Test utility & ImageJ-macro for ribcage suppression.

1. The Introduction

This package consists of ImageJ-macro & Win64-binaries".

1.1. Objective constraints

1.1a) Adult person's radiography by Flat Panel Detector ~43x43cm of 2999x2999..3999x3999pix (pixel_pitch 0.13-0.16mm). It excludes children, oldies & the most of invalids.

1.1b) MTF($1.5_{1/mm}$)>0.5; MTF($F_{Nyquist}$)<0.05; DQE($0_{1/mm}$)>0.66 (when measured in accordance with IEC62220-1).

It excludes older GadOx TFT FPDs of ~3072x3072pix (from manufacturing lines equipped ~< year 2019).

1.1c) Industry-standard diagnostic image-format 16 bit/pix with >=12 significant bits from ADC. It excludes (though doesn't prohibit) most of images <implicitly> prepared/assumed for fixed presentation in sRGB (e.g. "internet" images' formats). <Formally> process might allow 8bit/pix (with collateral damages by pixellation and cut darkest & brightest tones).

1.1d) OS Windows ~XP..11 (7 & 10 verified). CPU supporting AVX2.

1.2. Reasons of the constraints

The algorithms behind this utility refer ~earlier 1980th, when an anti-aircraft missile targeted by couple of geterodynes and a cruise missile without a CPU recognized rail-roads on video. Here are just hard-coded algebraic filters. The whole projects' code amount is <5000 lines (linking against C-language RTL and few Windows APIs). By subjective estimation this is ~3000 times shorter than code's amount (if count by the same metric) of a project using nowadays "MTANN" or ~500 times shorter than older "convolution networks".

Drawbacks of the simplicity are:

- the reason of "1.1a)":

Statistical determination of posteriors' arcs and anteriors' convexes refers expecting ribs' width as cardinal const 99pix (this doesn't suit for smaller pixel_pitch of high-end FPDs).

- the reason of "1.1b)":

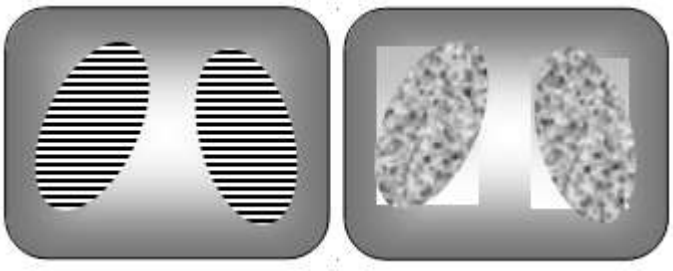
The difficulty for Radon's laplacians is to determine lungs' areas globally (it needs good dynamic range of signal to distinguish lungs' cupolas by ~thresholds). Standard & robust alternate approach is application of "active contours" for "Pavlidis' contours". Other alternate approach is User Interface for areas' selection (which will not work in single-click however). Both alternate approaches have less cognitive interest and need more debug than conceptually-plain Radon's filters (both are beyond of time-budget of this freeware).

- the reason of "1.1c)":

Short "dynamic range" cuts darkest, brightest tones and causes pixellation.

1.3. The work-flow

stage 1) As preliminary training, a radiographer comprehends (by a relevant data-series) how the process' options below eliminate specific encumbering images' entities.



stage 2) If an image (that fits "1.1a)") contains specific encumbering entities then radiographer might optimize visibility of important entities (empirically combining relevant process' options). The target is not to completely remove RibCage but to reduce one (until risk to kill important entities). Shadow frames around the lungs (not too prominent but easily visible on optimized image) explicitly indicate changed areas. If you can't distinguish shadow frames around lungs then calibrate display's presentation of sRGB.

stage 3) The radiographer might consider optimized image with smaller zoom and lesser fatigue, then refer suspicious areas (if are) in original image.

2. Brief description

2.1. The process' options

The options below preserve certain *shapes* of Radon's laplacians:

2.1a) *Arc* (intercostal posteriors).

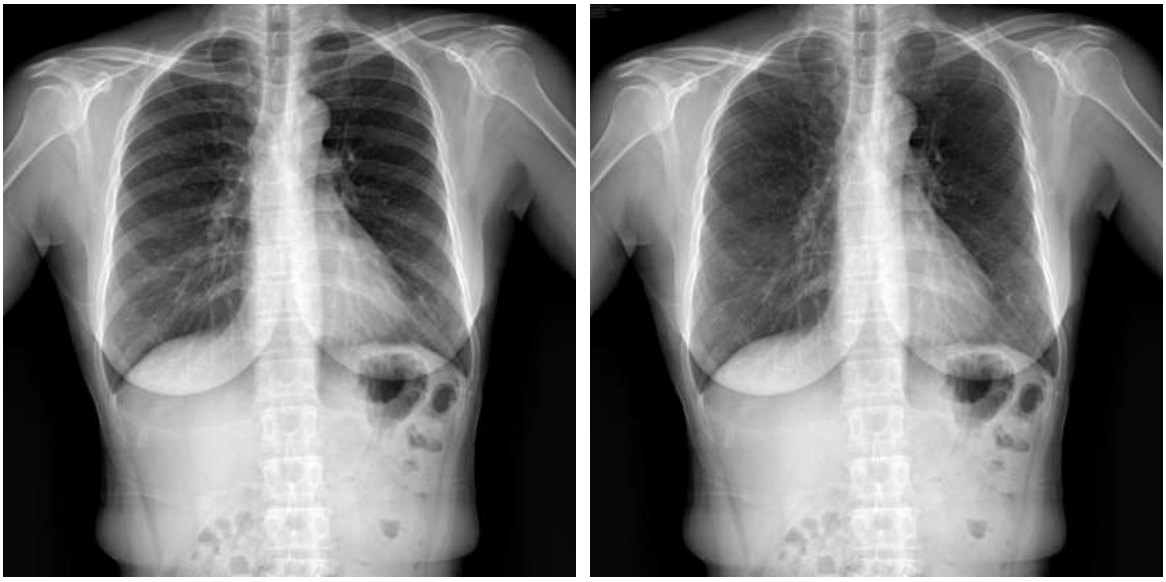
2.1b) *Concave* (clavicle,anteriors).

