Contents

Acronyms

Notation	Description
DC	Direct Current
DSP	Digital Signal Processor
LOW-RES	Low Resolution
MRI	Magnetic Resonance Imaging

Glossary

Notation	Description
LTspice	A freeware -based circuit simulator from Linear Technology/Analog Devices
MATLAB	Computing environment used for matrices, plotting and simulation interfacing
SPICE	SPICE ("Simulation Program with Integrated Circuit Emphasis") is an open-source IC and board-level circuit simulator

1 Introduction

The progress of diagnostic imaging has advanced significantly during the 20th century. As the cost of high speed computational systems has grown increasingly accessible, so has the use of of medical imaging become prominent. Advancement in scientific visualization have in turn generated more complex datasets of increased size and quality. Within the last few decades Three major technologies used are X-ray, MRI, and Ultrasound. Each of the technologies have distinct advantages and disadvantages in biomedical imaging, thus each are still relevant for modern medicine. **??** contains a comparison and summary of the various fundamental diagnostic imaging modalities.

Since medical imaging has been reportedly performed over 5 billion times as of 2004 [4], and later numbers from 2011 show a doubling of imaging per year, and a ten-fold increase in Ultrasound examinations between year 2000 and 2011 [6]. Potentially millions of people have been spared painful exploratory surgery through noninvasive diagnostic imaging. Lives can be saved by diagnosis and timely intervention.

1.1 Ultrasound

Ultrasound is a technology that transmit sound wave with frequencies above the audible range ($20\,\mathrm{Hz}$ to $20\,000\,\mathrm{Hz}$) to mechanically vibrate matter. The particles in the medium would be at rest and distributed uniformly. The wave propagates as a disturbance and the particles oscillate around their mean position due to the presence of the ultrasonic wave. Typically the frequency band used in clinical settings are from $2\,\mathrm{MHz}$ to $12\,\mathrm{MHz}$. **??** visualizes the propagation of a plane wave in matter. The oscillation occurs parallel to the wave's direction, making it longitudinal, and the disturbance will propagate with c, which is determined by the medium and is given by

$$c = \sqrt{\frac{1}{\rho_0 \kappa_S}} \tag{1.1}$$

Where ρ_0 is the mean density $(\mathrm{kg\,m^{-3}})$ and κ_S is the compressibility $(\mathrm{m^2\,N^{-1}})$. Since in the majority of cases, the propagation of ultrasound is linear, it is assumed in this work.

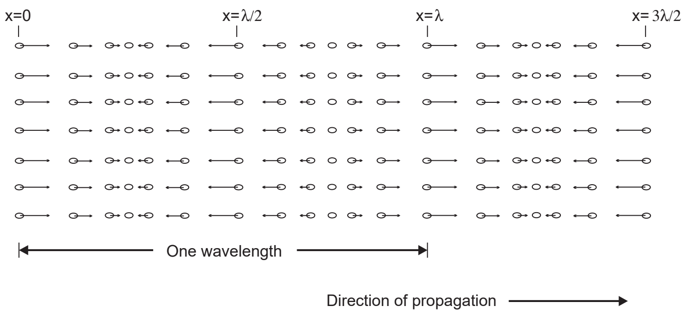

Figure 1.1: Particle displacement for a propagating ultrasound wave [5]

1.2 Project scope

As this project deals with a synthesis of a peculiar design and an analytical examination of a class-D system, this initial design will determine the specific direction of the qualitative analysis.

Modality	**Ultrasound**	**X-ray**	**CT**	**MRI**
Topic	Longitudinal, shear, mechanical properties	Mean X-ray tissue absorbtion	Local tissue X-ray absorbtion	Biochemistry (*T1* and *T2*)
Access	Small windows adequate	2 sides needed	Circumferential around body	Circumferential around body
Spatial resolution	Frequency and axially dependent, $0.2\,\mathrm{mm}$ to $3\,\mathrm{mm}$	$\sim 1\,\mathrm{mm}$	$\sim 1\,\mathrm{mm}$	$\sim 1\,\mathrm{mm}$
Penetration	Frequency dependent, $3\,\mathrm{cm}$ to $25\,\mathrm{cm}$	Excellent	Excellent	Excellent
Safety	Excellent for $>$ 50 years	Ionizing radiation	Ionizing radiation	Very good
Speed	Real-time	Minutes	20 minutes	Typical: 45 minutes, fastest: Real-time (LOW-RES)
Cost	$	$	$$	$$$
Portability	Excellent	Good	Poor	Poor
Volume coverage	Real-time 3D volumes, improving	2D	Large 3D volume	Large 3D volume
Contrast	Increasing (shear)	Limited	Limited	Slightly flexible
Intervention	Real-time 3D increasing	No, fluoroscopy limited	No	Yes, limited
Functional	Functional ultrasound	No	No	fMRI

Table 1.2: Comparison of Imaging Modalities [6]

The project is focused on the output stage of the system. Therefore analysis will comprise of distinctive variations of parasitic element combinations in the chosen output filter topology.

1.2.1 Learning objectives

See below for an outline of the project activities

Project specification
Learn a class-D amplifier topology, calculate component values
Understand and design a self-oscillating modulator amplifier
Investigate and test open loop output filter
Investigate and test closed loop output filter
Investigate output filter parasitic elements affects control loop
Make quantifiable performance measurements on system
Write a technical report documenting the project work

Table 1.3: Project specification table

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