DICOM image windowing

This live script demonstrates the use of windowing in DICOM images.

What is windowing and why we need it?

Medical images have a large number of gray levels. It is not uncommon for them to have four thousand or more levels.

Most computer screens, on the other hand, can display only 256 levels of gray. Even if a computer screen could display more gray levels, the human eye would not be able to distinguish them.

To get around these problems, medical images are displayed using windows, i.e. instead of mapping the large grayscale in the image linearly into the 256 gray levels supported by computer screens, specific ranges of the image grayscale are emphasized.

This article has a good explanation of the problem and demonstrations of how windowing solves it.

The next sections in the live script demonstrantes windowing with the MATLAB DICOM functions and MATLAB image processing functions.

DICOM image selection

Select a sample image from the MATLAB image toolbox or enter your own. The list of sample images is curent as of version R2020b.

To try your own images, select "(custom image)" and enter the path to the image below.

```
sample = "CT-MONO2-16-ankle.dcm"
```

```
sample =
"CT-MONO2-16-ankle.dcm"
```

If you selected "(custom image)", enter the full path to the image here, including the extension. Example: /Users/jsmith/images/dicomsample.dcm.

```
custom_image_path = "rqwrqw"
```

```
custom_image_path =
"rqwrqw"
```

Image information

Presss the button below once you selected an image in the section above.

Set a full file path, based on what was chosen above.

```
if sample == "(custom image)"
    filePath = custom_image_path;
```

```
else
    matlabSamples = fullfile(matlabroot,'toolbox/images/imdata/');
    filePath = strcat(matlabSamples, sample);
end

if ~isfile(filePath)
    fprintf("%s does not exist", filePath)
    return
end
```

Read the DICOM information and check if we have the correct image type.

```
info = dicominfo(filePath);

if info.ColorType ~= "grayscale"
    fprintf("Please select a grayscale image")
    return
end
```

Read the image.

```
image = dicomread(filePath);
minGrayLevel = min(image(:));
maxGrayLevel = max(image(:));
```

Display some pieces of information about the image.

```
fprintf("Study description: %s", info.StudyDescription)
```

```
Study description: RT ANKLE
```

```
fprintf("Width = %d, height = %d pixels", info.Width, info.Height)
```

```
Width = 512, height = 512 pixels
```

```
fprintf("Minimum pixel value = %d, maximum = %d", ...
    minGrayLevel, maxGrayLevel)
```

```
Minimum pixel value = 32, maximum = 4080
```

```
fprintf("Modality (acquiring equipment): %s", info.Modality)
```

```
Modality (acquiring equipment): CT
```

```
fprintf("Equipment manufacturer and model: %s, %s", ...
    info.Manufacturer, info.ManufacturerModelName)
```

```
Equipment manufacturer and model: GE MEDICAL SYSTEMS, GENESIS_ZEUS
```

Image histogram

The image histogram shows how the gray levels are distributed.

It is common for DICOM images to use dark colors (usually the lowest pixel value) as background. A histogram will show a large spike for that value, followed by signficantly smaller bars for the other values.

This imblance in the disitrbution may make it difficult to analyze the historgram. Change the minimum and maximum gray values shown in the histogram to analyze specific ranges of the grayscale used in the image.

```
minGrayToShow = 32
```

```
minGrayToShow = 32
```

```
maxGrayToShow = 2048
```

```
maxGrayToShow = 2048
```

```
figure
% histogram looks better than imhist imho
histogram(image)
xlim([minGrayToShow maxGrayToShow])
set(gca,'YScale','log')
```

