Adipose Quantification of CT Scans using Image Processing in Matlab

Ted Schuler-Sandy
Brianna Klein

30th April, 2009

Sponsor: Dr. Michaelann Tartis
Adviser: Dr. Hector Erives

Purpose

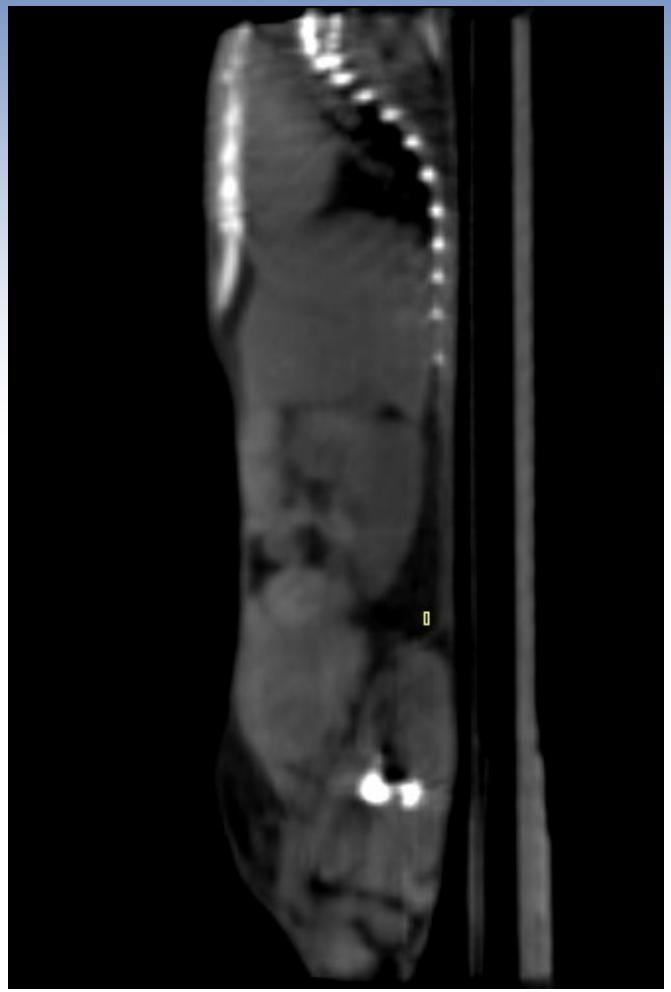
The project is to use image processing techniques to accurately quantify the amount of fat in a mouse CT scan.

Background

- Why is this being done?
  - To test the effectiveness of treatments for diabetes and obesity in laboratory mice.
- Overview of computed tomography

Views of Mice

Coronal



Sagittal

Transverse

Background - Previous Work

Approaches	Pros	Cons
Dissection	Accurate	Mouse Dies, Time Consuming
Position	Can be automated, Non-Fatal	Less Accurate
Intensity Highlighting	Can be automated, Non-Fatal	Less Accurate