Drawback of the simplicity: despite intuitive expectation, option "2.1b)" rarely distinguishes weak anteriors but rather subtracts clavicle (having opposite curvature against statistically-dominating posteriors).

2.1c) Strength (subtract multiplied laplacians): 0:min, 8:default, 15:max.

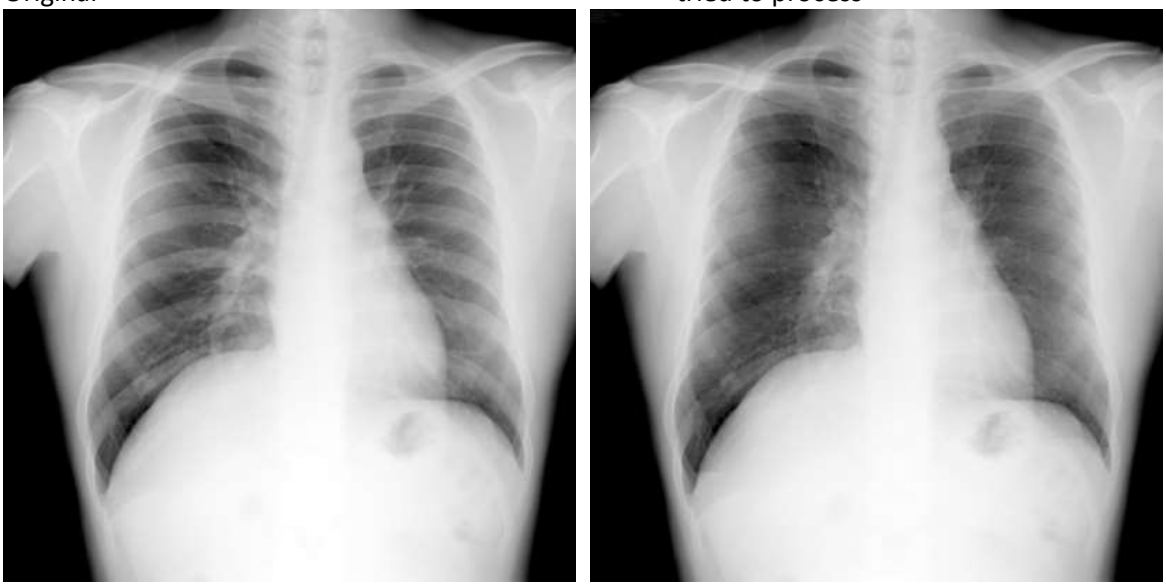
2.2. Working "Example0.DCM" (~recent TFT FPD, CSI, 43x43cm, 3268x3268)

Original Processed



2.3. Non-working "Example1.DCM" (older TFT FPD, GadOx, 43x43cm, 3268x3268)

Original tried to process



It doesn't match "1.1b)" (then global area's detection on right lung fails miserably). By menu "Analyze>Plot Profile" in ImageJ one could ensure that lungs' cupolas are far less prominent here against "Example0" (DQE($0_{1/mm}$) here is too small).

3. Detailed description

3.1. Install ~recent ImageJ's release

I wrote the macro-script with recent deployment archive in “`https://imagej.nih.gov/ij/download.html`“ (1.53k for Java SDK 1.80, Windows 64). I don't know which earliest ImageJ's release suits today’s built-in macros. Fortunately, refresh or recent ImageJ is easy:

step 1) Locate existing ImageJ’s directory (let's call it as "`C:\Program Files\ImageJ\`").

step 2) Rename that directory as "`C:\Program Files\ImageJ.1\`".

step 3) Download and decompress recent ImageJ's deployment archive as "`C:\Program Files\ImageJ\`".

step 4) Ensure that old desktop's shortcuts to ImageJ (if such ones exist) work.

3.2. Deploy the utility to hard-disk

Decompress deployment archive as "`C:\ImageJRibCage\`". The directory is fixed in macro-script. If you misprint the name then macro-script displays additional dialog (when locating exe). To remove this stuff (completely from the computer; in a future) just delete decompressed directory.

3.3. Initial demo-run

step 1) Start ImageJ. Click "Plugins>Macros/Edit" and browse for "`C:\ImageJRibCage\RibCage.ijm`". Macros-window (titled "RibCage.ijm") with macro-script appears.

step 2a) Open "`C:\ImageJRibCage\Example0.DCM`".

step 2b) Click "Macros>Run Macro" in menu of the macros-window. In appearing dialog-box click [OK]. Wait 5..30s. Consider new image-window (titled "$3268x3268.raw").

step 3) Repeat step2) for "`C:\ImageJRibCage\Example1.DCM`". It incorrectly detects right lung's area (left on the image).

3.4. Possible options' test

step 1) Associate extension "`.ijm`" with ImageJ (if ~AdobeAcrobat already caught extension ".ljm" then substitute "click on RibCage.ljm" by clicks on menu-items).

step 2) Run ImageJ and open a chest-radiography (within constraints "**1.1**").

step 3) In Windows-explorer click on "`C:\ImageJRibCage\RibCage.ijm`". In appearing dialog-box set "Strenght"~"15", "Suffix" ~ "F" then click [OK].