Addis Ababa University

Master's in Artificial Intelligence

Digital Image Processing (DIP) Laboratory Manual

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Environment: GNU Octave

Preface

This manual is prepared in a workbook style for AI Master's students at Addis Ababa University. It provides a hands-on introduction to Digital Image Processing using GNU Octave, covering basic to advanced topics. Each lab includes objectives, theoretical background, procedures, Octave code, checkpoints, try-it-yourself prompts, and collaborative assignments. The manual is intended to build foundational knowledge in Digital Image Processing and serve as a base for advanced studies in Computer Vision.

Chapter 3: Image Segmentation

Objective

To understand and implement basic image segmentation techniques using thresholding, edge detection, and region-based methods in GNU Octave.

1. What is Image Segmentation?

Description: Image segmentation is the process of partitioning an image into meaningful regions, typically to isolate objects or features.

2. Global Thresholding

2.1 Binary Segmentation using a Fixed Threshold

Code Snippet:

```
img = imread('cameraman.tif');
bw_img = img > 100;
imshow(bw_img);
title('Binary Image (Threshold = 100)');
```

Output Description: Displays a binary image separating brighter regions from darker ones based on a fixed threshold.

2.2 Otsu's Method for Adaptive Thresholding

Code Snippet:

```
level = graythresh(img);
bw_otsu = imbinarize(img, level);
imshow(bw_otsu);
title("Otsu's Thresholding");
```

Output Description: Automatically calculates an optimal threshold that separates foreground and background.

3. Edge-Based Segmentation

3.1 Sobel Edge Detection

Code Snippet:

```
edge_sobel = edge(img, 'sobel');
imshow(edge_sobel);
title('Sobel Edge Detection');
```

Output Description: Highlights edges in the image using the Sobel operator.

3.2 Canny Edge Detection

Code Snippet:

```
edge_canny = edge(img, 'canny');
imshow(edge_canny);
title('Canny Edge Detection');
```

Output Description: Detects edges with enhanced precision and noise reduction using the Canny method.

4. Region-Based Segmentation

4.1 Region Growing (Manual Seed Point)

Code Snippet:

```
pkg load image;
I = im2double(imread('coins.png'));
BW = im2bw(I, 0.4);
label = bwlabel(BW);
imshow(label, []);
title('Region Labels after Thresholding');
```

Output Description: Displays labeled regions in the thresholded image, demonstrating segmentation by grouping pixels.

5. Summary

- Thresholding is simple and fast for segmenting images based on intensity.
- Edge detection outlines object boundaries.
- Region growing groups pixels based on similarity and connectivity.

Suggested Exercises

1. Apply Otsu's thresholding to different test images.
2. Compare Sobel, Prewitt, and Canny edge detectors.
3. Create a region-growing algorithm with user-defined seed input.