AI Ultrasound for the VL Documentation Version 1.0

Our goal was to release a validated model for detecting the subcutaneous adipose tissue and vastus lateralis muscle in panoramic B-mode Ultrasound Images. We believe that alongside models, there is also a need to release open-sourced tools that apply that model to unseen images and permit adjustments of ROI's for end-users. In addition, those tools should be user-friendly, well-documented, and have automated options for processing and compiling large datasets. While we are currently working on building models with larger datasets and adding more features to our GUIs, here we release our model, images, and GUI's built in MATLAB for researchers to implement assessments of ultrasound with ease. Our hope is that researchers will utilize these tools and contribute images to build larger models. We are happy to help you get up and running if you run into issues. Feel free to reach out!

McKenzie S. White
Email: kenzieswhite@gmail.com

Arimitsu Horikawa-Strakovsky
Email: arimitsu0803@gmail.com

Data Export from Ultrasound Unit: Your images contain important information that is necessary to convert pixel to physical dimensions (e.g., pixel to centimeter conversion). As such, we suggest exporting your images as dicoms directly from the ultrasound unit. Some labs we have worked with have images in tif, jpg, or png files. The downside to dicoms, is that it takes longer to read dicom files in the GUI but it contains the resolution information we need. The downside to tif, jpg, or png files is that it does not contain the resolution information we need but is quickly read by the GUI. To overcome these hurdles, we offer the following 2 GUI's:

1) VL_CSA_DICOM = Reading the dicoms directly
2) VL_CSA_DICOM_to_TIF = A function to convert dicoms to tif files while saving the resolution directly from the header so the GUI will read the tif files while maintaining the necessary information on an image by image basis*
3) VL_CSA_MANUAL = Read tif/jpg/png files but requires a csv file with resolution per image

*Indicates this is what we suggest as it is faster and saves the info we need

Regardless of the option the file structure of your data should be as follows so you can select the study you want to process and all of the subjects for that study will populate in the GUI

Data
- StudyName_A
  - Study_A_Subject001
    - Subject001_R_VL_CSA_1.dcm
    - Subject001_R_VL_CSA_2.dcm
    - Subject001_L_VL_CSA_1.dcm
    - Subject001_L_VL_CSA_2.dcm
  - Study_A_Subject002
    - Subject001_R_VL_CSA_2.dcm
    - Subject001_L_VL_CSA_1.dcm
- StudyName_B
  - Study_B_Subject001
    - Subject001_R_VL_CSA_2.dcm
    - Subject001_L_VL_CSA_1.dcm
  - Study_B_Subject002
    - Subject001_R_VL_CSA_2.dcm
    - Subject001_L_VL_CSA_1.dcm

Getting Started

1) Installation
    a. Download the Github repo
        i. For DICOM version: Double click on DCM_GUI\compiled\VL_CSA_AI\for_redistribution\MyAppInstaller_web.exe
        ii. For DICOM2TIF version: Double click on DCM2TIF_GUI\compiled\VL_CSA_AI\for_redistribution\MyAppInstaller_web.exe
2) Organize Data
    a. If using dcms GUI, you don't really need to do anything unless you want to rename your dcm files.
    b. If using the tif GUI, you have 2 options
        i. Open the GUI and click the button convert dcms and choose the folder with raw dicoms in it
        ii. If you want more flexibility, you can also open matlab and run the code to convert dcms to tif files. The code is called step1_convert_dcms_to_tif.m
            1. To run this code, update lines 6-10 with the study name, main data path, path to dcms, and choose whether to convert dcms to tif for all subjects or only specific subject IDs
            2. Note:
                a. These will create a new folder called 'img_files'
                b. No dicoms are deleted
                c. Original dicom names with new tif file names are saved into each mat file and the study log file

MAIN GUI USAGE

MATLAB Application Info

Built in 2023b and requires Image Processing and Deep Learning Toolboxes

Load Data:

a. Choose Study Folder
    c. DCM GUI: Choose folder with raw dcms
    d. TIF GUI: Choose folder that was created above labeled img_files

Step 1: Apply Model

Choose to apply model to all images in the study folder, to all images in the select subject, or to a single image.

This step will make the model predictions and save the model predictions

Step 2 (optional)

You can apply filters for the selected image to determine how well the model predicted

Step 3: Choose if you want to use the model predictions, adjust model predictions, or start over (manually draw ROIs)

By default, using model predictions will be automatically chosen once you apply the model.

If you choose to keep model predictions, they are saved with “model_roi_” and “model_roi_subq_” prefixes

If you choose to adjust model predictions, the originals will stay saved, and the ROI’s will appear automatically for adjusting. Once you hit accept and save ROI’s, those ROI’s will be saved with “roi_” and “roi_subq_” prefixes

Note, the draw button will clear all model predictions and roi’s and you will need to draw each ROI again.

There are viewing options as well, so you can view the model predictions vs. your ROI. When the image is processed, the comparison between the model and final ROI will also be performed so you have an idea of how well the model performed by itself relative to ground truth. In the future, we will provide code to update the model based on your ground truth data.

Step 4: Process and Compile Options

There are user friendly options to process a single image, single subject, all subjects and/or to skip images that have already been processed. This is for ease of use and efficiency. For example, once the predictions are made and checked, they are saved automatically so instead of having to process image by image, you can draw the roi and go to the next image and then process and compile all data at once.

Processing the data will make the CSA, EI (corrected and uncorrected), and subq thickness measurements.

Compiling the data will save all processed data to a spreadsheet.