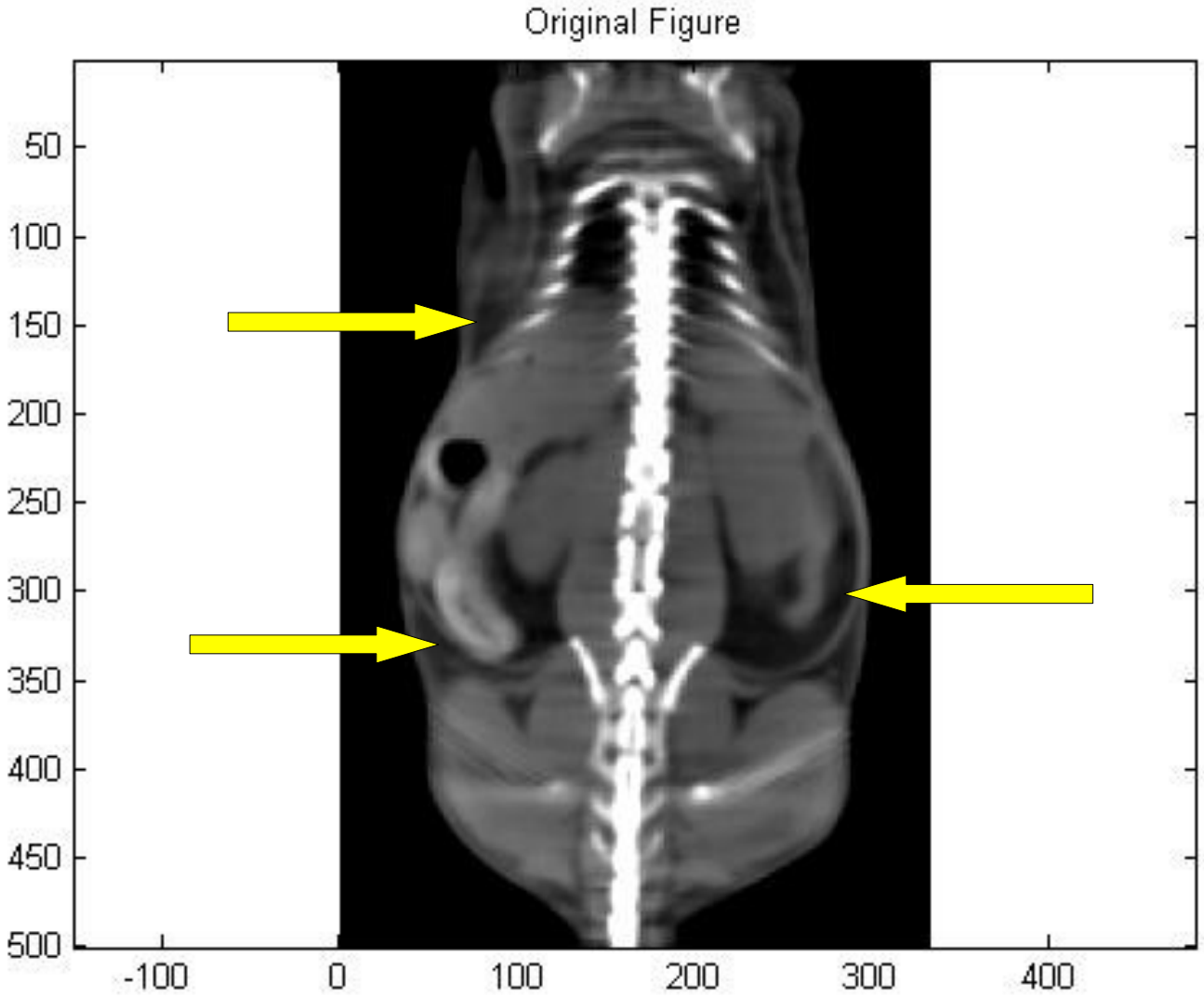
Specifications

- Automated
- Accurately identify fat in an image with minimum input from the user
- Calculate number of fat pixels on mouse image

Scope of Project

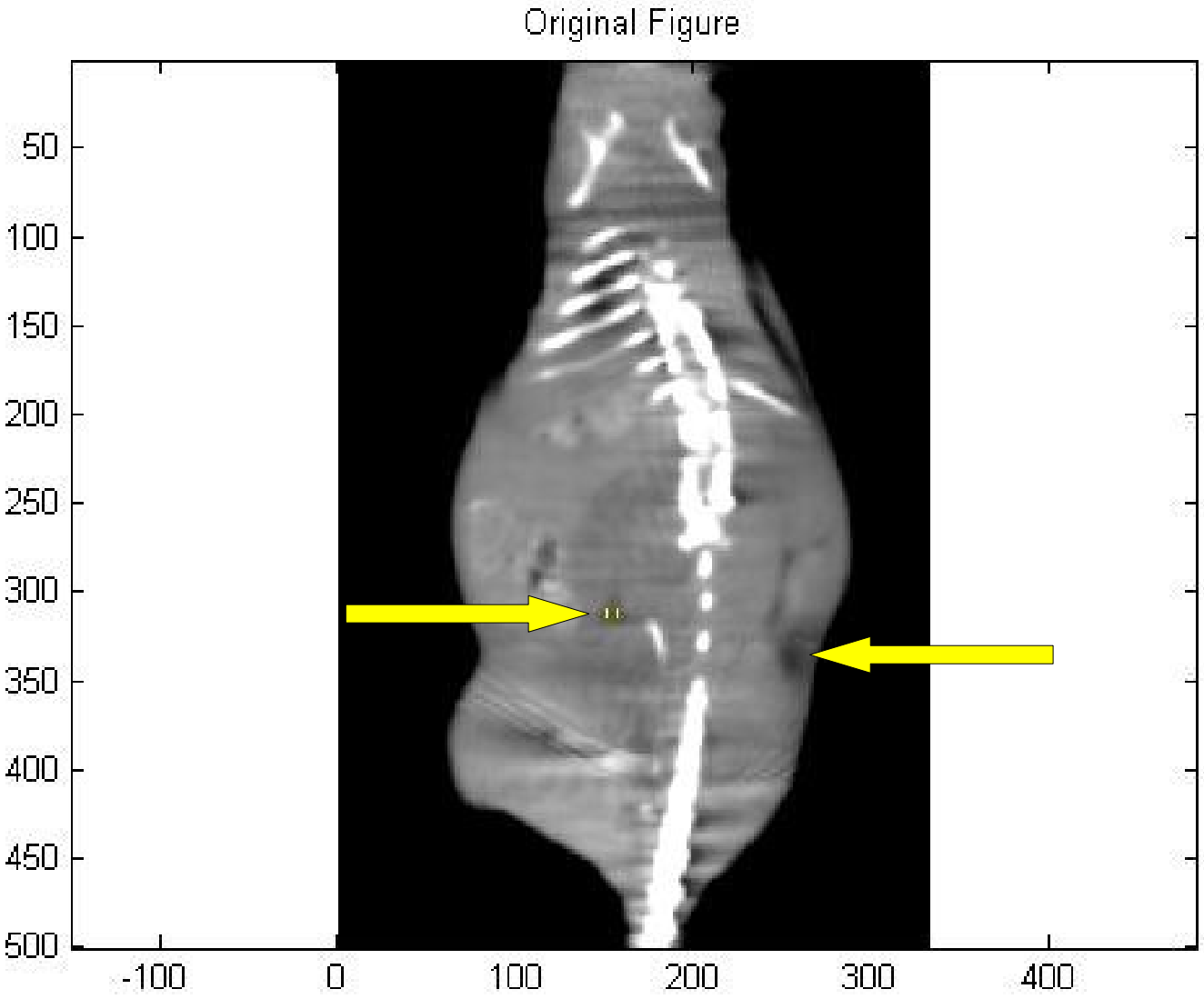
- Adult mice only
- Skinny, Medium, and Fat mice
- One view - coronal
- One image at a time
- Focusing on three specific fat pads

Where is the fat?



Fat Mouse Example

Where is the fat?



