Team Sky Group Project

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Overview

- Project Design
- Registration
- Segmentation
- Issues Encountered
- Record Video
- Future work
- Conclusion

Project Design

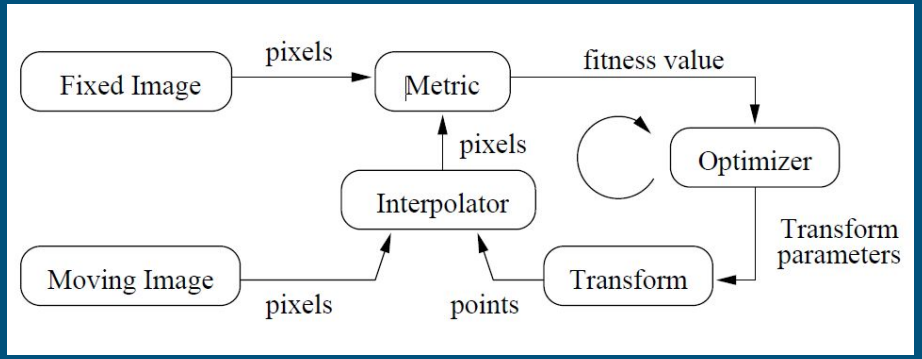
Images: Head-Neck Cetuximab-Demo, subject: 0522c0001

Source: National Biomedical Imaging Archive (NBIA)

Goal: Using single algorithm in both registration and segmentation parts to test several data sets.

- Registration: Landmark-based rigid registration
