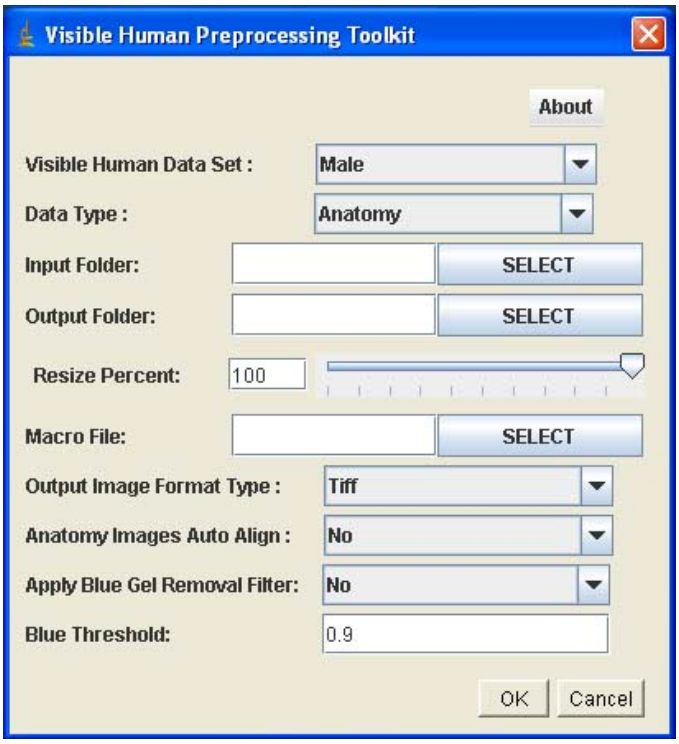
Visible Human Preprocessing Toolkit (v1.0) For ImageJ



When we started working with images from the Visible Human Project, we became aware that the pre-processing of the anatomical images (eliminating the blue gel, centering the images, eliminating labels) presented a set of unique challenges. The Visible Human Preprocessing Toolkit was created to provide a fast, easy, cross-platform set of tools for pre-processing Visible Human Project images using ImageJ. We hope this approach will facilitate access to Visible Human images by non-programmers.

The Toolkit allows the user to read and process both male and female data sets, which consist of anatomical (2048 pixels x 1216 pixels), CT and MRI images in raw format. It cannot be used (yet) for the higher resolution images (4096 pixels x 2700 pixels). Once the files are read, they can be processed in multiple ways. The Toolkit specifically includes a Blue Gel Removal tool, applicable to both male and female anatomical datasets, and an Align Feature which will align images in the male anatomical dataset. With the Toolkit, the user can also apply macros generated with ImageJ macro functions to the set of original raw images. After doing the pre-processing, this application allows you to save images in any of a variety of formats and sizes.

Install:

1. Download Imagej from http://rsb.info.nih.gov/ij/

2. Download the Visible_Human_Toolkit.jar from ******* and place it in the ImageJ→Plugins→Filters folder.

3. Start ImageJ

4. In ImageJ, go to Plugins→Filters. A filter labeled Visible Human Preprocessing Toolkit should be available. Select the filter and start working with the application.

User's Guide and Features:

Before you begin:

- In order to use the Visible Human Data sets you need to first uncompress the images. You will end up with a set of images in raw format.

- In case you decide to stop processing of images by the Toolkit once started, just press the Esc key.

About:

CIAR… : This is a link to our website. Learn more about the Center for Information Architecture in Research at the University of Puerto Rico Medical Sciences Campus

VHP Preprocessing Toolkit: Author, Version and Mission

Visible Human Data Set Selection:

The data sets provided by the Visible Human Project are divided into two mayor groups: the male and female datasets. Each set has its own characteristics. These characteristics are particularly important when applying the Blue Gel Removal Filter (for anatomical datasets) and the Images Auto Align feature (for anatomical Male VHP images only). If the wrong set is selected an error will occur. To select the desired dataset use the Visible Human Data Set drop box and choose either Male or Female.

Data Type:

There are three image subsets in the Male and Female datasets: Anatomy, CT and MRI. Each of these image types has distinctive characteristics. These characteristics have been taken into consideration when creating the application. The user may choose between Anatomy, CT and MRI images.

Input Folder:

Visible Human Project images are organized into different folders. This enables the user to work with either the full data set or a subset. To select the input folder where the desired set is found, press the SELECT button. Then the user can navigate the file system and to choose the desired folder. Make sure that the files you choose are the correct ones. If you select an incorrect dataset (for example CT images when you actually want to pre-process anatomical images) the application will fail to open the data correctly.

Output Folder:

To choose the folder where the processed images will be stored, press the SELECT button and navigate the file system to choose the desired folder. Please take into account the size of the images to be created. Images could be very large depending on the original size of the images, the resize factor and the desired image output format. Make sure you have adequate disk space.

Resize Percent:

In order to perform computing-intensive operations such as 3D rendering without large memory requirements, a resize feature is included. As the name implies, the user can choose the size of the output image as a percent of the input image. The resize factor can be adjusted using the slide bar. We suggest that you experiment with your particular system and size of data to find out what is better for you. Remember that the smallest the image the lower the detail.