Skinny Mouse Example

Challenges/Goals

- Maximum automation and ease for user
- Removal of non-fat highlights
  - Skin
  - Gas Pockets
  - Lungs
- Noise reduction not necessary
  - Initial images are clean

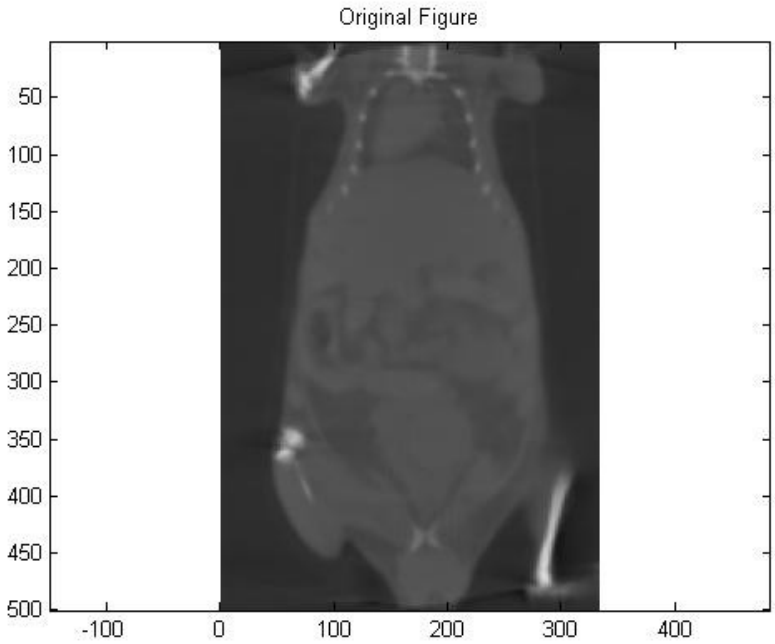
Design Solutions
Overview

- Obtain usable images*
- Intensity range identification*
- False identification reduction/removal
  - Skin
  - Gas Pockets*
- Fat percent calculation
- Intensity Highlighting

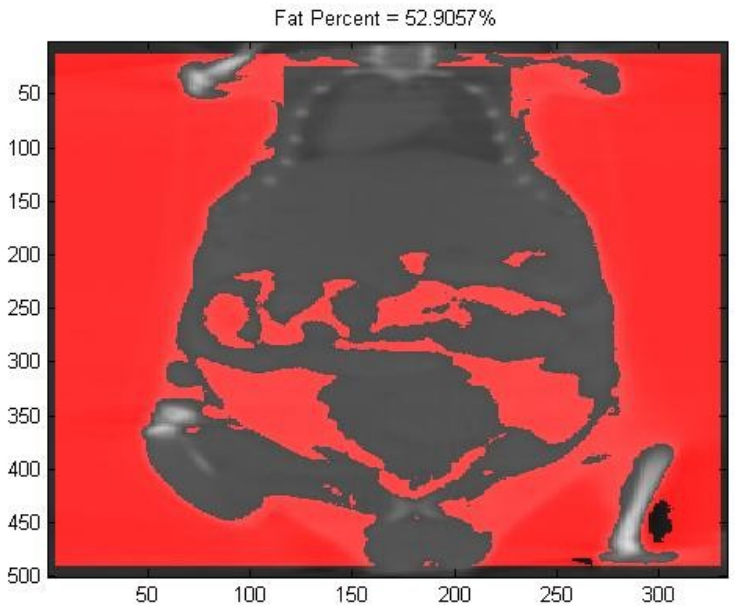
*Requires user input.

Design Solutions
Image Acquisition

- AMIDE
  - Select image slices (coronal, sagittal, transverse)
  - Automatic Histogram Processing
  - Convert to JPEG