- Segmentation: Watershed Segmentation

Image Registration



- Aligning a fixed image and moving image into a common coordinate system to monitor changes between them

- Two registration techniques:
  1. Image intensity to estimate the parameters of the transformation between using all the pixels in the images
  2. Feature points extracted from the images and the parameters of the transformation are estimated using only the feature points

Image Registration

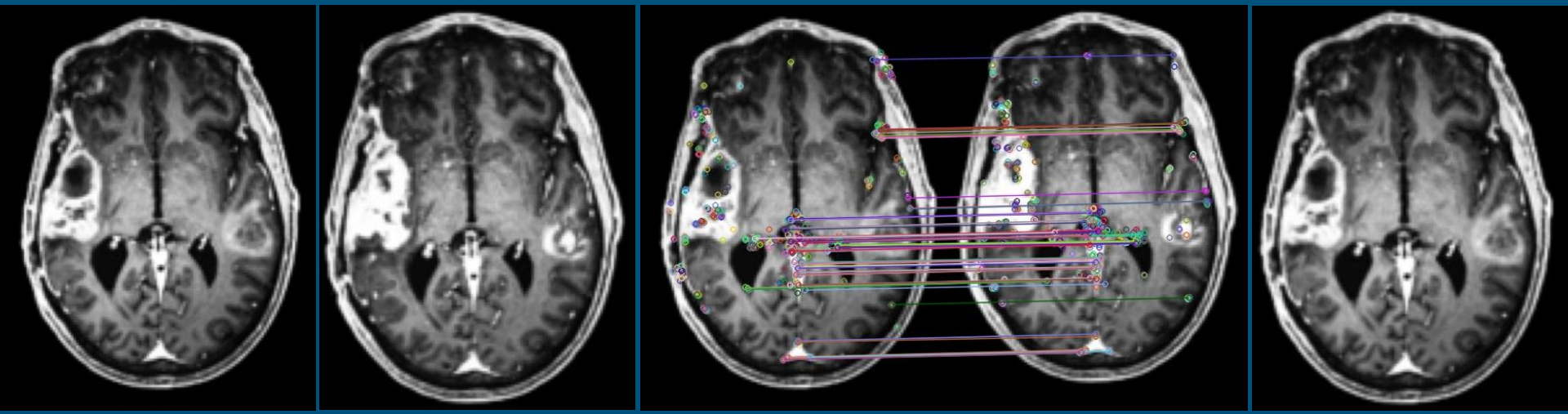
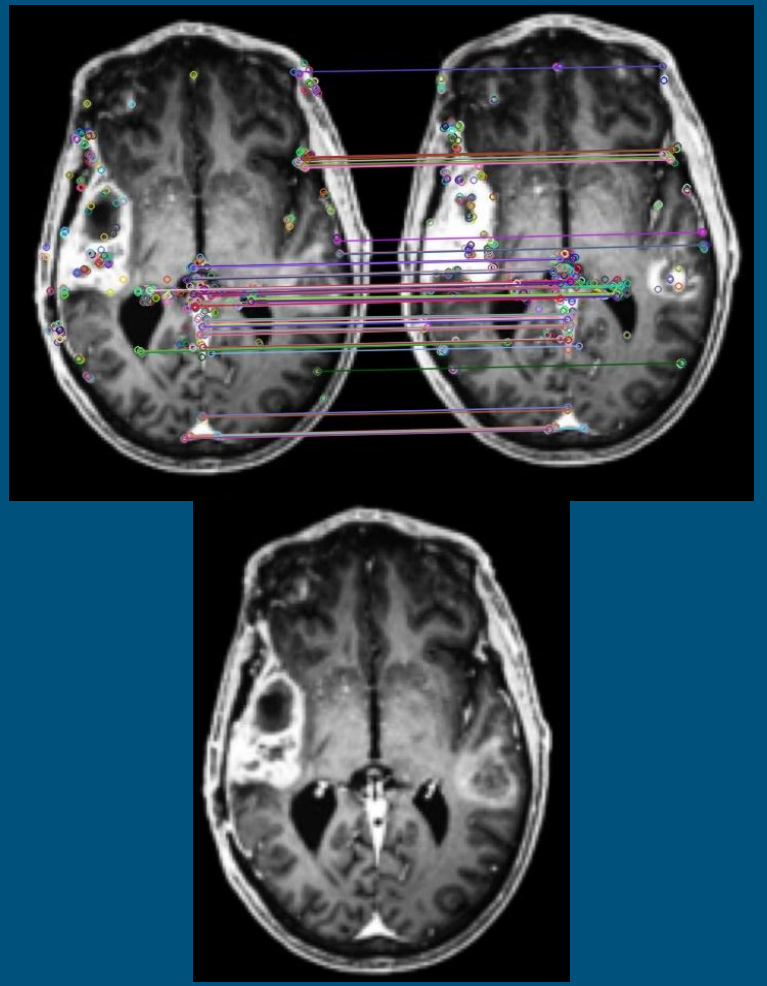


