Machine Learning Algorithm to Detect Shear Waves During Velacur™ Exams

Mohammad Honarvar[1], Julio Lobo[1], Caitlin Schneider[1]

[1] Sonic Incytes Medical Corp., caitlin@sonicincytes.com

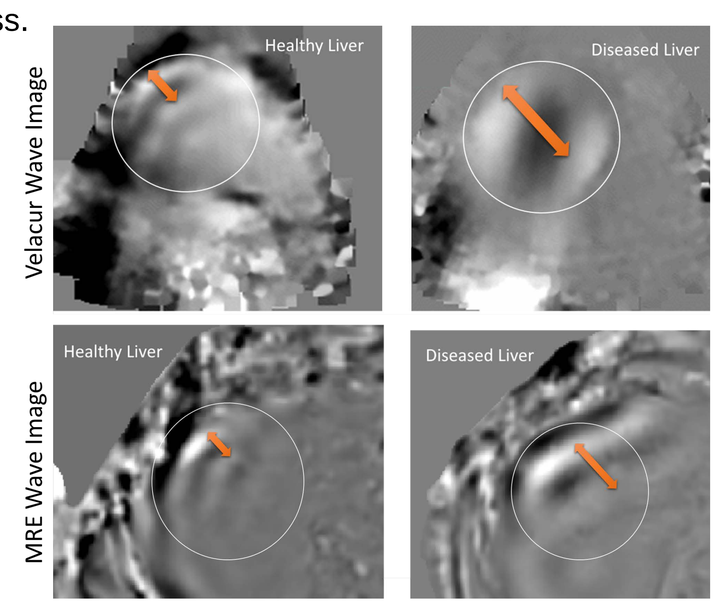
VELACUR™ LIVER ASSESSMENT

1. **Uses steady state shear waves**, which, like MR elastography, are used to measure liver stiffness.
2. **Powered with AI wave quality metric**, a novel feature which helps users identify when shear waves are present in the liver and ensure measurement accuracy.

The wave quality guide is a machine learning based algorithm that automatically segments the area of shear waves and acts as an assistant for the user.

SHEAR WAVES

Shear waves are produced from the activation unit and travel into the patient's liver, creating minute deformations. These waves travel faster through stiffer tissues (with a longer wavelength). These waves are invisible to the user during the exam, but essential to the accurate measurement of liver stiffness.



As if they were waves from a pebble in a pond, these post processed images illustrate the shear waves in both Velacur and MRE. The white area representing the peak and the black area the trough of the wave.

The left image shows a healthy liver with a short wavelength and the right is a patient with advanced liver disease, with a stiff liver and longer wavelength.

DATA SETS

TRAINING:

- 103 patients with approximately 50 images/per patient, for a total of 5,150 images each at 40, 50 and 60 Hz vibration.
- Collected from two clinical study sites.
- The waves were manually segmented by one of three experts with a review by the lead expert for quality assurance and overall consistency.

EVALUATION:

- 36 patients and volunteers, who were not included in the training set, for a total of 1476 images each at 40, 50 and 60 Hz vibration.
- Collected from three separate clinical study sites.

CLINICAL VALIDATION:

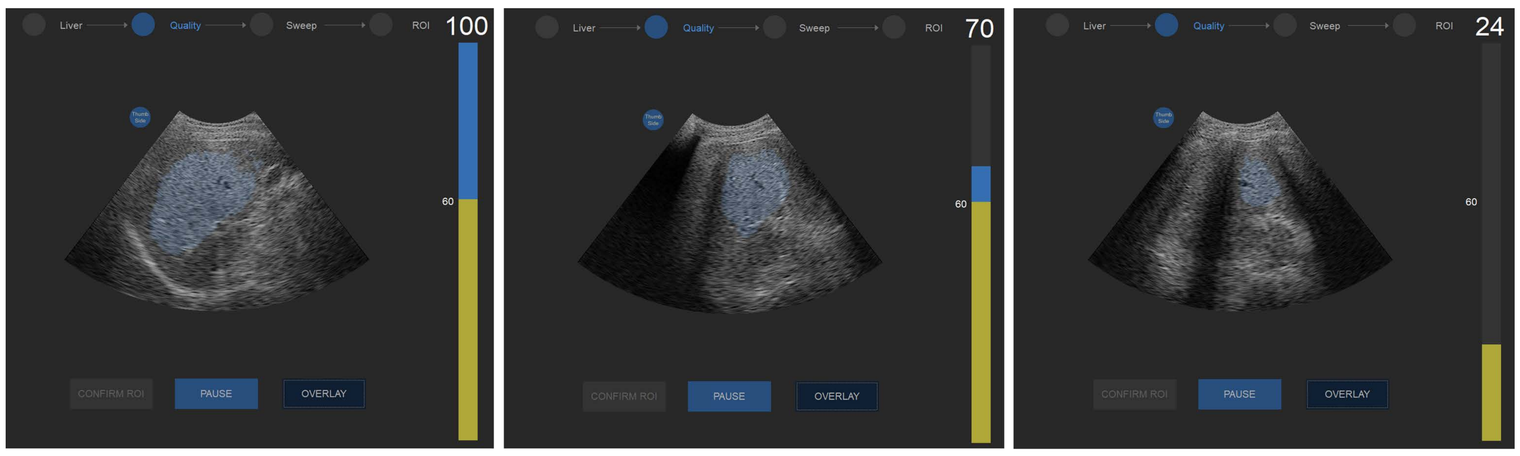
- Data from a single user at one site was used to evaluate the quality of scans before and after introduction of the new algorithm.

