

Appendix B Printed Circuit Board Layouts - presents the printed circuit board layouts of all parts in the design.

Appendix C Software Listings - presents the source code of software. The developed program for MCS32 part is listed in BASIC and assembly language. The assembly source code of TMS320 signal processing program is also provided.

Appendix D Operating Instructions - describes the operating procedures of signal averager.

Appendix E DSP Instructions set - shows the instructions summary of DSP. Instructions are categorized in six groups depend on their functions.