Image 1 Image 2 Feature Points Aligned Image

Image Alignment Method

- Given two images, detect features and compute descriptors for each image
- Sort matches and draw best feature matches and extract their locations
- Find the homography (how any two images in same planar surface relate to one another)
- Use homography, the reference image, and a tuple (width, height) as parameters for warpPerspective() to create an aligned image



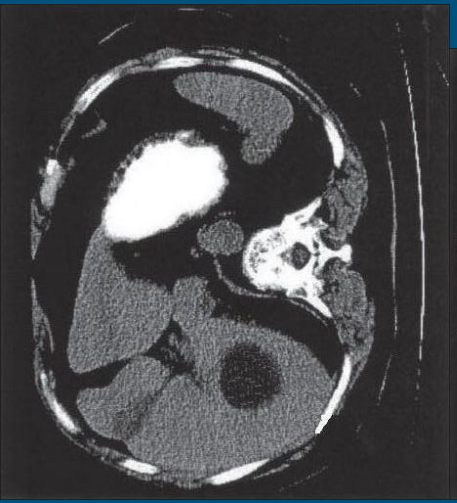


Image 1

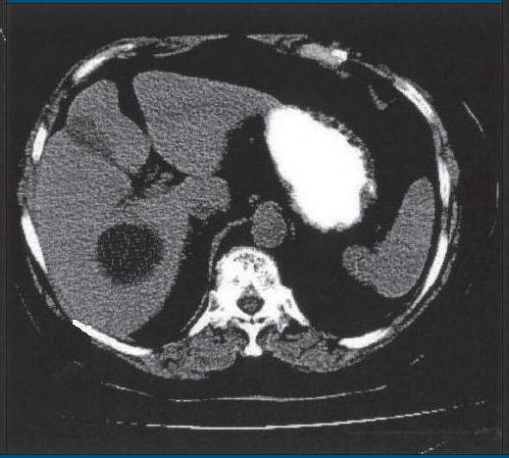
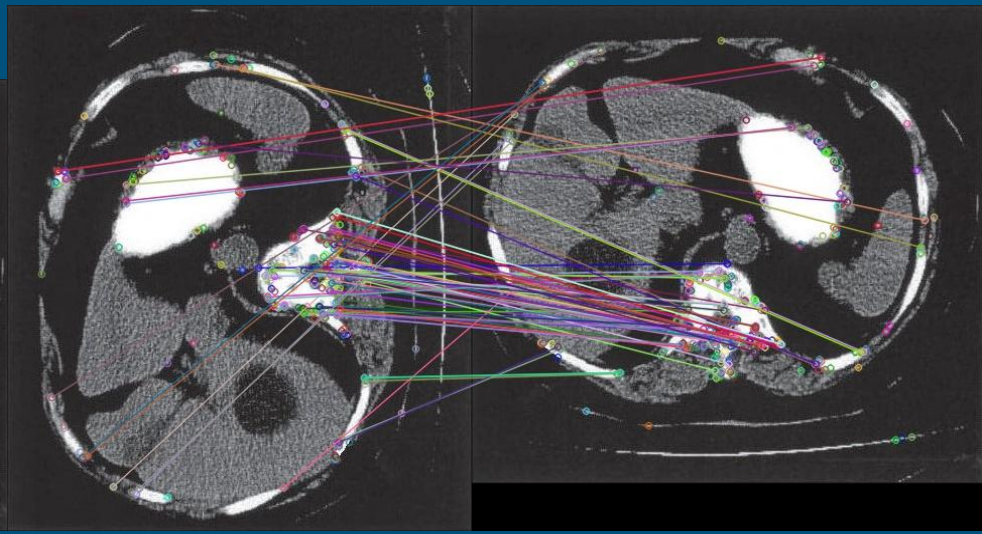


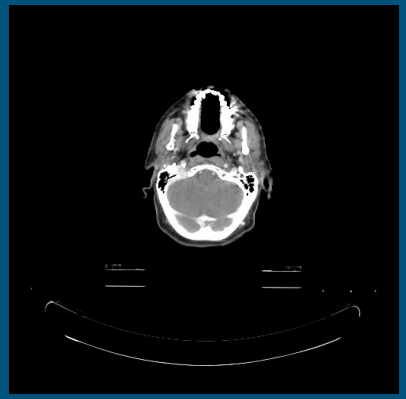
Image 2

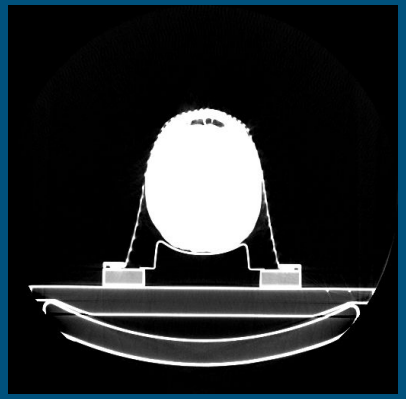


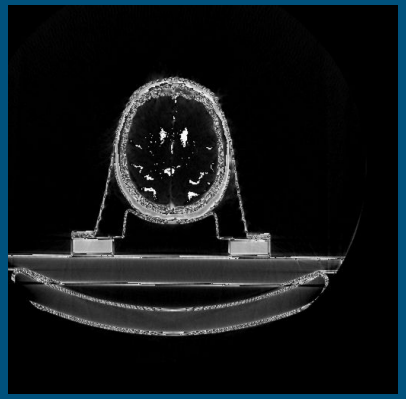
Matched Feature Points

Warp Image Filter

- Digitally manipulates the shapes of an image
- Used for correcting image distortion
- Moves the pixels of the Image

