SEMI-AUTOMATIC 3D SEGMENTATION

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• 3D images (i.e. stacks of 2D images) are increasingly common

• Segmentation of particular tissues is often a key step in image analysis

• Manual segmentation, using a computer mouse to trace boundaries, is time consuming and tedious

• Automatic methods exist, but are too specific to work when circumstances change: different tissues, breeds, species, scanners

• So we have developed a semi-automatic algorithm
Semi-automatic algorithm for segmenting a stack of 2D images:

- a human operator segments image 1 manually
- computer segments image 2, mimicking image 1 segmentation
- operator corrects any mistakes in image 2 segmentation
- computer segments image 3, mimicking image 2 segmentation
- operator corrects any mistakes in image 3 segmentation
- etc

Here is an illustration of how “mimicking” works:
pig CT image + boundary

next image in stack
+ perpendicular transects
⇒ same transects on next image
compare a transect
compare a transect

⇒ root-mean-square-difference
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts

position

pixel value

score

shift
compare a transect

at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts

![Graphs showing pixel value and score changes with position and shift.](image)
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts
compare a transect at different shifts

### Pixel Value vs. Position

- **Position**
  - Range: -10 to 10
  - Scale: 0 to 200

- **Pixel Value**
  - Range: 0 to 200

### Score vs. Shift

- **Shift**
  - Range: -10 to 10
  - Scale: 0 to 100
comparison of all transects
Parameters in algorithm:

- number of transects
- lengths of transects
- maximum shift allowed
- roughness penalty

can be tuned to application from manual segmentation of a few animals
Chicken breast: manual boundary

image 1
Chicken breast: automatic + manual correction (different boundary)
Chicken breast: automatic + manual correction (second boundary)
Chicken breast: automatic + manual correction (edited boundary)
Chicken breast: automatic (no manual correction)
Chicken breast: automatic (no manual correction)

dtimage 6

image 6
Chicken breast: automatic + any manual correction
Chicken breast: automatic + any manual correction
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last image
SUMMARY

The semi-automatic algorithm can handle many 3D segmentations:

- boundaries can be exterior or holes, and of any smooth shape
- pixel value templates are simply based on previous image
- Dynamic Programming is fast and robust for locating new boundaries

Segmentation time is reduced from hours to minutes per animal, provided consecutive images are similar

The basic algorithm is open to many generalisations, such as:

- rules for including/excluding air/bone in segmentation
- using previous two images and 3D roughness penalty
- exploiting accumulated database of manual corrections