Understanding Images in Matlab

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1 Colormaps

A colormap is an $m \times 3$ array, each row of which contains the $[R\ G\ B]$ levels of an individual color using numbers in the range 0 to 1. For example, the row [1 0 0] represents red, [0 1 0] represents green and [0 0 1] represents blue, [1 1 1] represents white, [.5 .5 .5] represents medium gray and so on.

- **Using colormaps**

  The MATLAB statement colormap(M) installs the matrix M to be used as the colormap in the current Figure window.

- **Displaying colormaps**

  The pcolor function can be used to display a color map. For example, the statements

  ```
  >>c=[1 0 0]
  >>colormap(c)
  >>pcolor([1:2;1:2]')
  ```

  produce a figure consisting of one rectangle painted in red.

- **Built in colormaps**

  Matlab has a number of buit in colormaps, each one, by default is a 64×3 array. The one that most concerns us is the gray color map. It displays monochorme graphics ranging from black ([0 0 0]) to white ([1 1 1]) in 64 grades. To see the contents of the gray colormap type

  ```
  >>gray
  ```

  Other colormaps are hot, cool, winter, summer,.... These colormaps accept an integer argument m. For example, the statement

  ```
  >>hot(8)
  ```

  rescales the range of colors of the colormap hot into 8 colors instead of 64. To see these colors type

  ```
  >>colormap(hot(8))
  >>pcolor([1:9;1:9])
  ```

2 Images

Images are displayed using two statements: image() and imagesc(). We will get familiar with these statements in what follows. An image in Matlab is a data matrix that contains information about the pixels in the image. Usually a colormap is needed to display an image. There are three types of image data matrices: indexed images, intensity images and RGB images.

1. *Indexed images*: If an image is represented by a matrix X in indexed mode, then the element X_{ij} represents the color of the pixel P_{ij} as an index into the colormap. For example, if $X_{ij} = k$, then the color of pixel P_{ij} is the color represented by row k of the color map cmap. This means that the values in the matrix X must be integer values in the range [1 length(cmap)].

2. *Intensity images*: This type is usually used in monochormatic displays, e.g. gray colormap. Data in the matrix X do not have to be of any specific numerical type and they are rescaled over a given range and the result is used to index into the colormap.

   For example, the statements

   ```
   >>imagesc(X, [0 1]); colormap(gray)
   ```

   assigns the smallest value 0 to the first color (black) and the last value 1 to the last color (white). Values in X are then used to obtain an index into the color map by proportionality. If scale is omitted, its default is [min(min(X)), max(max(X))].

3. *True colot or RGB* images are created from $m \times n \times 3$ arrays containing RGB triples. So $X\,(i, j, :)$ contains the RGB values that specify the color of pixel P_{ij}. In this case no colormap is needed. To display such an image we use

   ```
   >> image(X)
   ```

The following examples should make the above discussion clear.

```
>> load clown                          %load a file called clown.mat (the image)
>> who                                 %determine the variables associated with
                                       clown
X      caption      map
>> size(X)                             %determine the size of X
200     320                            (this means that clown is indexed)
>>X(20,160)
77                                     (the color of pixel (20,160) in the clown
                                       image is map(77,:))
>>map(77,:)
.9961     .8672     .7031              (a whitish color)
>>image(X);colormap(map)               %display the image of the clown using the
                                       colormap "map"
>>colormap(gray)                       %cahnge the colormap to black and white.
```

2.1 Image Files

Image data can be saved to files and reloaded into Matlab using the save load commands. For example, if you've created an image data matris X use

```
>>save myimage.mat    X
```

to save it. If you've created a nonstandard colormap (say "map") use

```
>>save myimage.mat    X    map
```

to save the colormap. To reload your image, use

```
>>load myimage
```

If no colormap was saved, the current colormap is used.

Matlab also supports several industry standard image file formats using the "imread" and imwrite "functions". Information about the contents of a graphics file can be obtained using the "imfinfo" function. These three image functions support the formats: bmp, hdf, jpg (or jpeg), pcx, tif (or tiff), xwd.

The calling syntax for imread is the following.

```
[X, map]=imread('filename','fmt')    for indexed images
X=imread('filename','fmt')    for intensity images or truecolor images
```

Following are some examples

```
>> J = imread('cat.jpg');                      %read truecolor image data from a JPEG file
>> [X, map] = imread('icon.bmp','bmp')         %read bitmap image and colormap
>> G = imread('grayday','tiff')                %read grayscale intensity image
>> [H, hmap] = imread('hootie.ras','hdf')      %read hdf image and colormap
```

The calling syntax for imwrite is the following

imwrite(X,map,'filname','fmt')   for writing an image X and its associated colormap map into a file named filename

imwrite(X,'filname','fmt')   for writing intensity images or truecolor image in X into filename.