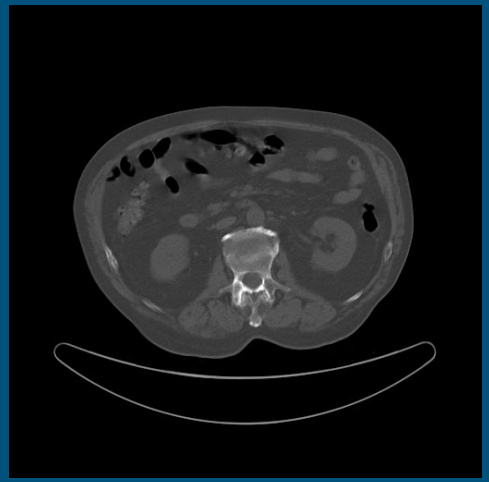




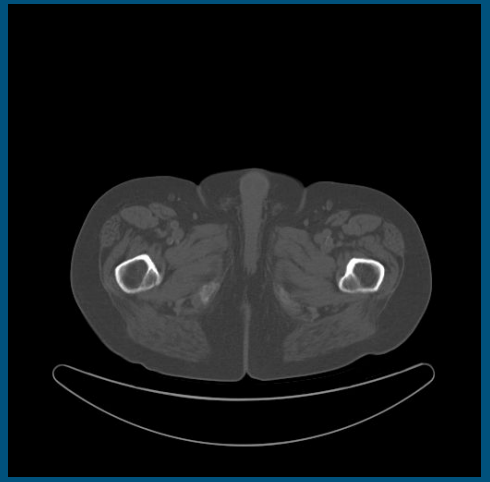


Warp Image Filter Example

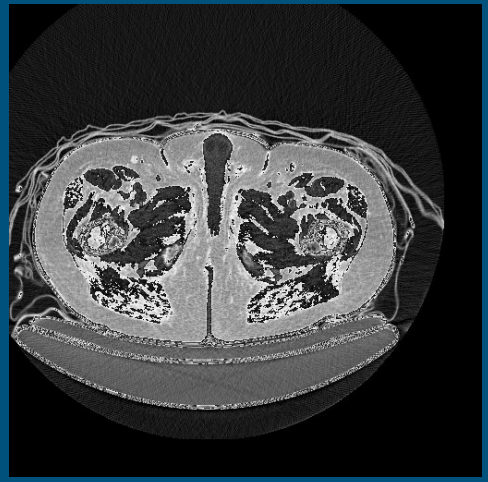
Baseline



Baseline + 4 months



Output

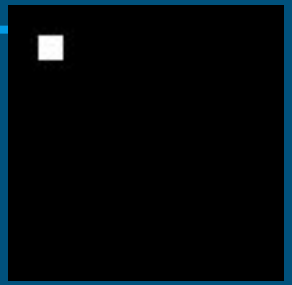


Landmark Based Transform Initializer

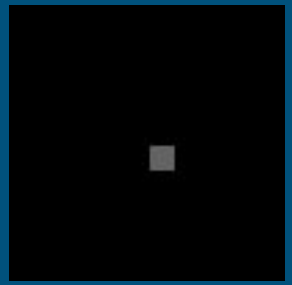
- Calculates the transform that aligns the fixed and moving images with a given set of pair landmarks.
- The calculated transform gives the best fit transform that usually maps the fixed and moving images.
- The indices are taken to relate.
- Example: point 2 in the first set of indices will get mapped to point 2 in the second set of indices.