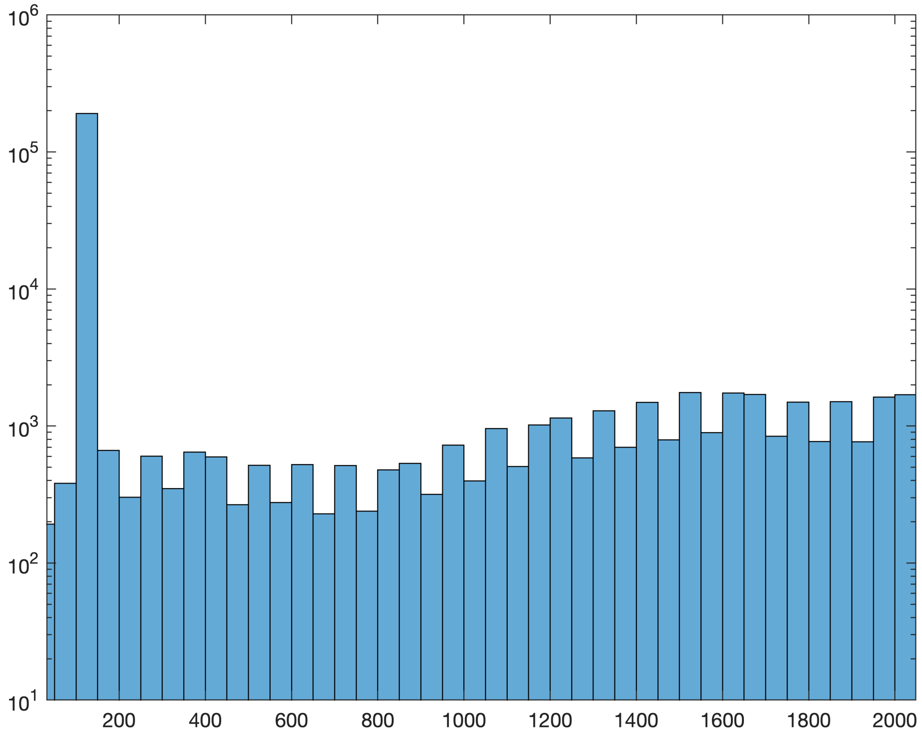

Image without windowing

This section shows the image wihtout using windowing.

Simply showing the image results in a linear mapping of the large grayscale to the 256 scale support by monitors. The result is usually not pleasant.

```
figure
imshow(image)
```

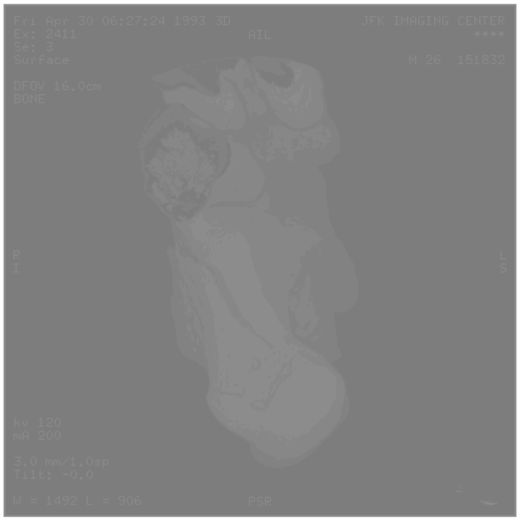

Image with automatic contrast adjustment

MATLAB has contrast-enhancing functions that result in better displayed images.

```
enhancement = "imadjust"
```

```
enhancement = 
"imadjust"
```

```
figure
imshow(feval(enhancement, image))
```

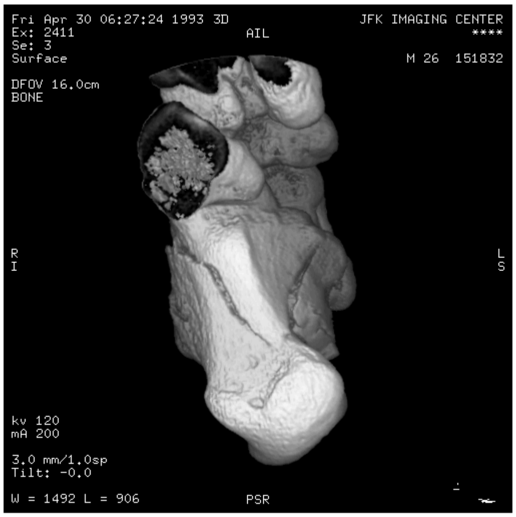

Image with the DICOM windowing parameters

This sections shows the image with the windowing values stored in the DICOM file.

```
fprintf("Window center = %d, width = %d", ...
    info.WindowCenter, info.WindowWidth)
```

```
Window center = 1024, width = 4095
```

old code

List all DICOM images

print pieces of info

- window center, width

```
% min_value = min(X(:))
% max_value = max(X(:))
% figure
% imhist(X)
% % https://www.mathworks.com/matlabcentral/answers/336138-how-can-i-properly-create-hi
% xlim([min_value max_value])
```

```
% figure
% imshow(X);
```