SIIM CMIMI24 Oct 21-22 | Boston, MA
Conference On Machine Intelligence In Medical Imaging

Artificial Intelligence System for Estimation of Liver Size on Pediatric Abdominal Ultrasounds

Dana Alkhulaifat, MD, Children's Hospital of Philadelphia; Mario Sinti-Ycochea, MD; Vahid Khalkhali, PhD; Michael Welsh; Laith Sultan, MD, MPH; Susan Sotardi, MD, MSc

Introduction/Background

Ultrasound (US) is a safe and efficient imaging tool for estimating liver size and detecting parenchymal abnormalities, and is essential for diagnosing and treating liver diseases in children. Unlike adults, children’s liver sizes vary with age, making accurate measurement according to age crucial for disease detection. Organ segmentation methods vary between manual and automated approaches. Artificial intelligence (AI) exhibits great potential in improving the accuracy of liver segmentation and size estimation to achieve reliable liver measurements on US images. Thus, our aim was to develop an AI model to accurately predict liver size on US images in pediatric patients.

Methods/Intervention

In this retrospective, IRB-approved study, a dataset of 55 abdominal US images containing a sagittal view of the liver was utilized. The estimated liver size was extracted from each image. The liver was then manually segmented by a radiologist with 3 years of experience using 3D Slicer. 33 images were used for re-training a pretrained fully convolutional neural network (FCN50). 11 images were used for validation and 11 images for testing, respectively. Shape features were extracted from the segmented liver area of any image based on physical pixel spacing that were taken out of original DICOM tags. Image post-processing was deployed to remove artifacts and clean the segmented liver area. A Random Forest regressor predicted the liver spans after standard scaling of liver shape features and truncating the liver lengths to centimeters without decimal points. R2-score and cross validation with 5 folds in a Monte Carlo iteration were used as performance metrics.

Results/Outcome

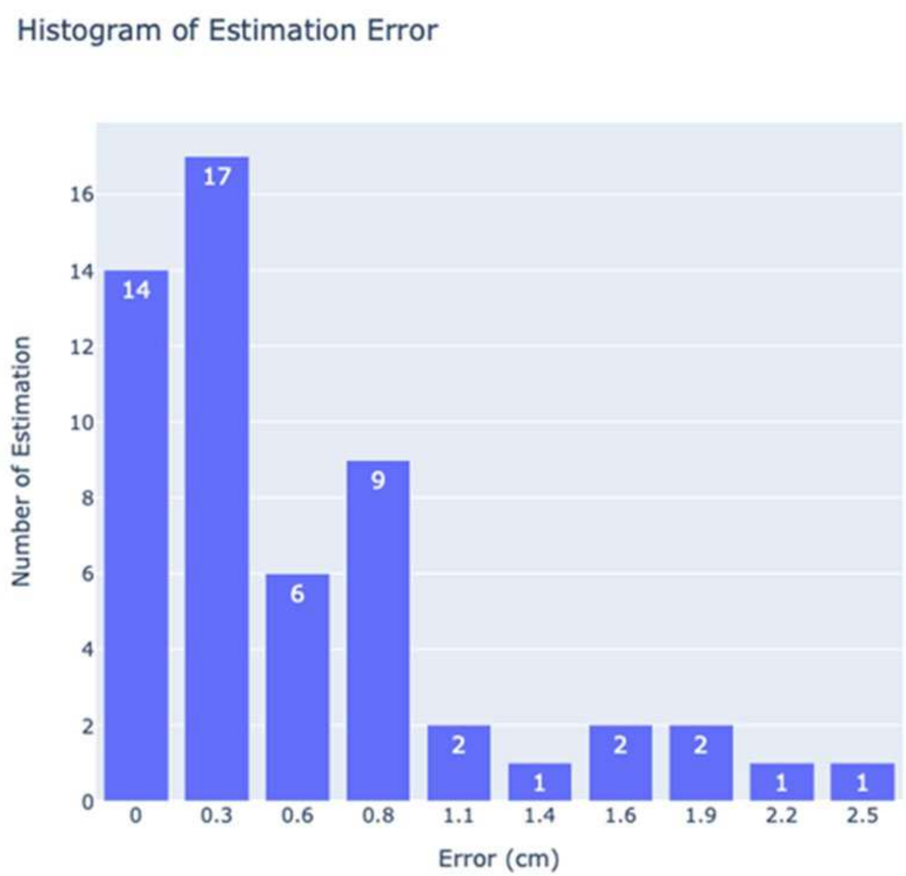
55 patients (25 male) were included in the analysis, with a mean age of 8.17 years (SD 6.83 years). The 3-phase model was able to predict the liver span with an average R2 of 0.59 and a maximum R2 of 0.74. Attached histograms show the absolute error and the percentage errors of the estimations.