Landmark Based

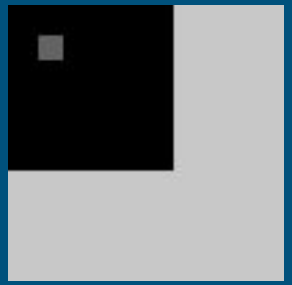
Fixed Image



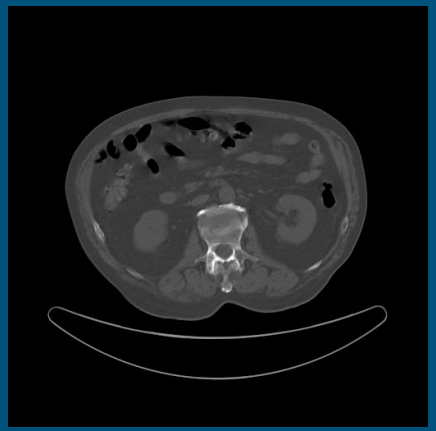
Moving Image



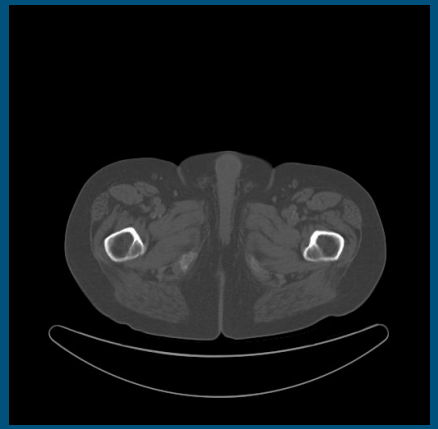
Output



Baseline



Plus 4 months



Output

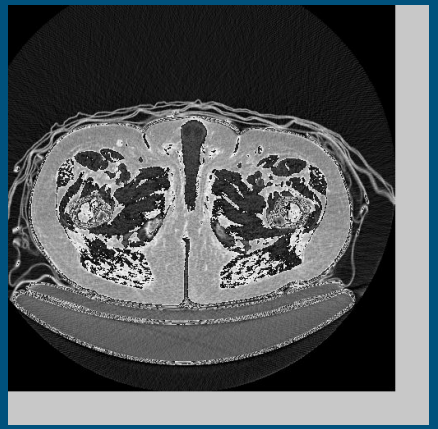


Image Segmentation

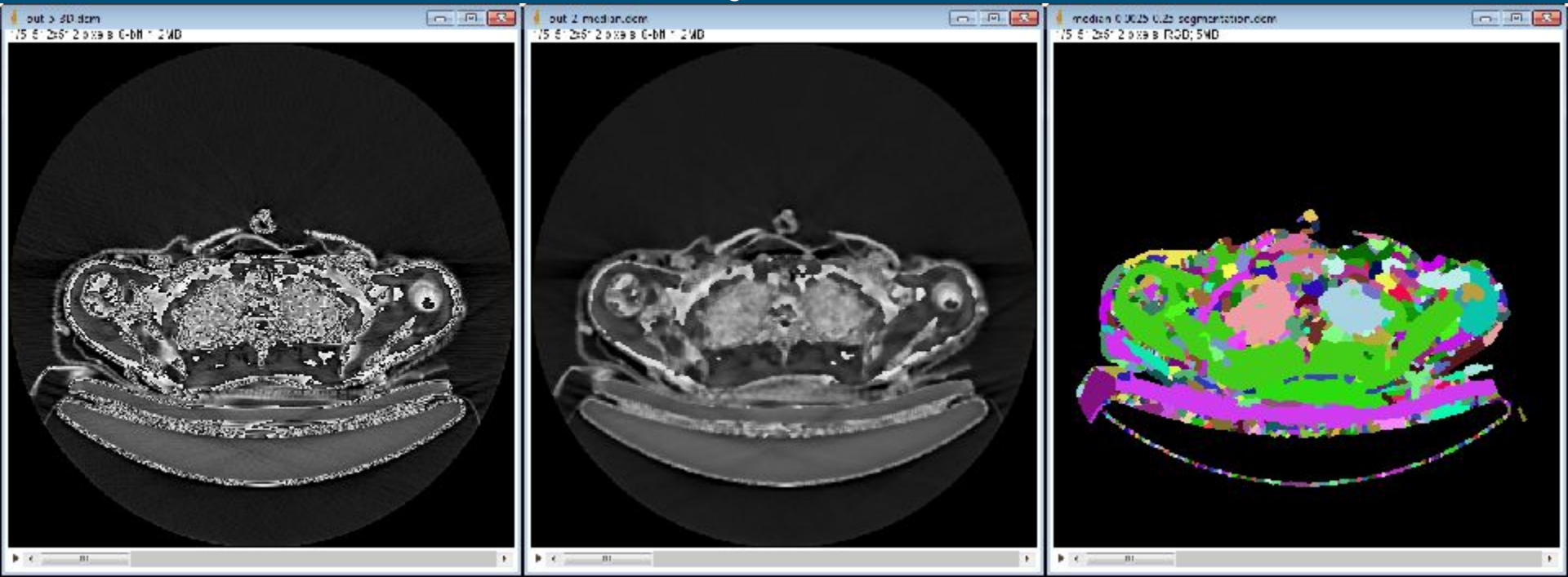
- Dividing an image into regions based on similar properties i.e. gray level, color, or contrast
- Help to identify regions of interest i.e. tumor location and to measure tissue volume and growth over time
- Methods based on gray levels:
  1. Amplitude Segmentation based on histogram features
  2. Edge Based Segmentation
  3. Region Based Segmentation

Watershed Segmentation

- Any grayscale image can be viewed as a topographic surface.
- Work of filling water and building barriers (by gradient) until all the peaks are under water.
- Disadvantage: This approach is sensitive to noise or other irregularities in a image which will give you an over-segmented result.
  - We applied watershed segmentation after applied smoothing filters to overcome noise or irregularities.
  - Examples shown below.
    - Each example uses a threshold of 0.0025 and a level of 0.25

