Acoustoelastic evaluation of tissue damage using DSP

Bogdan Dzyubak
Jonathan Meyer
Joe Helfenberger
Matt Parlato

Overview

- Ultrasound Imaging Advantages and Mechanics
- Current and Future Goals
- Digital Signal Processors
- Processing Algorithms
- Available Programming Languages

Ultrasound Imaging Advantages

- Noninvasive
- Provides qualitative data
- Unrealized potential for quantitative data

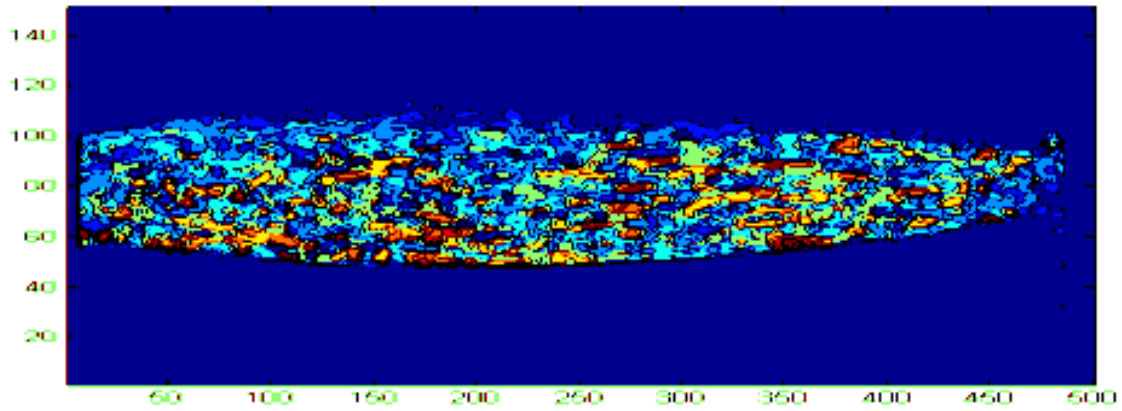
Ultrasound Mechanics

- Tissue stiffness affects echo
- Increasing tension increases echo pitch
- Acoustoelasticity

(http://www.clipartgallery.com/music/instruments/guitars/guitar_acoustic1.jpg)

Importance of Changing Stiffness

- Stiffness vs. strain analysis
  - Can differentiate healthy and damaged tissue
- Real-time processing opens new possibilities



(Kobayashi and Vanderby, 2008)

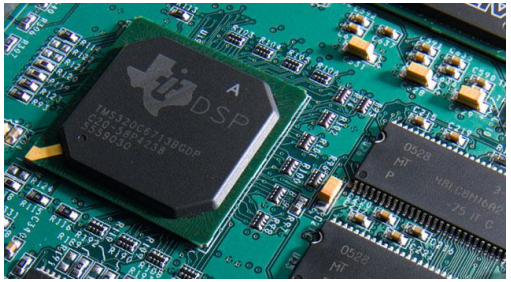
Ultrasound Image to Stiffness Distribution

Ultrasound Device

(Kobayashi and Vanderby, 2008)

Video stream

Real time processor



(http://www.logicpd.com/services/dsp_design)

Calculation of stiffness distribution

Output Device

(http://img.alibaba.com/photo/10589354)

Colorized display of stiffness distribution

Current and Future Goals

- This semester: Research Device
  - Create a device to analyze stiffness
  - Implement algorithm
  - Analyze stored data
  - Increase speed

- Future: Surgical Device/Diagnostic Tool
  - Interface directly with ultrasound machine
  - Optimize for real-time analysis