Conclusion

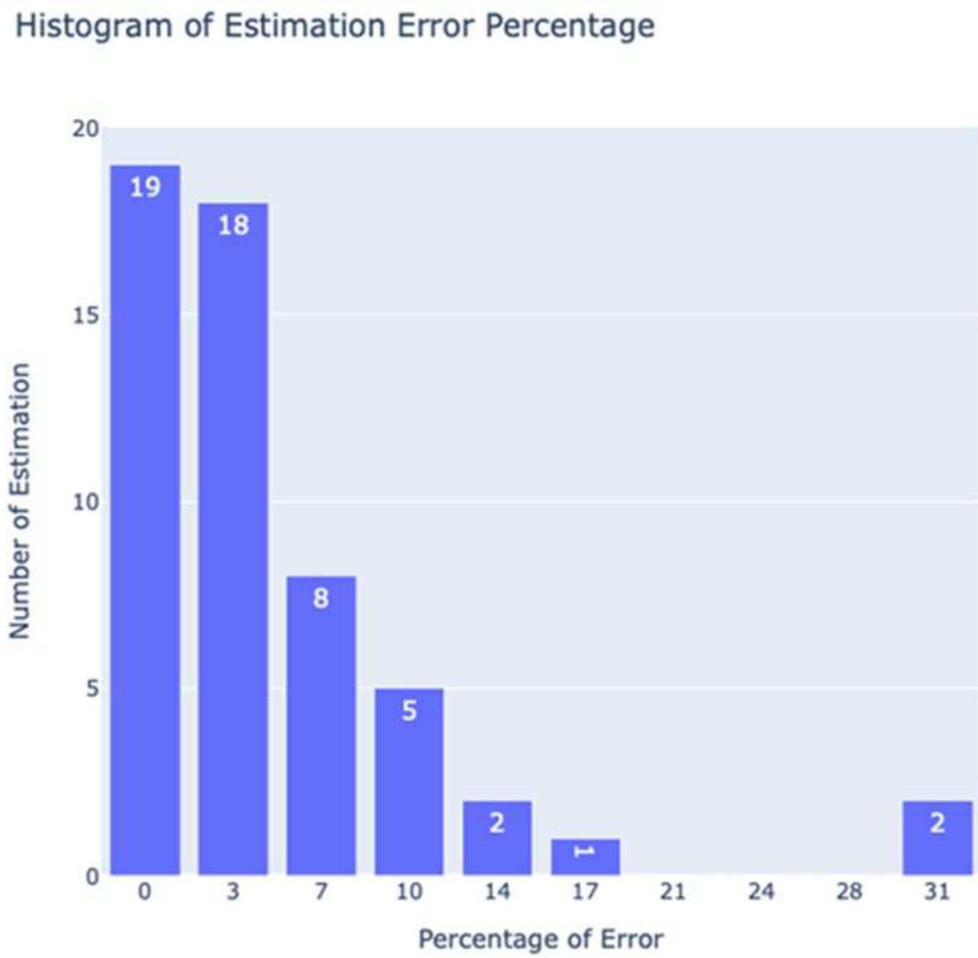
A three-phase system consisting of a transfer deep learning model (FCN50), image post-processor, and a machine learning regressor (Random Forest) can estimate the liver sizes from pediatric ultrasound images with great accuracy.

Statement of Impact

This proposed system holds significant potential in detecting anomalies on liver ultrasound images.



Histogram plot showing the distribution of measurement error (calculated as actual liver size minus predicted liver size) for all images.



Histogram plot showing the distribution of the percentages of estimation errors (calculated as the percentage difference between the actual liver size and the predicted liver size relative to the actual liver size) for all images.

Keywords
deep learning; ultrasound; pediatric radiology