Macro File:

A nice feature of the ImageJ program is the Macro plugin. This feature allows users without any programming skills to design macros that they will use on particular images. In order to use this feature to process the raw images, first use ImageJ to import a VHP image (File→Import→Raw,

then select the image and click OK in the Import window). Once this is done, go to Plugins→Macros→Record. This will open a window that will create the macro for you by recording your actions on a particular image. For example, run the Sharpen process (Process→Sharpen) and then the Enhance Contrast process (Process→Enhance). In the recorder you should have the following:

run("Sharpen");
run("Enhance Contrast", "saturated=0.5");

Press the Create button on the Macro Recorder window and save the file with any name you wish (File→Save).

NOTE: Remove any Close or Open statements that you may have in the macro file, because this will interfere with the normal operation of the plug-in.

After you have created the macro, you may apply it to the Visible Human Project dataset of your choice. Just choose the Visible Human dataset; data type; input and output folders; and resize percent. Then press the SELECT button for the Macro File feature, and navigate your file system to choose the macro file.

In ImageJ, it is possible to run a macro on a stack of images. However, all images have to be loaded as a stack into memory, creating potential problems with available memory size. To overcome this problem, the Toolkit Macro function will process a series of images in the dataset of your choice one image at a time.

Output Image Format Type:

You may elect to save the image processed images in a number of different formats: TIFF, 8-bit TIFF, JPEG, BMP or RAW. This is done by selecting in the drop box the desired option. To open an un-resized raw saved image using ImageJ go to ImageJ→Import→Raw… and set the following values.

Image Type: 24-bit RGB
Width: 2048
Height: 1216
Offset to First Image: 0
Number of Images: 1
Gap Between Images: 0

Leave unchecked: White is Zero, Little-Endian Byte Order, Open All Files in Folder.

Anatomy Images Auto Align:

The anatomy images in the Male anatomical dataset are not perfectly aligned. In order to align the images, we created an image-specific pixel displacement array. It consists of the X and Y pixel displacement values of the images in the Male data set. The values were generated with other software using as reference mainly the fiducial rod embedded in the gel with the cadaver. Any values for alignment can be easily integrated into the program array. We appreciate any suggestions to improve the alignment values as well as any other features.

To use the Auto Align feature use the drop box and select “Yes”. Remember, this only works on Male anatomical images.

Apply Blue Gel Removal Filter and Blue Threshold:

The male and female cadavers were encased in a blue stabilizing gel that allowed more precise slicing. The anatomical images contain the cross sections of the cadavers surrounded by the blue gel, as well as additional image information. The Blue Gel Removal Filter was created to remove this irrelevant information from the images. Using the fact that there is little or no blue on the human body, an equation was utilized to remove the gel. The default Blue Removal Threshold is 0.9 but it can be adjusted to your particular needs. We find that this threshold is good enough for initial testing. Some artifacts may appear, but by varying the threshold you can reach your desired result. You may also elect to do the initial removal with the Toolkit, and then fine-tune the removal of any remaining blue artifacts using other tools.

To use the filter, select Yes in the in the Apply Blue Gel Removal Filter combo box, then type the Blue Threshold value in the field provided, or leave the default. Remember this will work only in the Male and Female anatomical images.

Contact information:

If you have any comments or questions, please contact

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ImageJ: Image Processing and Analysis in JAVA.

ImageJ is developed by Wayne Rasband at the Research Services Branch, NIH.
http://rsb.info.nih.gov/ij/

Batch Converter

Developed by Wayne Rasband, NIH
Converts a folder of images in any format supported by ImageJ's Open command (Tiff, Jpeg, Gif, bmp, DICOM, FITS) into Tiff, 8-bit Tiff, Jpeg, Zip or Raw.
http://rsb.info.nih.gov/ij/plugins/batch-converter.html

RGB Recolor
Developed by Kieran Holland

This plugin allows linear alteration of the colors in the red, green and blue planes of an RGB image or stack. It provided the basis for the RGB image manipulation used for the gel removal feature. http://rsb.info.nih.gov/ij/plugins/recolor.html

Volume Rendering of the Photographic Visible Human Data Set
Steven Matuszek, MS

This paper provided the information for the equation to remove the blue gel.
http://matuszek.net/development/graphics/visible/

The Visible Human Project®
National Library of Medicine, NIH

The Visible Human Project is an outgrowth of the NLM's 1986 Long-Range Plan. It is the creation of complete, anatomically detailed, three-dimensional representations of the normal male and female human bodies. Acquisition of transverse CT, MR and cryosection images of representative male and female cadavers has been completed. The project is led by Michael J. Ackerman, PhD, Director, Office of High Performance Computing and Communications, Lister Hill National Center for Biomedical Communications, National Library of Medicine, NIH.
http://www.nlm.nih.gov/research/visible/visible_human.html

Melvin L. Spann, PhD
Associate Director, National Library of Medicine (Retired)

Mel is the person who originally encouraged us to work with the Visible Human Project Database. His advise and experience are always valuable sources of guidance for the development of our Center.

RCMI Program, University of Puerto Rico Medical Sciences Campus

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