Volume : 4 | Issue : 11 | November 2015 • ISSN No 2277 - 8179

Research Paper

Matlab as a Tool in Image Processing

Engineering

KEYWORDS : Matlab, image processing, graphics,graphical user interface, digital filters, colormap, image processing toolbox.

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ABSTRACT

The world of the computer graphics is evolving rapidly every day. The market is full of image processing applications. But how many of them really contribute to the growth of the science and technology? Is there any program that combines image processing functionalities with programming techniques ? The answer to these questions is Matlab. Matlab is a software that provides a high level programming language, many thematic libraries and easy implementable Graphic User Interface mechanisms. This paper presents information on wide aspects of the computer graphics, introduction to Matlab and its Image Processing Toolbox. Later, it focuses on GUI as a GUIDE tool. All theoretical studies are followed by an implementation of an image processing application. A very important step of software production is testing. Few examples of test scenarios along with short descriptions are listed in the final part of this paper. Solutions presented in this paper leaves an open door for the future development.

INTRODUCTION

Every single day world is evolving very fast. Rapid development of the computer technology has affected all the scientific areas. Medicine, automation, data analysis, finances, biology, chemistry, economics and many, many more have benefited from the technology expansion. In the same time programmers were working on designing a system, that would perform operations on vectors and matrixes in a simple, interactive way. Not long time after creating Matlab, it became very popular, especially among teaching facilities. Many libraries has been developed, among them Image Processing Toolbox. No program works better with using for example morphological transformation than Matlab. It also gives a lot of possibilities for creating linear and nonlinear filters. High level programming language that hides unnecessary details from designers can definitely be considered as an asset too. In order to decide if Matlab is the right tool to implement a software with, the future programmer has to take a closer look on the main purpose of the application.The purpose of this paper is to show some typical examples from this field where the applications can be useful.Paper demonstrate the ability of Matlab to have a 'regular' image processing functionality as well.

IMAGE PROCESSING

Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The *acquisition* of images (producing the input image in the first place) is referred to as imaging.

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digtal signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form ofm multidimensional systems.

Image processing refers to processing of a 2D picture by a computer. Basic definitions:

An image is defined in the "real world" is considered to be a function of two real variables, for example, a(x,y) with a as the amplitude (e.g. brightness) of the image at the real coordinate position (x,y).

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers. The goal of this manipulation can be divided into three categories:

- Image Processing (image in -> image out)
- Image Analysis (image in -> measurements out)
- Image Understanding (image in -> high-level description out)

WHAT EXACTLY IS MATLAB?

The name 'Matlab' comes from two words: matrix and laboratory. According to The MathWorks (producer of Matlab), Matlab is a technical computing language used mostly for high-performance numeric calculations and visualization. It integrates computing, programming, signal processing and graphics in easy to use environment, in which problems and solutions can be expressed with mathematical notation. Basic data element is an array, which allows for computing difficult mathematical formulas, which can be found mostly in linear algebra. Most important feature of Matlab is easy extensibility.

MATLAB "GUIDE" TOOL

User friendly graphical interface

Matlab provides a helpful tool called 'GUIDE'. After typing guide into Matlab's command line, a quick start window appears. From the choice of exemplary positions it is recommended to pick 'Blank GUI'. In the new window it is possible to drag and drop each object into the area of the program. On the left side of the created figure there is a list of possible components. The list includes a push button, slider, axes, static and edit texts.

Components of GUI:

α. Common knowledge
β. Buttons and sliders
χ. Axes

DESIGN AND IMPLEMENTATION OF AN IMAGE PROCESSING APPLICATION USING MATLAB AS A TOOL

1.Designing the window

Matlab will help in creating the program on the computer. After typing guide command, the choice window appears. To start designing from the beginning, a blank GUI should be selected.

a. Menu File

Menu item 'File' contains five elements, which are: Open, Save, Save with compression, Info about the file and Exit. It is necessary to change each element's label and tag property. The reason is enabling easier maintenance within the components. Also setting the 'Accelerator' field will make the application more familiar to users.

b. Menu Transformations

Transformations' menu heading will allow a user to rotate, flip and crop the image. There are two options for the rotation angle – 90 degrees clockwise and 90 degrees counterclockwise. It will be available to flip the picture either vertically or horizontally, however, this option will become enabled only if the picture is

Volume : 4 | Issue : 11 | November 2015 • ISSN No 2277 - 8179

black&white or in grayscale.

c. Menu Filters and Help
Two headings considered in this paragraph are 'Filters' and 'Help'. First one includes three different ways to blur an image, sharpening, adding and removing noise along with circulating effect of the picture. Next option is a histogram equalization and correction of contrast. It is also possible to convert a color picture into the grayscale or make it a bitmap. Last main menu item is 'Help'. It is not that important for the application to work but often users want to know facts about the program, the author and how it actually works.

