# AUTOMATED LIVER VOLUME ASSESSMENT FROM CONTRAST SCANS: IMPACT OF PATHOLOGY

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**Introduction:** Liver volume assessment for transplant, pathologic and metabolic changes using MR has primarily been via semi-automated methods [1][2]. We have developed an automated method to extract the liver region from fast 3D high resolution LAVA scans. Variability in images from abdominal LAVA scans arising from acquisition, patient anatomy and pathology, bolus timing and coverage of contrast agent pose considerable challenge to designing robust algorithms for automatic image processing. Contrast uptake also tends to vary with location, extent and distribution of pathology [3]. We have applied our algorithm to delineate liver region from a single phase (portal) of contrast enhanced LAVA scan. This study is aimed at assessing the sensitivity of our method to a range of patient pathology.

**Methods:** Breath held contrast enhanced, multiphase T1 wt (LAVA) MR imaging was performed on seven subjects, on a GE 1.5T Signa system. The segmentation method comprises of automated detection of the organ location from a single phase (portal) of the contrast scan using topological analysis of the image. A statistically driven data adaptive 3D geodesic active contour is then applied to extract the organ from the image. The algorithm is evaluated by comparing the results to manually drawn regions by an expert medical personnel for Liver Volume, Kappa (κ) statistics [4], Sensitivity and Specificity.

**Results:** The average liver volume measured using manual ground truth is 2003(±275) cc while the automated technique yields 1653(±222) cc with an error of -17% (±7.3%). The average κ-statistic is calculated as 0.88 (±0.036), with a sensitivity of 80.4% (±6.3%) and specificity of 99.86% (±0.09%). Figure-1 shows the results of three cases, one with small intrahepatic lesions, second with large peripheral cystic lesions and third with multiple surface cystic lesions. Corresponding performance metrics are listed below. Figure-2 summarizes the performance across all seven cases by comparing the volumes of the automated segmentation method with that on manual segmentation.

**Discussion:** The automatic algorithm provides consistent assessment of liver volume. Focal liver lesions confined to the parenchyma do not significantly alter the performance of the algorithm. The underestimation of the liver volume is due to under-segmentation in the superior and inferior liver regions and at the angular edges of segments VI and III. This can potentially be corrected by applying a controlled dilation algorithm. The performance tends to degrade in the presence of cysts on the surface of the liver in a subject with polycystic liver disease. This is due to low contrast uptake causing low intensity sub-regions within the liver. Intra and inter-observer variability studies with additional cases in under consideration.

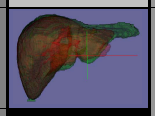
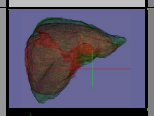
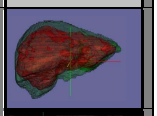
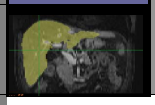
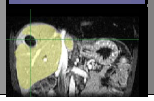
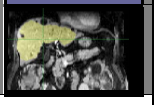
| Cases | P-1 | P-2 | P-3 |
|---|---|---|---|
| Joint Rendering |  |  |  |
| Segmentation Overlay |  |  |  |
| Volume Error (%) | -10.60 | -9.70 | -31.03 |
| κ | 0.92 | 0.90 | 0.81 |
| Sensitivity (%) | 87.12 | 85.44 | 68.54 |
| Specificity (%) | 99.88 | 99.70 | 99.98 |

Fig. 1 Performance variation across three representative cases
P-1, very small intrahepatic lesions
P-2, single large cystic lesion
P-3, multiple distributed cystic lesions

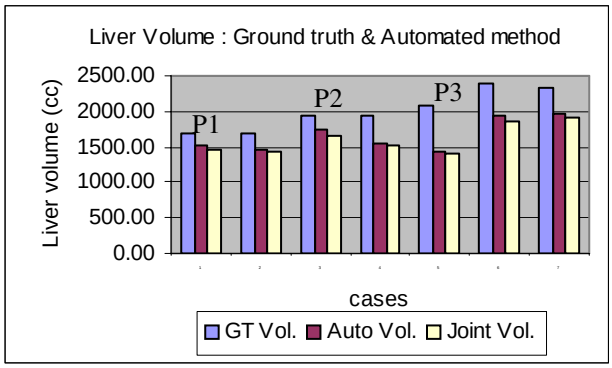



Fig. 2 Liver Volume estimation - variation across cases

**References:** [1]Gary R. McNeal et al., Radiology 1988; 169:851–854. [2] S.W.Farraher et al., Radiology 2005; 237:322–328. [3] Pari V. Pandharipande et al., Radiology 2005; 234:661-673. [4] Harold L. Kundel et al., Radiology 2003; 228:303–308.