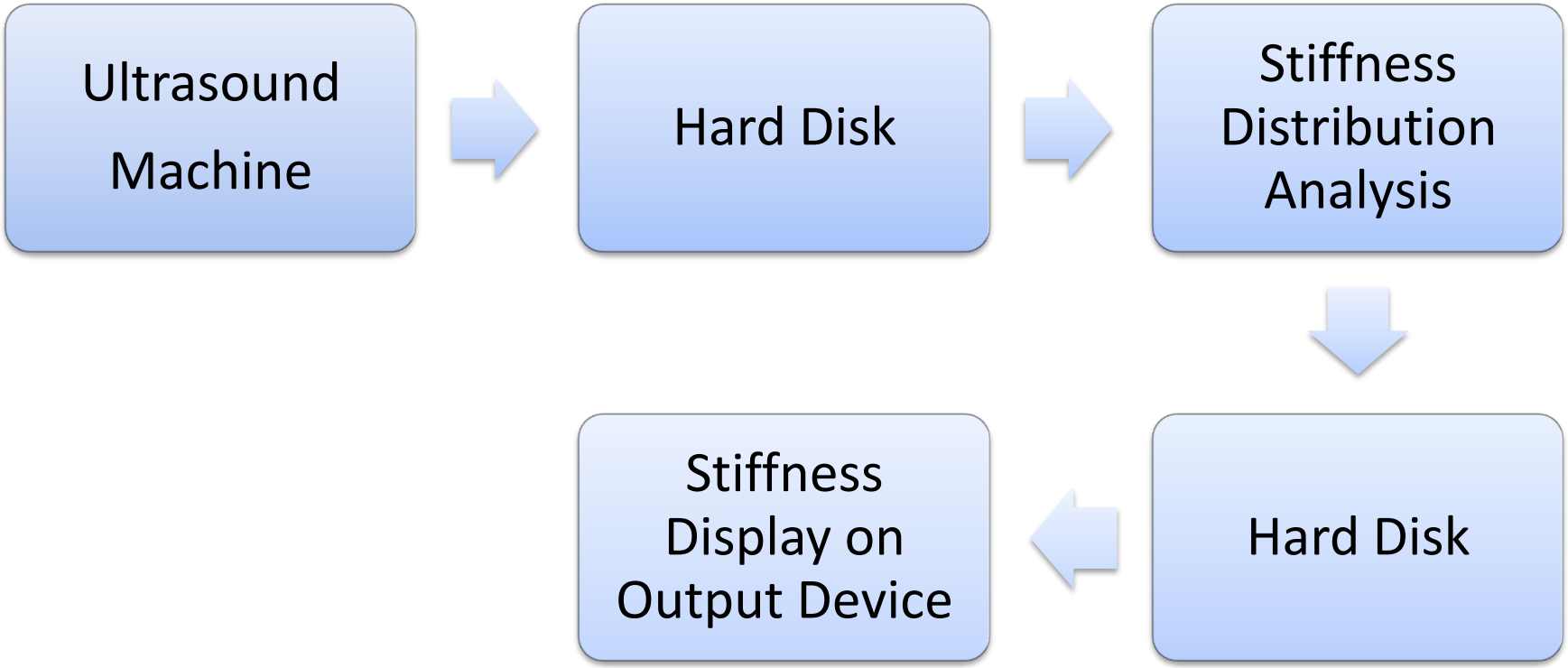
Real time image processing

- Necessary operations:
  - Simple math
  - Many iterations
- Computers not optimized for real time
  - Data management and storage

Digital Signal Processors are designed for real-time calculations

- Designed for speed
  - Parallel computing
  - Separate program and data memory
  - No memory management unit
- Ideal for Image Processing

Current Image Processing



- Reading/Writing to hard disk is slow

Processing Algorithms

- Clipping

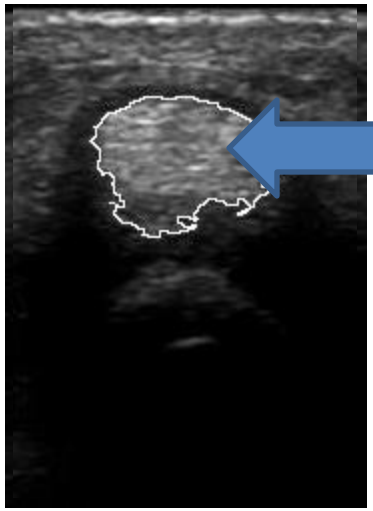
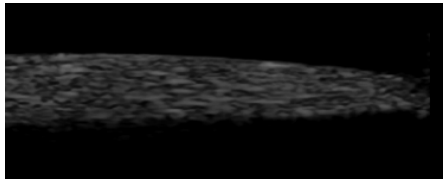


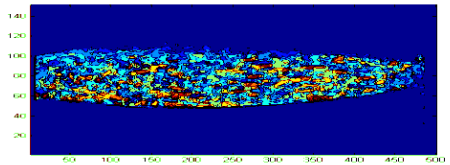
Image clipping path around area of interest

(Kobayashi and Vanderby, 2008)

- Stiffness vs Strain Analysis

Grayscale ultrasound image





Colorization representing strain distribution

(Kobayashi and Vanderby, 2008)

Requirements for the DSP chip

Memory

Very important

Frequency

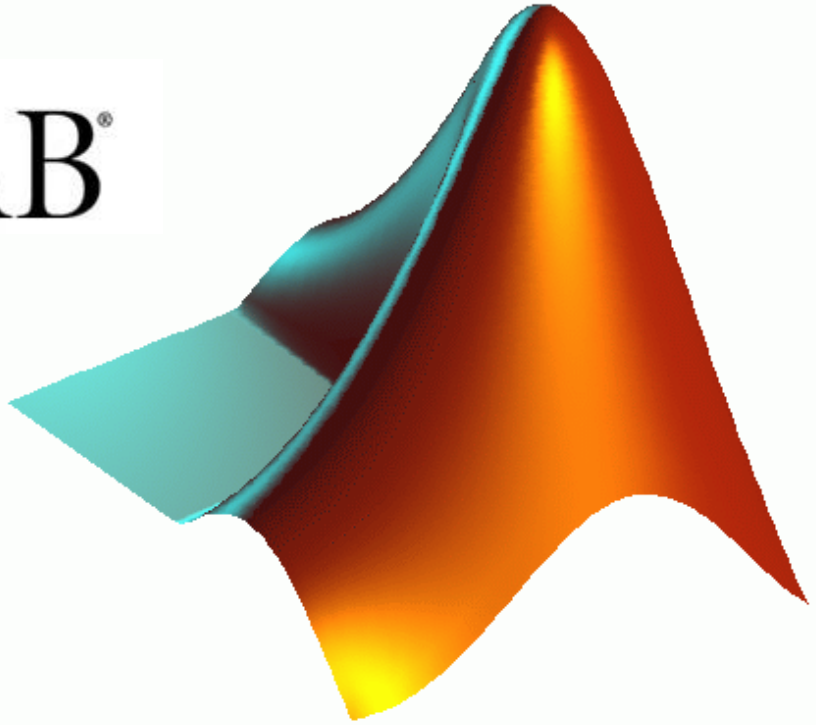
Highest available for a given memory

C6000™ High Performance DSP

Memory: 2112 KB *Frequency: 1200 MHz*

Available Programming Languages

MATLAB®



http://homepage.univie.ac.at/saptarshi.das/toolBox/matlab_logo.gif

In Conclusion…

- Goal: A device to evaluate tissue health using DSP

- Method: analyze tissue stiffness vs. strain with ultrasound