USER EXPERIENCE

Shear waves need to be displayed to the user, without interfering with the normal exam:

1) The transparent blue overlay displays the areas of the image where waves are detected

2) The overall quality is shown to the right of the image, as a scale from 0 to 100.



The left image above shows a good location, with a large area of waves and 100% quality. The center image shows a smaller area of waves, with 70% quality. The right image shows a poor location to scan, with the blue area being very small and the overall quality being only 24%, which falls below the 60% acceptance threshold.

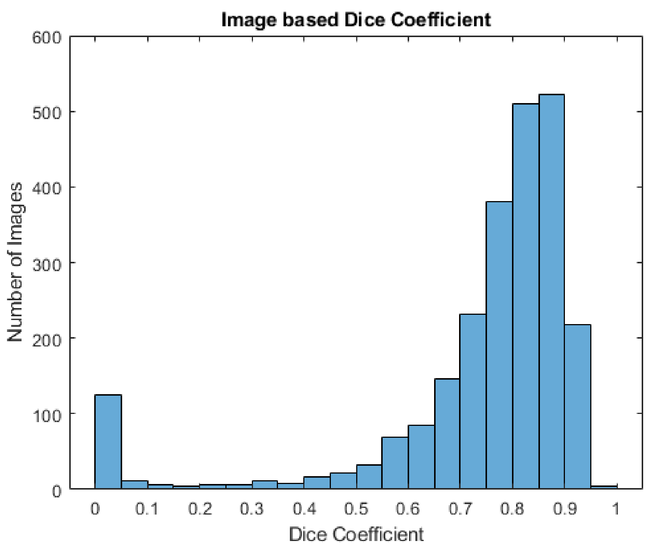
PERFORMANCE

Evaluation

1) The Dice coefficient is used to measure the pixel overlap of two different segmentation methods; in this case, the manual segmentation and the resulting liver detection mask.

*Dice = (2*overlap of the two segmentation methods)/(manual segmentation + algorithm segmentation)*

2) Sensitivity and Specificity will be used to evaluate the algorithm's ability to detect a good image. A good image defined as having waves in at least 5% of the image.

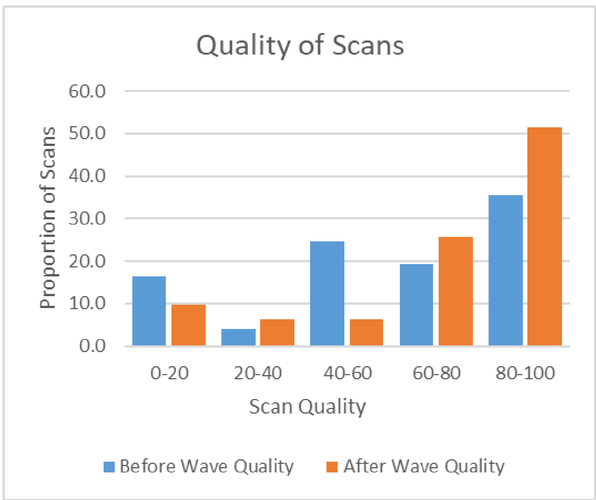


Metric		Training Result	Evaluation Result	Pass/Fail
Sensitivity	Image Based	0.82	0.81	Pass
Specificity	Image Based	0.97	0.84	Pass
Dice Coefficient	Image Based	0.74	0.74	Pass
	Patient Based	0.70	0.75	Pass

Clinical Validation

The quality of the collected scans, before (blue) and after the introduction of the new wave quality algorithm (orange), are shown *overlapped* on the graph to the right.

With the feedback from this algorithm and user interface, the average quality of the scans increased, with many more of the scan falling above the 60% threshold, increasing from an average of 62% to 72%.



CONCLUSION

The machine learning algorithm was trained and evaluated on real patient data and performed well on the new patient data presented during evaluation. It was shown to be able to detect and present the shear waves to the user in a way that can better ensure the quality of scans collected with Velacur.

Initial clinical validation at a single site shows that the overall quality of scans will improve with the additional user features provided as part of this algorithm.