A Multi-Anatomy System for Computing and Centering Field of View from Localizer Images

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Introduction:
The acceleration of clinical workflows through automated analysis technology is a rapidly evolving field [1]. In this paper a system is demonstrated for automatically deriving and centering oblique scan extents/fields of view (FOV) from localizer scans. Our method differs from prior work in the field [2,3] by being markerless [2] and allowing for automated acquisitions oblique to the input localizer [2,3]. By constraining acquisition to the precise extents of the anatomy being sought acquisition time is reduced. For the case of a phase FOV change from 1 to .8 this scan time reduction would be around of 10-20%. This acquisition time reduction is particularly valuable in cardiac and abdominal imaging: given the need for breath-held scanning. Furthermore, by prescribing an optimal field of view we also reduce potential wrapping artifacts and can improve the consistancy of image representation.

Methods

Acquisition: Cardiac data was acquired on a 1.5T Signa Excite and 3T Signa HDx MRI scanner (GE Healthcare, Waukesha, WI) with an 8 element cardiac phased array coil.

Processing: As described in Figure 1 (right) the system acquires a localizer image and generates a 3D anatomical mask from it. To compute field of view for a desired orientation: (a cardiac example might be acquiring a 4 chamber view) the system then rotates the mask and calculates to extents and centering for the rotated configuration. An optional step then orients the reformatted mask along its longest axis, enabling a additional potential reduction in scan time. (see Figure 3 below)

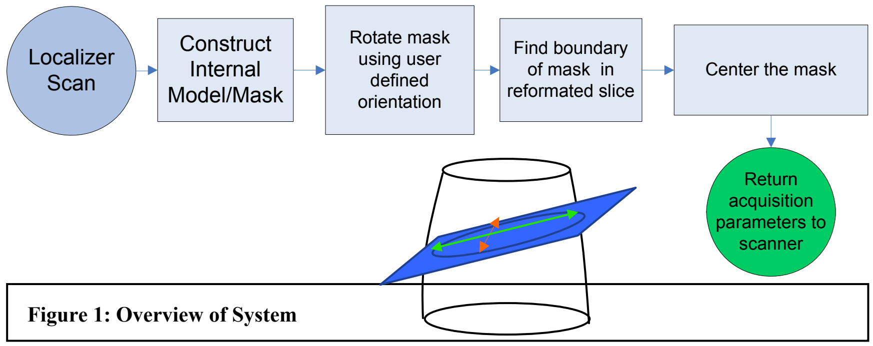

Figure 1: Overview of System

The mask generation problem can be understood as finding an interior/exterior interface between internal physical structure and the primarily air exterior. To find this the thresholding methodology described in [4] is applied. Briefly, an edge response histogram is constructed from voxels in the input localizer. Using this histogram the intensity value possessing the highest edge response is found, and a first pass mask is generated. Structural continuity constraints are then imposed on this interface to arrive at a final mask.

Evaluation: A validation experiment was performed for our primary cardiac use case. For this experiment FOV/scan extents were computed on a population of 50 cases. To ensure robust population diversity the testing population was a mix of volunteer (16) and pathology (34) cases collected at three separate sites.

Results:

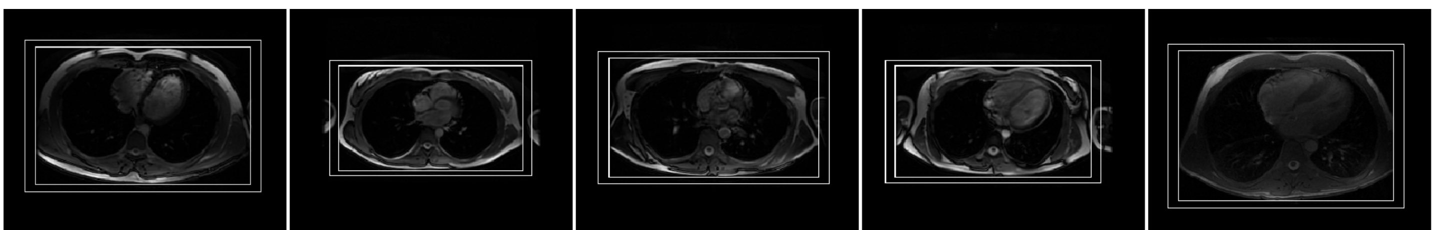

Figure 2: Cardiac Localizers with Marked FOV

For the experiment described above our internal evaluation found extents were within 2cm of torso boundary for 48/50 cases (96%). Figure 2 (above) provides a visual display of 5 sample cases from this population with marked FOV extents. Figure 3 (right) displays results after the technology is applied to an oblique slice, Figure 3 also demonstrates the plane ‘twist’ option.

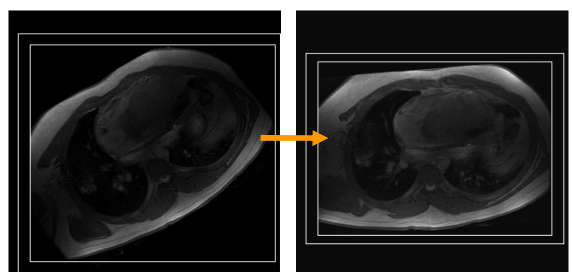

Figure 3: Optional in Plane Rotation Step

Figure 4 (right, below) demonstrates the technology applied to other anatomical regions. The technology is independent of scanner or anatomical details and does not require case specific tuning. Computation time is 2 seconds for a 256x256x22 localizer image using a 2.66Ghz Intel X5355 Xeon processor.

Discussion and conclusions

We have demonstrated an anatomy and scanner independent technique for optimizing image acquisition and retrospectively evaluated its perfornance. Furture work will include additional prospective validation experiments of our system across an anatomical spectrum. Furthermore, we seek to integrate this capability with other workflow acceleration techniques [1] to enable interlinking automated workflows.

Figure 4: Liver, Spine, Knee

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