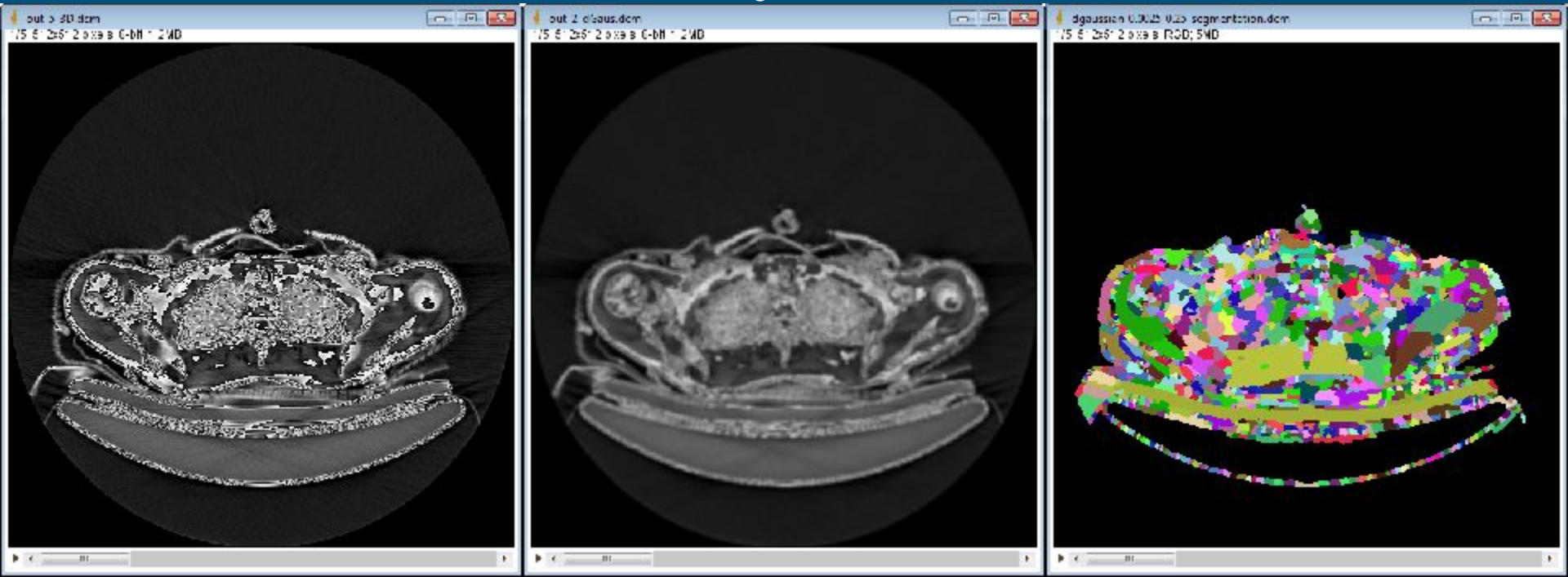
Watershed Segmentation - Example

- Tile Filter -> Median Filter -> Watershed Segmentation



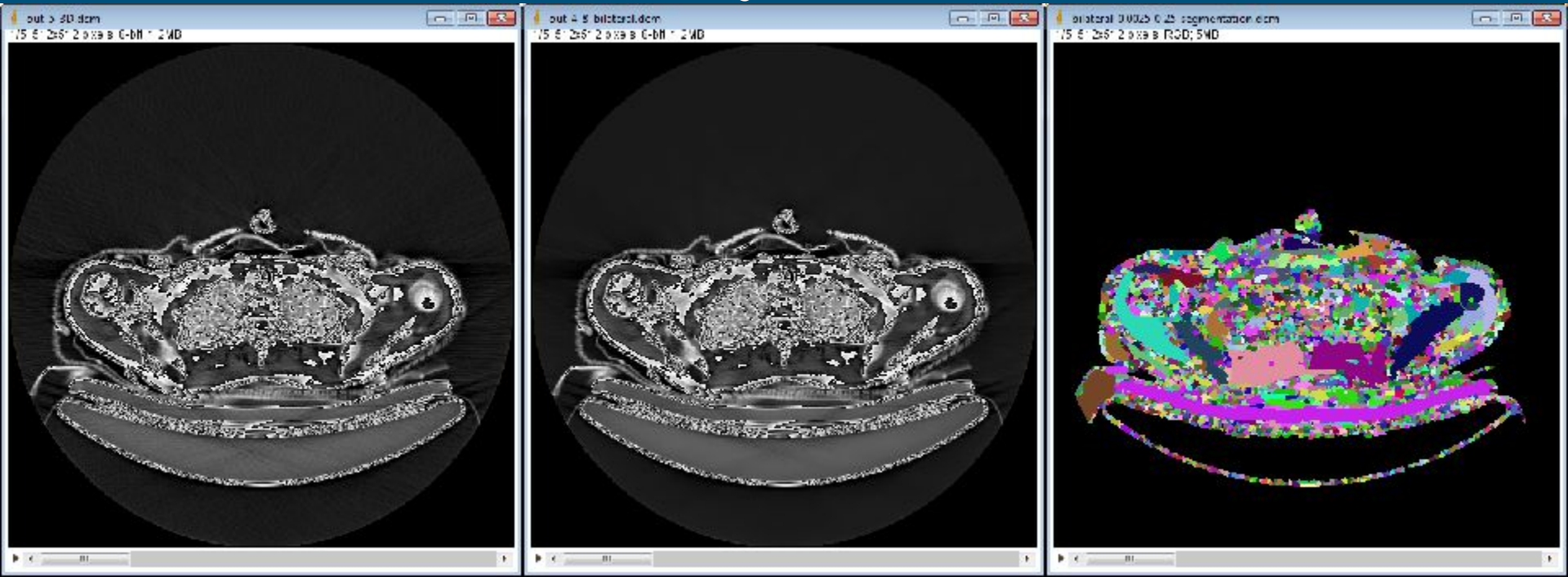
Watershed Segmentation - Example

- Tile Filter -> Gaussian Filter -> Watershed Segmentation



Watershed Segmentation - Example

- Tile Filter -> Bilateral Filter -> Watershed Segmentation



Watershed Segmentation - Feature Extraction

- Attempt to extract meaningful information by refining segmentation results
