Context Sensitive Labeling of Spinal Structure in MR Images

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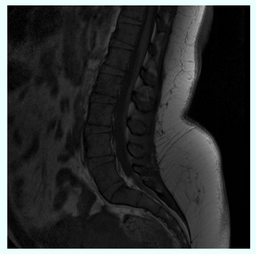
CADI

Introduction

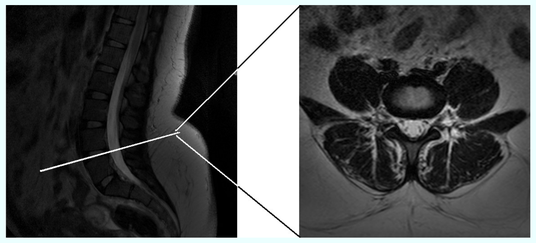
- Low back pain: a very common problem[1]
- Abnormalities like herniation, desiccation, spondylolysis, stenosis
- Would like automatic disease diagnosis
- First step: Label disks and vertebrae, define a function $L(I) = < l_i; (x_i; y_i; z_i) >$ where l_i are the disc labels.

Data

- 3T MRI scans
- 16 normal patients and 51 patients with abnormalities
- Wide variation in age and weight of patients



T1W sagittal (12 slices)
5mm spacing



T2W sagittal (12 slices)
5 mm spacing

T2W axial (24-30 slices)
4.5 mm spacing

Salient Points

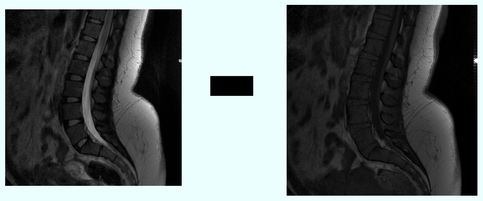
•Use of full protocol[2]

•Dependent on co-registration done by technicians during scanning process

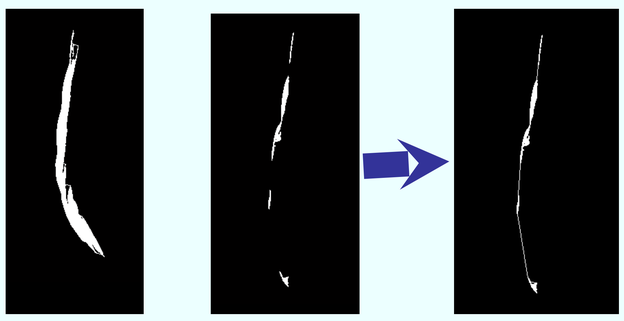
•Others have used graphical models[3-4], active shape[6] and appearance models, Hough transforms, Markov Random Fields, normalized cuts[7], watershed algorithms for segmentation and/or labeling

•We use a variation of the intensity profiles used by Yao et al[5]

Approach

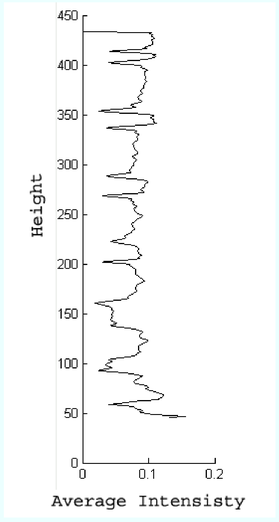


- Extract spinal cord by using difference and a filter



- Interpolate pieces
- Extrapolate
- Select correct sagittal slice

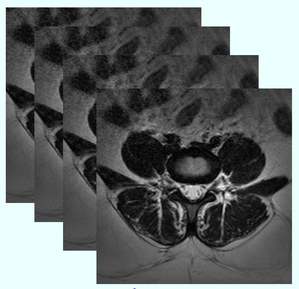
- Extract the left boundary (pink)
- Draw normals



Draw intensity profile using the normals

- Threshold for Anulus Fibrosus
- Eliminate unlikely disc center candidates

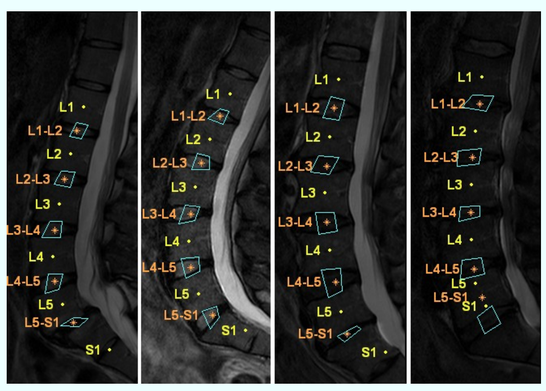
Use axial slice location and orientation

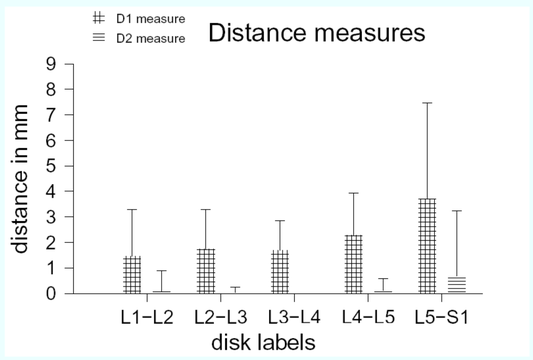


Label structure

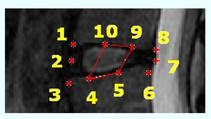
Results

98.8% correct labeling on 335 disks





- Shows variations in data with results
- Last image shows an error case



points marked for evaluation

Conclusions and Future Work

- Achieve high accuracy using the full protocol for labeling

Would like to:

- Learn parameters that are currently set empirically
- Use current work for diagnosis of different lumbar problems

References

1. National Ambulatory Medical Care Survey, 2005
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3. Schmidt et al, "Spine detection and labeling using a parts-based graphical model", IPMI, 2007
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5. Yao et al, "Automated spinal column extraction and partitioning", IEEE ISBI, 2006
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