No Histogram Processing

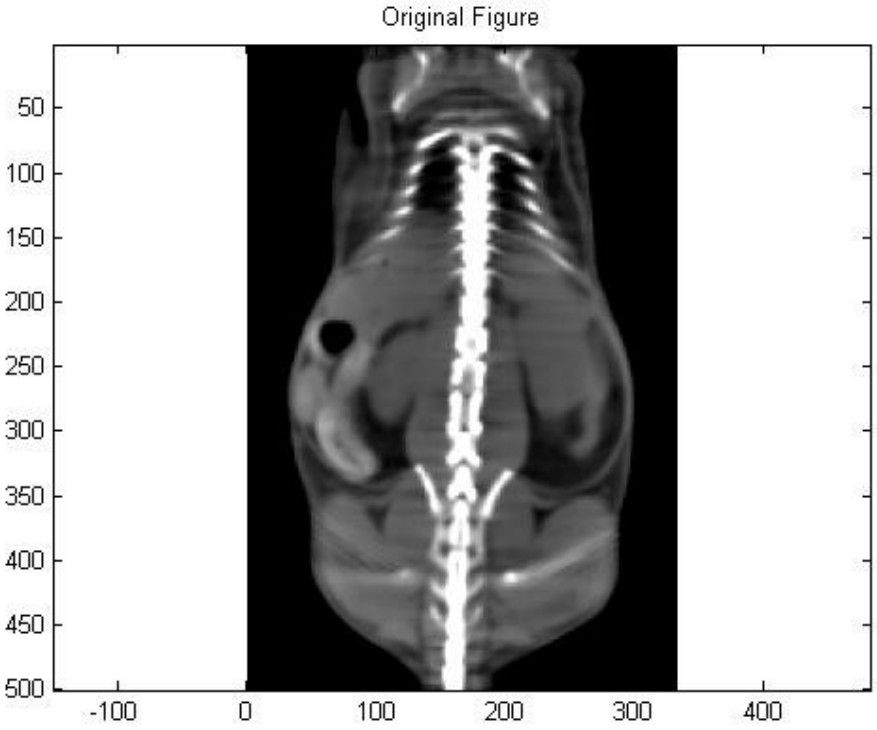


Intensity Highlighting

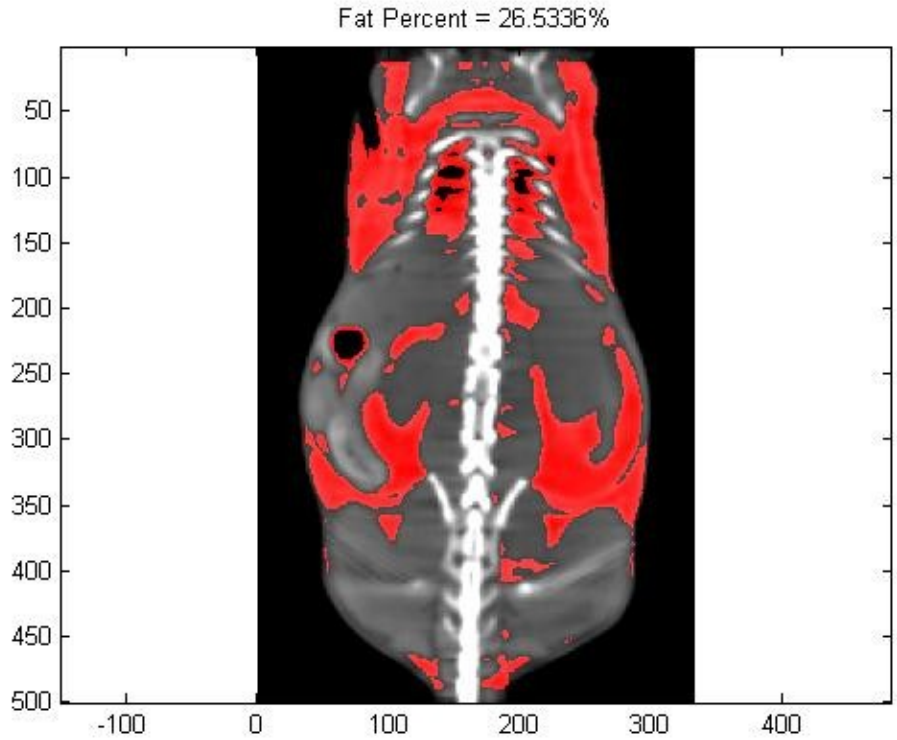
Design Solutions
Intensity Range Identification

- The fat lies within a specific intensity range, which can vary from image to image.
  - Dynamic Intensity Range Selection
- User Input
  - Maximum and minimum intensity selection
  - Problem: Other non-fat parts can lie within this intensity range, causing false identification.

False Identification Example



Unhighlighted Image

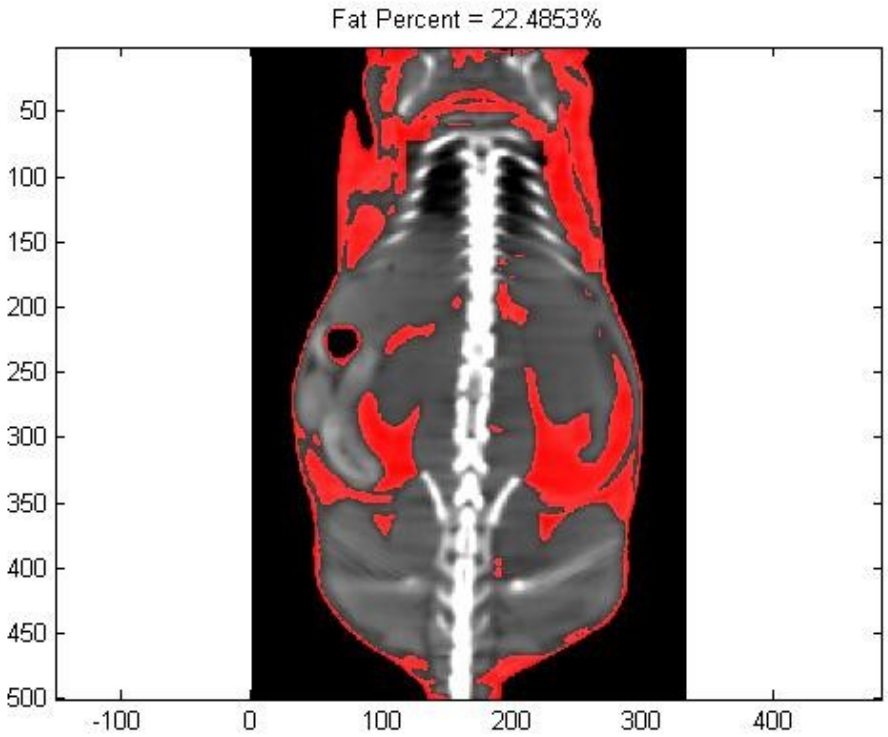


Fat Highlighting

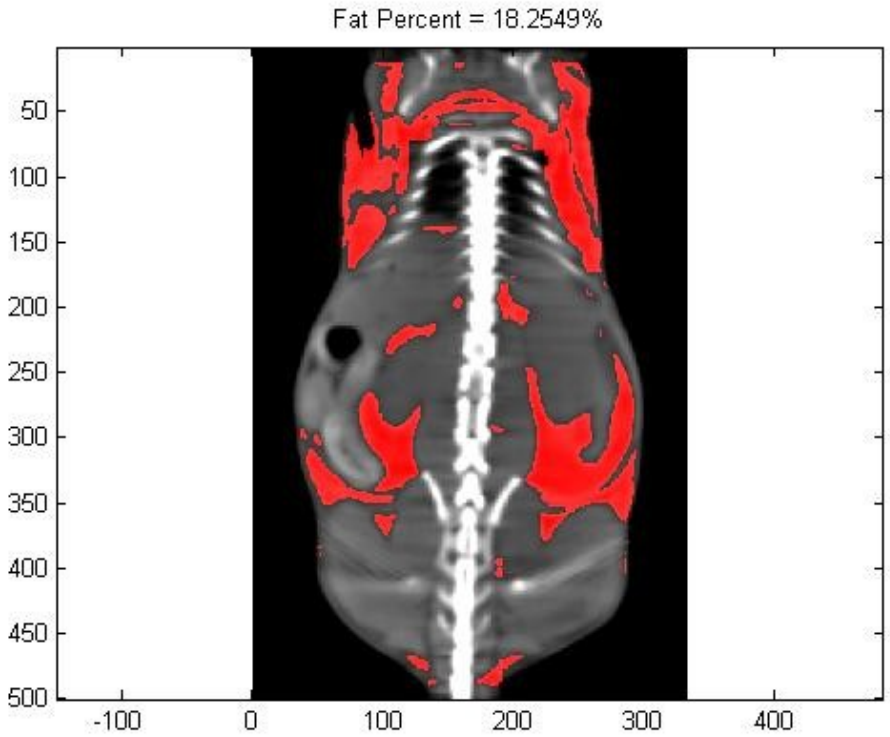
Design Solutions
False Identification Reduction/Removal