- Remove labels that have a count less than N
  - Watershed segmentation is sensitive to noise - remove tiny segments
- Remove labels whose mean is less than 5
  - Remove labels from empty areas

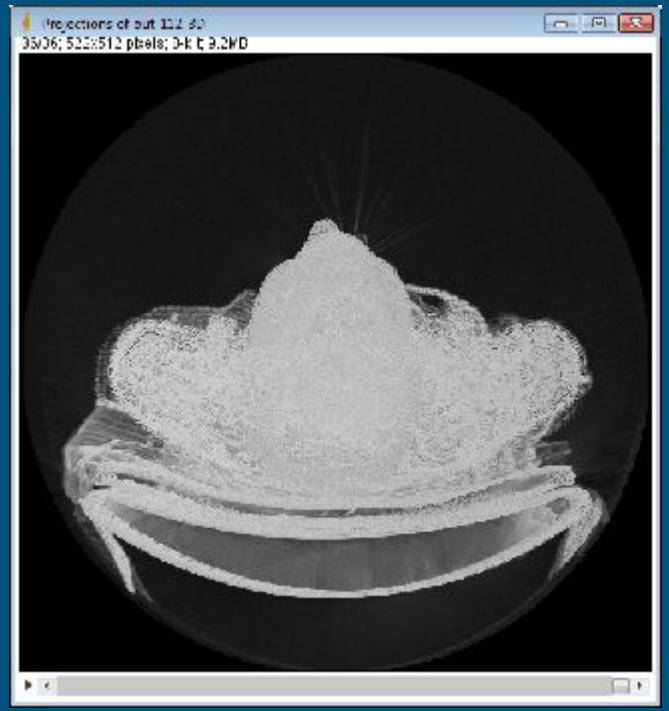
Feature Extraction Results

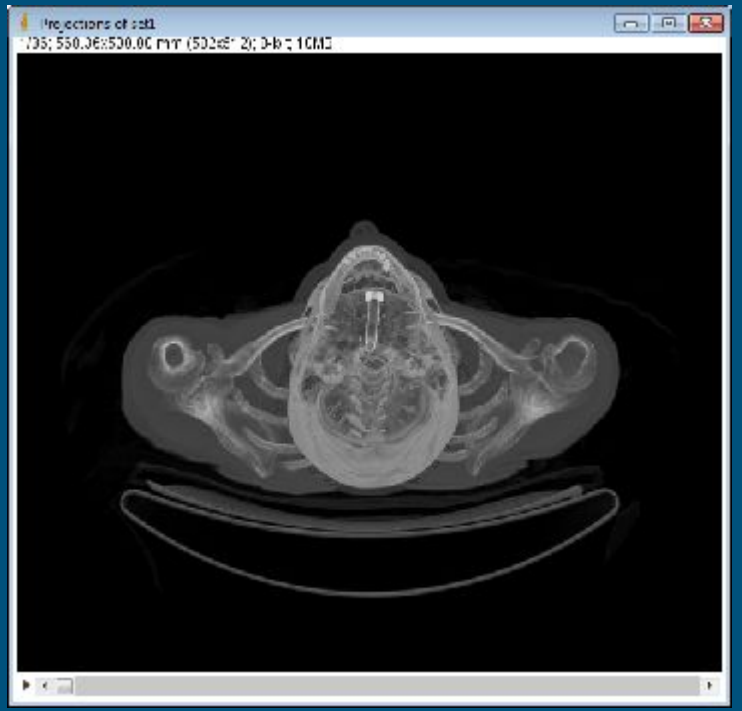
- Tested with median filter results - remove labels that have a count just below the average count of all labels
- In this example 1008 labels were removed
- May help to isolate large areas and help when viewing in 3D