2 . General rules of coding
After creating the graphical user interface it is time to connect it with Matlab functions. There are two ways of doing it: the first one demands from a programmer coding in .m file, where he has to create all the components. Function uigetfile allows selecting the file from the computer. Command srtcat connects the name of the file with its path. This brings the possibility of using imread to load the picture. Later on imshow presents the image and all the changes in GUI are updated with guidata command.

3. Testing new application
The next and final step on the way of creating a new application is testing. This stage is very important. It helps to find mistakes or malfunctions of the program.

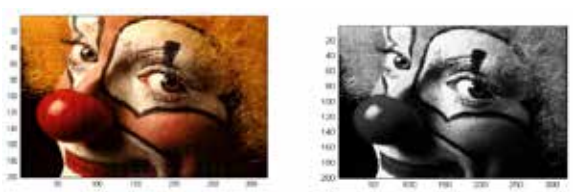

Figure 1: Transformation from color to grayscale

Figure 2:Removal of the noise for the grayscale picture

Aspects of image processing
It is convenient to subdivide different image processing algorithms into broad subclasses. There are different algorithms for different tasks and problems, and often we would like to distinguish the nature of the task at hand.

Image enhancement. This refers to processing an image so that the result is more suitable for a particular application. Example include:

- sharpening or de-blurring an out of focus image,
- highlighting edges,
- improving image contrast, or brightening an image,
- removing noise.

Image restoration. This may be considered as reversing the damage done to an image by a known cause, for example:

- removing of blur caused by linear motion,
- removal of optical distortions,
- removing periodic interference.

Image segmentation. This involves subdividing an image into constituent parts, or isolating certain aspects of an image:

- finding lines, circles, or particular shapes in an image,
- in an aerial photograph, identifying cars, trees, buildings, or roads.

IMAGE PROCESSING: APPLICATIONS AND ITS IMPORTANCE
The field of digital image processing has experienced continuous and significant expansion in recent years. The advances and wide availability of image processing hardware as further enhanced the usefulness of image processing.

Image processing has an enormous range of applications; almost every area of science and technology can make use of image processing methods. Here is a short list just to give some indication of the range of image processing applications.

1. Medicine
- Inspection and interpretation of images obtained from X-rays, MRI or CAT scans,
- analysis of cell images, of chromosome karyotypes.

2. Agriculture
- Satellite/aerial views of land, for example to determine how much land is being used for different purposes, or to investigate the suitability of different regions for different crops,
- inspection of fruit and vegetablesdistinguishing good and fresh produce from old.

3. Industry
- Automatic inspection of items on a production line,
- inspection of paper samples,
- digital cinema

4. Law enforcement
- Fingerprint analysis,
- sharpening or de-blurring of speed-camera images.

5. Communication
- remote sensing
- facsimile

6. other applications include:
• multidimensional image processing
• image processing architectures and workstations
• video processing
• programmable DSPs for video coding
• high-resolution display
• high-quality color representation
• super-high-definition image processing
• impact of standardization on image processing.

XRAY IMAGING USING PSEUDO COLORING MATLAB
Samples with the same color or appearance in the visible region of the electromagnetic spectrum , which are therefore indistinguishable to the Human eye, can have different properties in other parts of the spectrum. Basically, the reflectance or transmittance spectra of these samples are expected to be similar in the visible region, but can differ in other regions.

Pseudo coloring comprises of assigning colors to gray values based on a specific criterion. The term Pseudo color or false

color is used to differentiate the process of assigning colors to monochrome images from the process associated with true color images. The first and foremost use of pseudo color is for human visualization and Interpretation of gray scale events in an image or sequent of images. The Principal cause of using color is the fact that humans can discern thousands if color shades and intensities, compared to only two dozen or shades of gray.

For example :

RAINBOW COLORMAP:

This color map (LUT) is applied to the original grayscale image to obtain pseudo colored output image.