- Skin Highlighting Removal
  - Zero-padding
  - Scan rows and columns to remove a threshold of pixels from selected intensities
  - Alternate solutions
- Gas Pocket Removal
  - Manual Identification

Skin Removal
Example

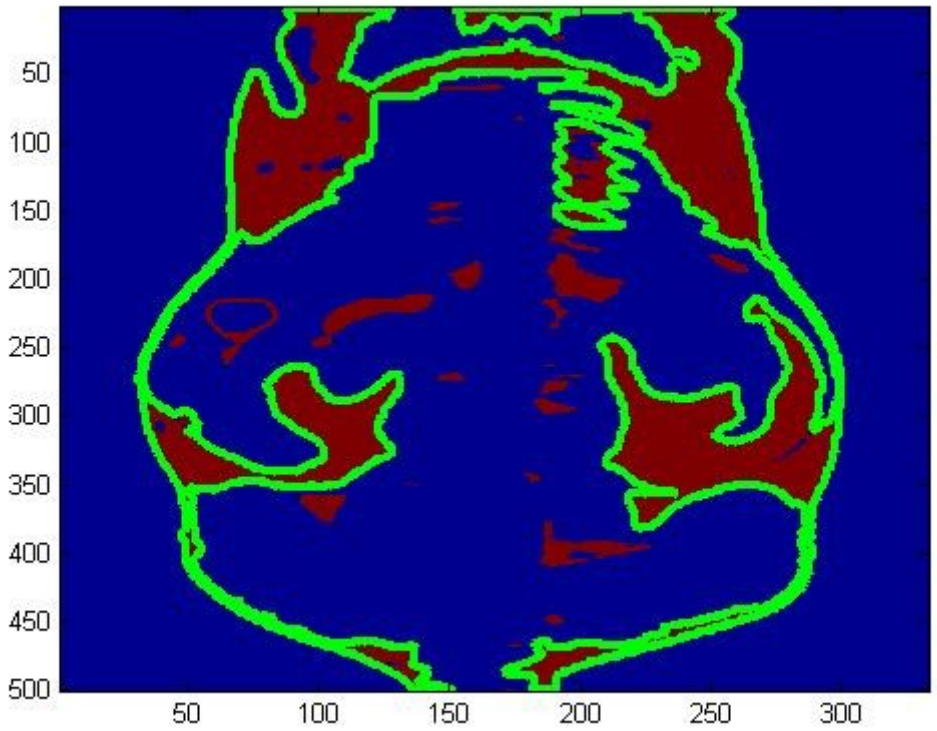


Skin Highlighting



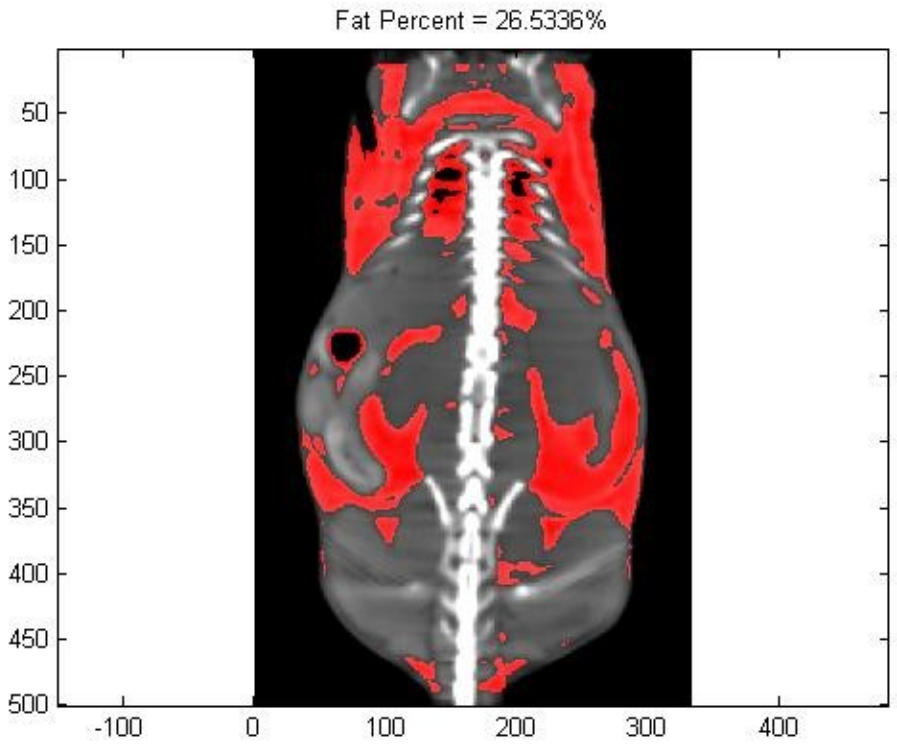
Skin Highlighting Removed

Skin Removal
Alternatives

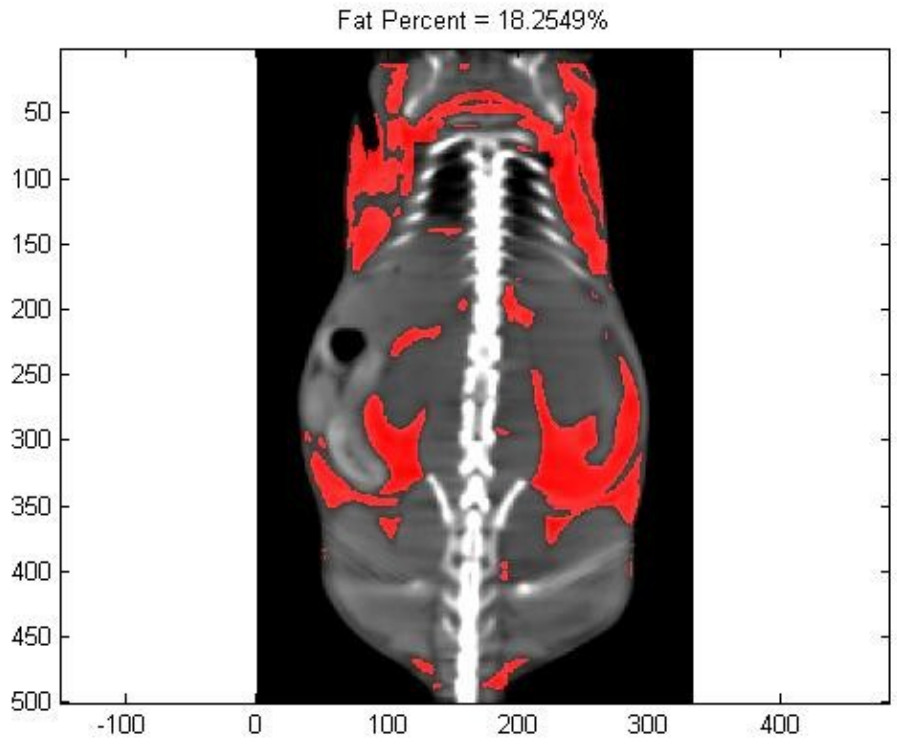


Boundary Trace using the Image Processing Toolbox

Removal by User



Gas pockets Highlighted



Highlighting Removed

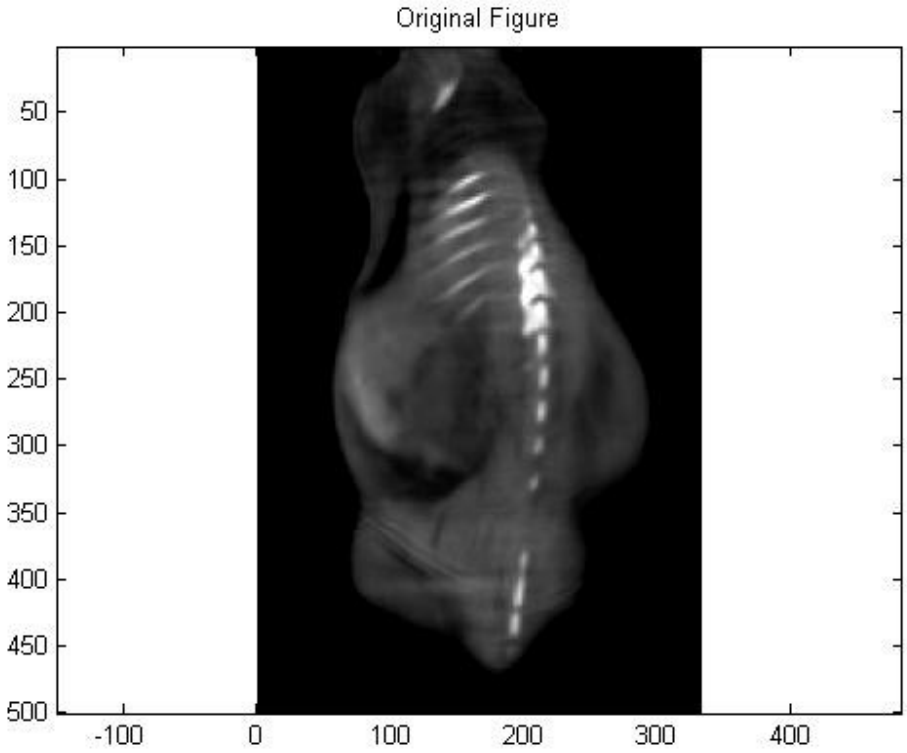
The lungs and gas pockets can easily be removed from the identified pixels.