Issues Encountered

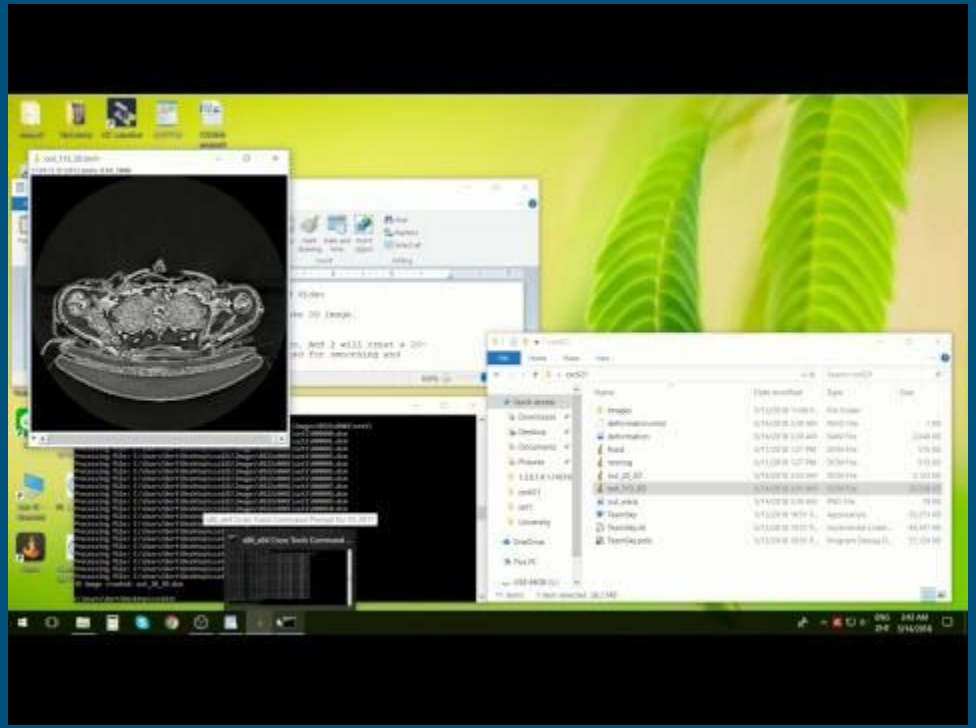
- Running time grows exponentially with regard to sample size
- Finding quality image datasets for testing, NBIA images not in order
- Tile Filter disregards meta-data and image quality is reduced
    - We added the ability to produce a 3D image with preserved meta-data but it would not work with the segmentation code we already wrote.

Tile Filter Image vs. GDCM series Image





Record Video



Future Work

- GUI where users can change parameters
- 3D image registration
- Update algorithms to work with correct 3D format

Complete project with documentation:
https://github.com/amelieakc/CSC621_TeamSky

Conclusion

- We accomplished the coding part that all functions in our program work properly.
- We discovered some problems that we could choose better algorithms and filters to create 3D images and watershed segmentation.
- We also found solutions to resolve the problems that mentioned above.
- Our project is done, but can be more integral when we move on to future work.

Works Cited

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- Wyawahare, Medha V., et al. *Image Registration Techniques: An Overview*. International Journal of Signal Processing, Image Processing and Pattern Recognition , Sept. 2009, www.sersc.org/journals/IJSIP/vol2_no3/2.pdf.

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Works Cited

- OpenCV. (2015, December 18). *Image Segmentation with Watershed Algorithm*. Retrieved from https://docs.opencv.org/3.1.0/d3/db4/tutorial_py_watershed.html

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Q & A

Thanks for listening!

Do you have any questions?