Using deep learning techniques to improve liver disease diagnosis and treatment

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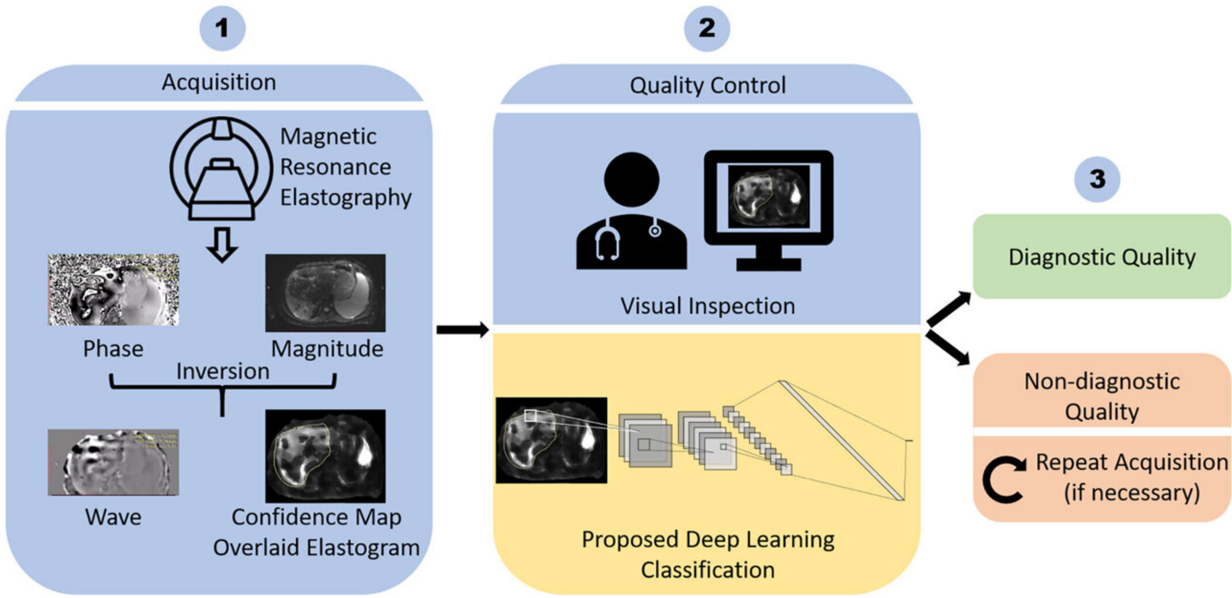

Comparison of the workflow between the proposed deep learning-based image quality classification and the traditional visual inspection. Credit: *Journal of Magnetic Resonance Imaging* (2024). DOI: 10.1002/jmri.29490

Hepatic, or liver, disease affects more than 100 million people in the U.S. About 4.5 million adults (1.8%) have been diagnosed with liver disease, but it is estimated that between 80 and 100 million adults in the U.S. have undiagnosed fatty liver disease in varying stages. Over time, undiagnosed and untreated hepatic diseases can lead to cirrhosis, a severe scarring of the liver that cannot be reversed.

Most hepatic diseases are chronic conditions that will be present over the life of the patient, but early detection improves overall health and the ability to manage specific conditions over time. Additionally, assessing patients over time allows for effective treatments to be adjusted as necessary.

The standard protocol for diagnosis, as well as follow-up tissue assessment, is a biopsy after the return of an abnormal blood test, but biopsies are time-consuming and pose risks for the patient. Several non-invasive imaging techniques have been developed to assess the stiffness of liver tissue, an indication of scarring, including magnetic resonance elastography (MRE).

MRE combines elements of ultrasound and MRI imaging to create a visual map showing gradients of stiffness throughout the liver and is increasingly used to diagnose hepatic issues. MRE exams, however, can fail for many reasons, including patient motion, patient physiology, imaging issues, and mechanical issues such as improper wave generation or propagation in the liver.

Determining the success of MRE exams depends on visual inspection of technologists and radiologists. With increasing work demands and workforce shortages, providing an accurate, automated way to classify image quality will create a streamlined approach and reduce the need for repeat scans.

Professor Jun Ueda in the George W. Woodruff School of Mechanical Engineering and robotics Ph.D. student Heriberto Nieves, working with a team from the Icahn School of Medicine at Mount Sinai, have successfully applied deep learning techniques for accurate, automated quality control image assessment.

The research, "Deep Learning-Enabled Automated Quality Control for

Liver MR Elastography: Initial Results," was published in the *Journal of Magnetic Resonance Imaging*.

Using five deep learning training models, an accuracy of 92% was achieved by the best-performing ensemble on retrospective MRE images of patients with varied liver stiffnesses. The team also achieved a return of the analyzed data within seconds. The rapidity of image quality return allows the technician to focus on adjusting hardware or patient orientation for re-scan in a single session, rather than requiring patients to return for costly and timely re-scans due to low-quality initial images.

This new research is a step toward streamlining the review pipeline for MRE using deep learning techniques, which have remained unexplored compared to other medical imaging modalities.

The research also provides a helpful baseline for future avenues of inquiry, such as assessing the health of the spleen or kidneys. It may also be applied to automation for image quality control for monitoring non-hepatic conditions, such as breast cancer or muscular dystrophy, in which tissue stiffness is an indicator of initial health and disease progression.

Ueda, Nieves, and their team hope to test these models on Siemens Healthineers magnetic resonance scanners within the next year.

More information: Heriberto A. Nieves-Vazquez et al, Deep Learning-Enabled Automated Quality Control for Liver MR Elastography: Initial Results, *Journal of Magnetic Resonance Imaging* (2024). DOI: 10.1002/jmri.29490

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