Design Solutions
Fat Percent Calculation

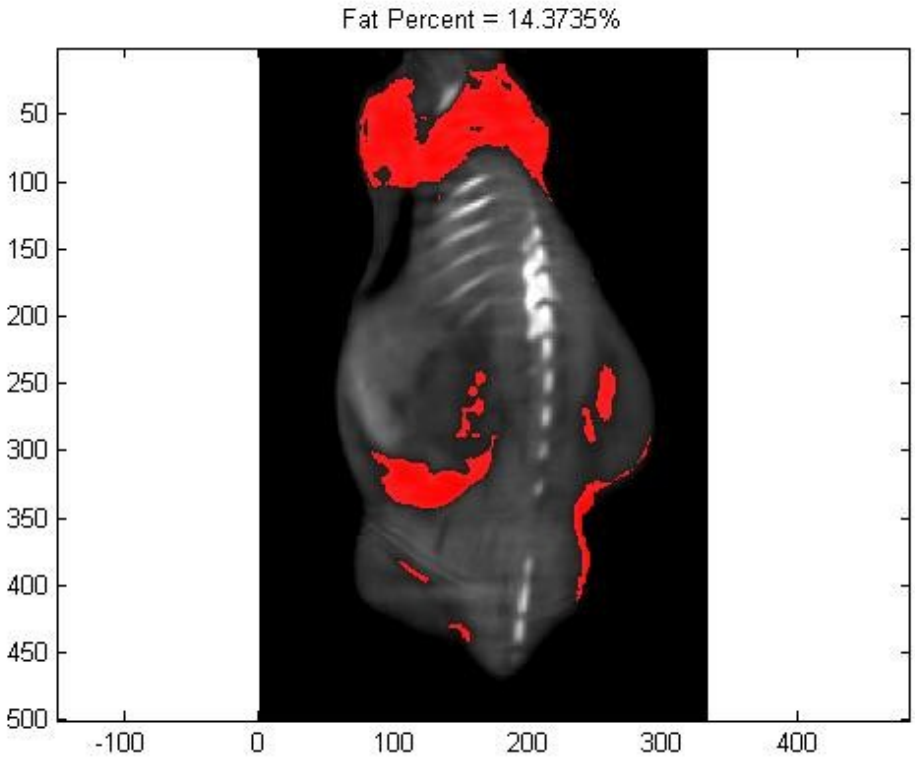
- Method similar to skin removal counts total pixels of mouse

