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A dynamic contrast-enhanced MRI-based data-driven computational technique for early detection of chronic liver diseases

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Abstract

Liver diseases are always on the list of the top ten causes of death in Asian countries. Generally speaking, liver disease progression can be classified into three stages: liver fibrosis, liver cirrhosis, and liver cancer. One of the research focus for clinical practice is to develop some noninvasive technique used for determining the status of the liver disease. Early diagnosis of the liver's fibrosis with some proper treatments can decrease the hepatocellular carcinoma chance. In this work, we propose a data-driven computational technique in conjunction with the dynamic contrast-enhanced MRI (DCI-MRI) for the early detection of chronic liver diseases. The proposed technique's kernel is a Darcy solver weakly coupled with an unsteady convection-diffusion solver used to simulate the blood flows through the liver, assumedly as a kind of porous medium, and the relative signal enhancement scanned by MRI varied in time. Our approach consists of two phases: the online and online stages. We correlate the porosity in the mathematical model to the degree of liver fibrosis during the online phase, determined by the liver biopsy result using the clinical data. During the online stage, to help the doctors' diagnosis, we perform the numerical simulation by using the patient-specific data to determine the liver's fibrosis stage. Our method achieves a 93% success rate for diagnosing moderate liver fibrosis status from the mild one correctly.