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Electrical, Electronic & Telecommunication Engineering

ET3112 – Image Processing and Machine Vision

Practical II - Simulation for Histogram generation

KDU Reg		Intake		Marks	

Objectives

By the end of this practical work, a student should be able to:

- Define Digital image and histograms.
- Understand the grayscale image.
- Explain the basics of image segmentation.
- Explain the thresholding theory.

I. Preliminary Reading

A. Brief Introduction to Histograms and Image Segmentation

A digital image is a two-dimensional function which can be represented as f(x,y). x and y are spatial coordinates. The amplitude of the smallest unit in the digital image (pixel) is called intensity or grey level.

A histogram is a graphical representation of the distribution of data. It is a bar graph that shows the number of data points that fall within a certain range of values. Histograms are often used to visualize the distribution of continuous data, such as height, weight, or temperature.

In image processing, a histogram is a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value and allows a viewer to judge the entire tonal distribution at a glance. Histograms are used to analyze an image and predict the properties of an image by the detailed study of the histogram.

Image segmentation which is used in various areas such as machine vision, medical image processing, object detection systems, traffic management systems etc. It is useful in simplifying and meaningful analyzing of the image. In addition, image segmentation is required for an efficient and valid transferring or storing of the image information.

Thresholding based image segmentation is the simplest and commonly used image segmentation method. It is based on the pixel value/ intensity level of the each pixel. Basically, thresholding is performed on gray scale images where the intensity levels of the pixels are in between 0 to 255 to obtain a binary image where the pixel values are either 0 or 1. The pixels in the gray scale image which are greater or equal to thresholding value are assigned to be 0 while all the other

pixels are assigned to be 1.

More than threshold value can be used where more categories are needed.

(A) (B)

Figure 1 : Difference between the original and thresholding based segmented image.

A – Original image (Standard MATLAB Lena) , B – Thresholding based segmented image

Figure 2: cameraman.tif

B. Basic Image Processing Functions in MATLAB

```
% Clear the workspace
clc;
clear all;

% Load the grayscale image
I = imread("cameraman.tif");

% Display the original image
imshow(I);
title('Original Image');

% Size of the image
N = size(I);
```

```
% Directly assign the grayscale image to A, since I is already grayscale
A = I;

% Find the global threshold of the grayscale image
Threshold = graythresh(A);

% Convert image to binary using the calculated threshold
bw = imbinarize(A, Threshold);

% Simultaneously display original and binary images
subplot(1, 2, 1), imshow(I), title('Original Image');
subplot(1, 2, 2), imshow(bw), title('Binary Image');

% Introduce width (i) and height (j) of the image
i = size(I, 1);
j = size(I, 2);

% Plot the histogram of the grayscale image
figure;
imhist(I);
title('Histogram of the Grayscale Image');
xlabel('Pixel Intensity');
ylabel('Number of Pixels');
```

C. Image Histogram (imhist) Implementation

An image histogram can be defined as the graphical representation of pixel intensity values in a digital image.

Matlab provides an predefined in-built function for plotting the image histogram i.e. imhist.

```
% Load the color image
X = imread("cameraman.tif"); % X is the Reference Image

% Add Gaussian noise to the image
Y = imnoise(X, 'gaussian', 0, 0.05); % Y is the Noisy Image

% Denoise the image using a median filter
Z = medfilt2(Y, [3, 3]); % Z is the Denoised Image

% Plotting the histogram of the Reference Image
histo = imhist(X);
plot(histo, '-r', 'LineWidth', 2); % Plot histogram of Reference Image
hold on;

% Plotting the histogram of the Denoised Image
histo1 = imhist(Z);
plot(histo1, '-b', 'LineWidth', 2); % Plot histogram of Denoised Image
hold off;

% Label the axes and add a legend and title
xlabel('Pixel Values');
ylabel('Number of Pixels');
legend('Reference Image', 'Denoised Image');
```

```
title('Histogram Plot of Reference Image and Denoised Image');
```

Topics for Self-study

1. Histograms

2. Image Segmentation

3. Thresholding based Segmentation

II. Preliminary Work

Try out the functions given in Preliminary Reading part B and observe the results.

III. Practical Work

Get the below Figure and test figure.

Figure 3 : Bellpeppers

1. Implementing a MATLAB code to segment the above figure 3 using MATLAB in-built function ‘’im2bw’.

- Follow the given instructions.

I. Clear the workspace.

II. Load the color figure 3.

III. Convert the image to grayscale.

IV. Plot the histogram of the image.
V. Find the global threshold of the image.
VI. Segment the image using MATLAB in-built function ‘’im2bw’.
VII. Sub-plot the original image, gray scale image and segmented image with titles.
VIII. Save the image as a JPEG image.

2. Implementing a customize MATLAB code to segment figure 3.

- Follow the given instructions.

I. Clear the workspace.
II. Load the colour figure 3.
III. Convert the image to grayscale.
IV. Plot the histogram of the image.
V. Get the peak of the histogram.
VI. Assign either ‘0’ or ‘1’ for each pixel using ‘if’ condition within a ‘for’ loops for the image size in x and y directions. Use the peak value of the histogram as the threshold.
VII. Sub-plot the original image, gray scale image and segmented image with titles.
VIII. Save the image as a JPEG image.

3. Segment the figure 3 using 2 threshold values.

I. Referring to code implemented in Q2, implement a code to segment the image using two threshold values.
II. Compare the segmented image with the segmented images in Q1 and Q2.