$$Fat\ percent = \left(\frac{N_{fat}}{N_{total}} \right) * 100$$

Non-Ideal Pictures

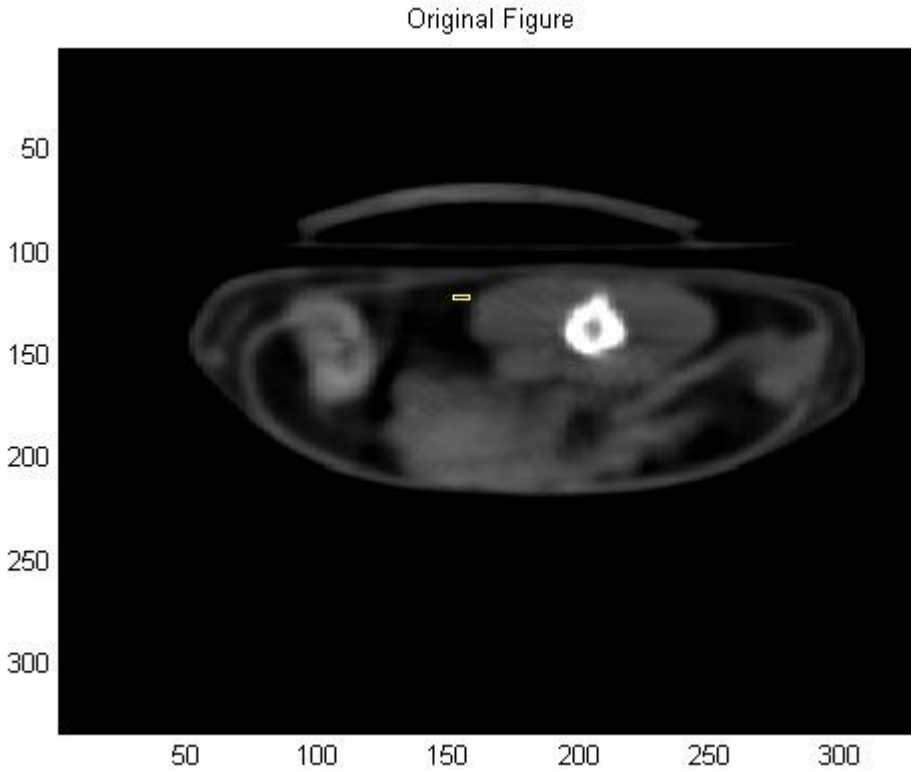


Twisted Coronal Image

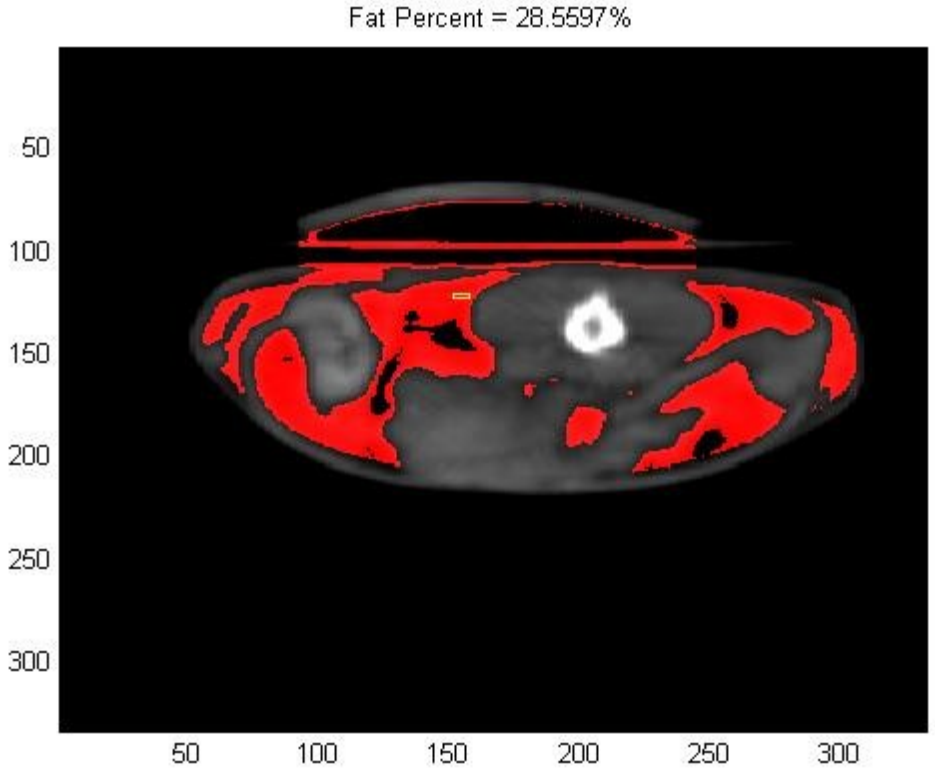


Highlighted Fat

Other Views
Transverse



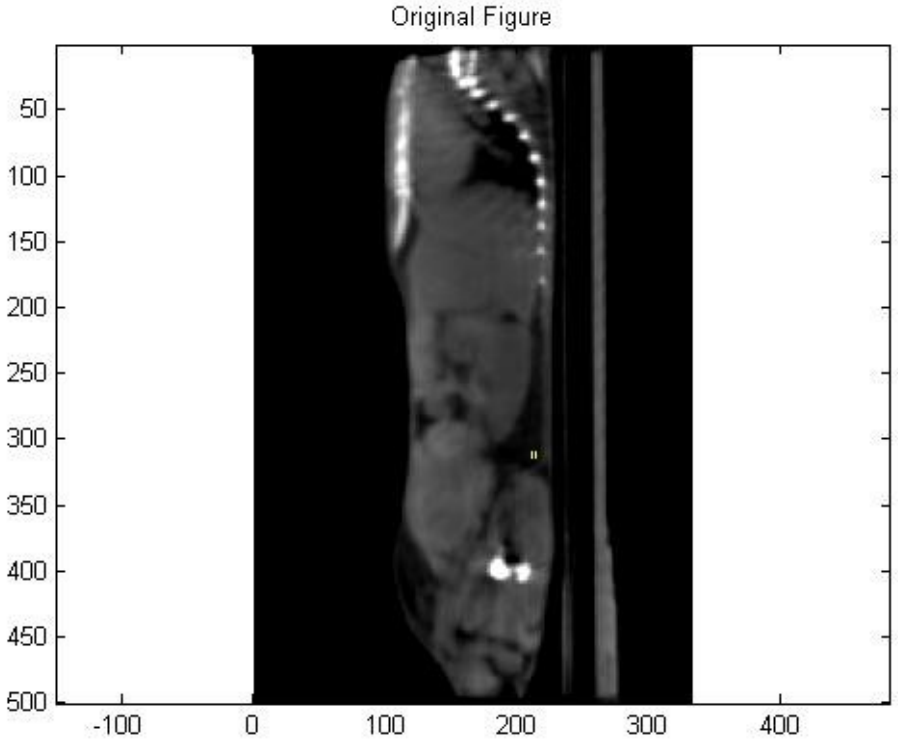
Transverse Image



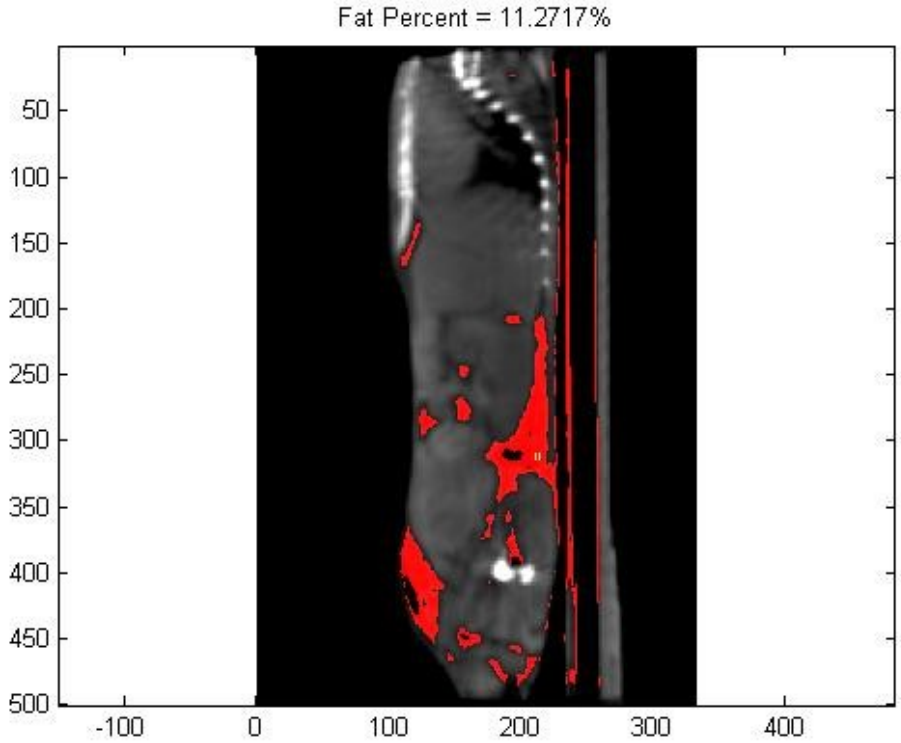
Highlighted Fat

Transverse images highlight the bed where the mouse is sitting.

Other Views
Sagittal



Sagittal Mouse Image



Highlighted Fat

Results

- Extra conversion step before processing
- High sensitivity to intensity selection
- Requires user input
- Automated calculation

Conclusion

- Specifications met
  - Automated highlighting
  - Fat pixel count calculation
- Further Work:
  - Removal of test bed in Sagittal and Transverse
  - Three dimensional image processing

Adipose Quantification of CT Scans using Image Processing in Matlab

Ted Schuler-Sandy
Brianna Klein

30th April, 2009

Sponsor: Dr. Michaelann Tartis
Adviser: Dr. Hector Erives