MATLAB coding for rainbow (LUT) :

```
%This program uses cosine function to produce rainbow color coding.

clear all
% getting the image from the file
[ fname,pname]=uigetfile('*.jpg','Browse to...');
im=imread( fname);
figure,imshow(im);
img=rgb2gry(im);
figure,imshow(img);
% deletes the xtra black space around the image
% img = trimimage(img);
% intensity adjustment
mmax=max(max(img));
mmax=double(mmax)/255 ;
img1 = imadjust(img,[0 mmax],[0 1]);
figure,imshow(img1);
% histogram of the image
% figure, imhist(img1,64)
[r,c]=size(img1);
% h = waitbar(0,'Processing...');
level=input('Enter the number of COLOR levels:');
for i=1:level
map(i,1)=(1+cos((4*pi*double(i))/(3*255)))/2;
map(i,2)=(1+cos((4*pi*double(i)/(3*255))-(2*pi/3)))/2;
map(i,3)=(1+cos((4*pi*double(i)/(3*255))-(4*pi/3)))/2;
end
figure,imshow(img1)
colormap(map)
```

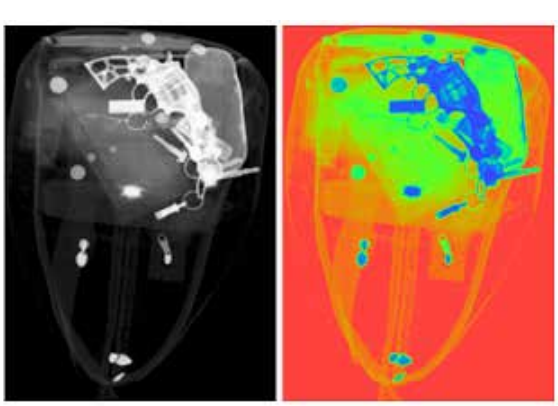

Figure 5. Input x-ray image followed by the output obtained by applying rainbow LUT

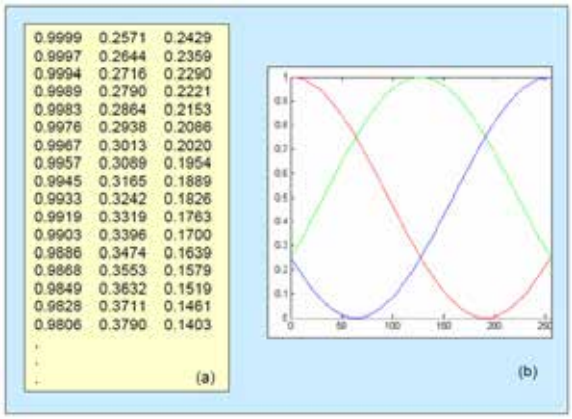

Figure 6. (a) Sample look up table and (b) the values from the table plotted into R, G and B .Only the most prominent color map (rainbow) is listed here.

CONCLUSION:

The study about MATLAB as a tool in Image Processing reveals that Matlab is not only good for complicated and complex mathematical drawings but also provides a broad collection of regular image processing functions. Of course it is great for medical image transformations and recognition,as shown in the paper by XRAY imaging using pseudo coloring MATLAB , but that is not all. Many programmers do not realize the full potential of Matlab and the Graphical User Interface guide tool that it provides. Advances in satellite, medical, hyperspectral, and other imaging systems are producing bigger and more numerous images than ever before. Recent enhancements to MATLAB and Image Processing Toolbox address the challenges, with image processing speed increased in some cases by orders of magnitude. Despite the outcome of my paper, including the image processing application, the topic stays open to the future modifications and development. There are many possibilities for the future development of the application created within this paper. Matlab is a powerful tool that provides with multiple methods and techniques required for building even very complex programs. The functionality and the design are limited only by the programmer's imagination. But is there a place for a Matlab-created image processing application among many free software that already exist ? It is hard to answer that question one way. As any other program, Matlab has its advantages and disadvantages. It depends strictly on the purpose for the new software. In my opinion basic image processing – maybe not, but anything more than simple transformations is eligible for Matlab environment. Especially when it is about complex modifications including using digital filters in the image enhancements.Overall, Matlab is developing very fast and it is becoming more and more popular among researchers. Maybe someday it will prevail in the computer software world? There is nothing left but wait and see what future will bring.

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