Automated Vertebra Numbering and Plane Prescription along the Spine Using a Multi Model Atlas

Hima Patel[1], Rajat Vikram Singh[2], Vidit Aatrey[3], Ramasubramanian Sundararajan[1], and Vivek Vaidya[1]
[1]Global Research, General Electric, Bangalore, Karnataka, India, [2]Information Technology, Indraprastha Institute of Information Technology - Delhi, New Delhi, India, [3]Electrical Engineering, Indian Institute of Technology - Delhi, New Delhi, India

Introduction: Manual numbering & plane prescription along spinal MRI images is a tedious and time consuming task[1]. We describe a technology to streamline this process by simultaneously automating annotation/numbering, and oblique axial plane prescription along the vertebral column.

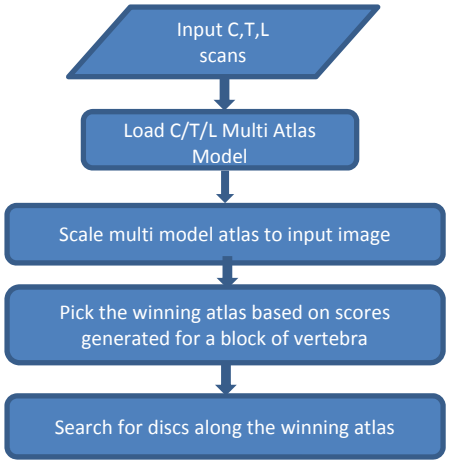

Figure 1: Technology Description

Process: Our testing population consisted of 68 FRFSE sagittal acquisition: 24 cervical, 12 thoracic, and 32 of the lumbar region. The approach has been tested on a variety of GE MR platforms with field strengths of 1.5T and 3T.

Methods: The technology picks a winning atlas from a set of model atlases that fits the best to the input image. Using the winning atlas as guidance, we search for the inter-vertebral discs along the vertebral column for plane prescription. Vertebrae are then located between subsequent disc and labeled. The multi model atlas technology can be applied in conjunction with the C2/S detection technology previously developed by the team and described in [2] or can be seeded using operator input.

Results: We discussed the results of our plane prescription technology previously [3] and here we concentrate on vertebra numbering results. The technology achieved labeling accuracies of 99.4% (cervical cases), 96.2% (thoracic cases) and 97% (lumbar cases). Our accuracy criteria required that derived labels are centered within the vertebral body and if a label was missed by the algorithm while counting all subsequent labels were scored as failures. Visually, the images below show numbering on spinal images with variation in spine curvatures and sizes of the vertebral bodies.

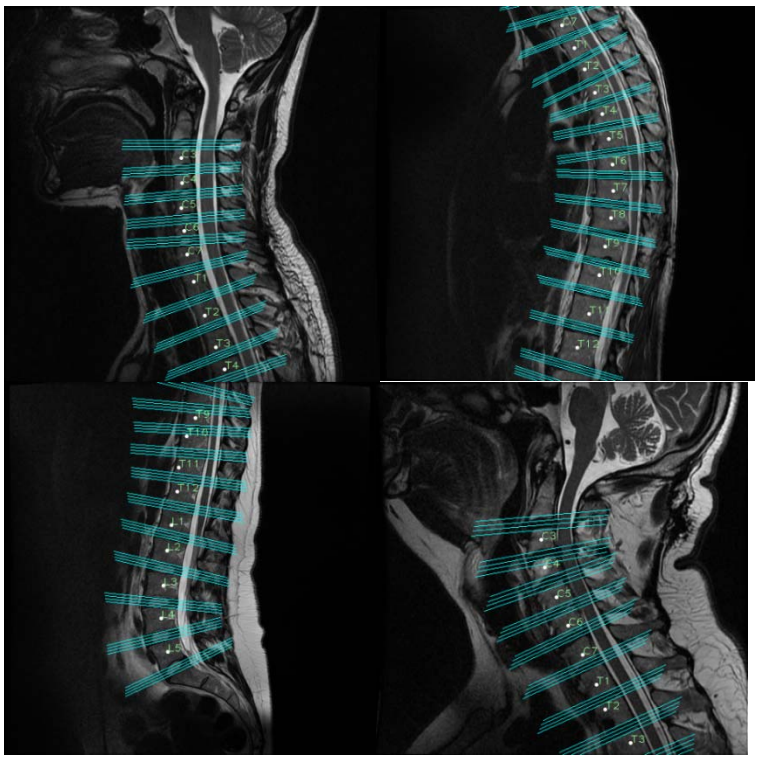

Figure 3: Selected results illustrating labels and oblique axial MSMA plane prescription

References:
1.Weiss, K.L., Storrs, J.M., Banto, R.B.,"Automated spine survey iterative scan technique", Radiology 239, pp. 255–262 (2006)
2. Pai, A., et al, "Automated Localization and Classification of Vertebra Landmarks in MRI Images" SPIE, 2011.
3. Narasimhamurthy, A. et al,"Automatic Derivation of Scan Plane Angles along the Vertebral Column of the Human Spine", ISMRM 2011