20MCA24C DIGITAL IMAGE PROCESSING

UNIT IV - MORPHOLOGICAL IMAGE PROCESSING

FACULTY

Dr. K. ARTHI MCA, M.Phil., Ph.D.,

Assistant Professor,

Postgraduate Department of Computer Applications,

Government Arts College (Autonomous),

Coimbatore-641018.

UNIT IV

MORPHOLOGICAL IMAGE PROCESSING

_INTRODUCTION Morphology About the form and structure of animals and plants

Mathematical morphology Using set theory Extract image component

Representation and description of region shape

Sets in mathematical morphology represent objects in an image Example ◦ Binary image: the elements of a set is the coordinate (x,y) of the pixels, in Z2 ◦ Gray-level image: the element of a set is the triple, (x, y, gray-value), in Z3

OUTLINE Preliminaries – set theory Dilation and erosion Opening and closing

PRELIMINARIES – SET THEORY A be a set in Z2. a = (a1, a2) is an element of A. a is not an element of A Null (empty) set: Aa Aa

- SET OPERATIONS A is a subset of B: every element of A is an element of another set B Union Intersection Mutually exclusive BA BAC BAC BA
- GRAPHICAL EXAMPLES (CONT.) AwwAc BwAwwBA ,
- LOGIC OPERATIONS ON BINARY IMAGES Functionally complete operations AND, OR, NOT
- BA BA AB
- OUTLINE   Preliminaries   Dilation and erosion Opening and closing
- DILATION)ˆ(ABzBA z B:structuring element
- DILATION Dilation is one of the basic operation in mathematical morphology. Dilation adds the pixels to the Boundaries of an object in an image. Dilation process in which binary image is expanded from its original image. W B

- DILATION FORMULA, $f(x)\ h(s)=\max\{f(x)+h(s-x)\}$ f(x) original Image EXOR operation s Structuring pattern matching.
- DILATION EXAMPLE Original Image expanded Dilation
- EROSION □ □ABzBA z □ □)(z: displacement B:structuring element
- EROSION •Erosion is the Reverse process of the Dilation. •Erosion Remove the pixel on object boundaries. • B W
- EROSION FORMULA $f(x)\ h(s)=\min\{f(s+x)+h(x)\}$ f(x) original Image EXNOR operation s Structuring pattern matching.
- EROSION EXAMPLE Original Image EXNOR Erosion

- STRUCTURING ELEMENT □The number of pixel added or removed from the object in an image depends on the size and shape structuring element. •It's s matrix 1's and 0's. □The center pixel of the structuring element, called the origin.
- DILATION AND EROSION ARE DUALS
- APPLICATION: BOUNDARY EXTRACTION Extract boundary of a set A: First erode A (make A smaller) A – erode(A))(BAA)
- APPLICATION: BOUNDARY EXTRACTION Using 5x5 structuring element original image
- OUTLINE □ Preliminaries □ Dilation and erosion □ Opening and closing

- OPENING Dilation: expands image w.r.t structuring elements Erosion: shrink image erosion+dilation = original image Opening= erosion + dilation BBABA)
- OPENING (CONT.) Smooth the contour of an image, breaks narrow isthmuses, eliminates thin protrusions Find contour Fill in contour
- CLOSING Closing = dilation + erosion BBABA)
- CLOSING (CONT.) Find contour Fill in contour Smooth the object contour, fuse narrow breaks and long thin gulfs, eliminate small holes, and fill in gaps
- Noisy image opening Remove outer noise Remove inner noise closing

- Morphological Algorithms Using the simple technique we have looked at so far we can begin to consider some more interesting morphological algorithms We will look at: Boundary extraction
- Boundary Extraction Extracting the boundary (or outline) of an object is often extremely useful The boundary can be given simply as β(A) = A – (AB)
- Illustration
- Example A simple image and the result of performing boundary extraction using a square structuring element Original Image Extracted Boundary
- Conclusion Morphology is powerful set of tools for extracting features in an image We implement algorithms like Thinning thickening Skeletons etc. various purpose of image processing activities like segmentation.

- IMAGE SEGMENTATION
- Introduction to Image Segmentation The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application □ The segmentation is based on measurements taken from the image and might be grey level, colour, texture, depth or motion
- Introduction to Image Segmentation Usually image segmentation is an initial and vital step in a series of processes aimed at overall image understanding Applications of image segmentation include Identifying objects in a scene for object-based measurements such as size and shape Identifying objects in a moving scene for object-based video compression (MPEG4) Identifying objects which are at different distances from a sensor using depth measurements from a laser range finder enabling path planning for a mobile robots

- Introduction to Image Segmentation
- Example 1 Segmentation based on grey scale Very simple ‘model’ of greyscale leads to inaccuracies in object labelling
- Introduction to Image Segmentation
- Example 2 Segmentation based on texture Enables object surfaces with varying patterns of grey to be segmented
- Introduction to Image Segmentation
- Example 3 Segmentation based on motion The main difficulty of motion segmentation is that an intermediate step is required to (either implicitly or explicitly) estimate an optical flow field The segmentation must be based on this estimate and not, in general, the true flow

- Introduction to Image Segmentation
- Example 3 Segmentation based on depth This example shows a range image, obtained with a laser range finder A segmentation based on the range (the object distance from the sensor) is useful in guiding mobile robots
- Segmentation techniques
- Segmentation Techniques
- two very simple image segmentation techniques that are based on the greylevel histogram of an image Thresholding Clustering
- Segmentation Techniques
- A. THRESHOLDING One of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image.

- Segmentation Techniques
- THRESHOLDING TECHNIQUESE MEAN TECHNIQUE- This technique used the mean value of the pixels as the threshold value and works well in strict cases of the images that have approximately half to the pixels belonging to the objects and other half to the background
- . P-TILE TECHNIQUE- Uses knowledge about the area size of the desired object to the threshold an image.
- HISTOGRAM DEPENDENT TECHNIQUE (HDT)- separates the two homogonous region of the object and background of an image.
- EDGE MAXIMIZATION TECHNIQUE (EMT)- Used when there are more than one homogenous region in image or where there is a change of illumination between the object and its background.n
- VISUAL TECHNIQUE- Improve people's ability to accurately search for target items.

- Segmentation Techniques Threshold techniques from left to right original image, Vis technique T = 127, Mean Technique, P-Tile technique T = 127, I Technique and EMT Technique
- Segmentation Techniques T = 167 T = 43

- Segmentation Techniques
- A. CLUSTERING Defined as the process of identifying groups of similar image primitive.It is a process of organizing the objects into groups based on its attributes. An image can be grouped based on keyword (metadata) or its content (description) KEYWORD- Form of font which describes about the image keyword of an image refers to its different features CONTENT- Refers to shapes, textures or any other information that can be inherited from the image itself.

Segmentation APPROACHES

- Segmentation Approaches
- A.WATER BASED SEGMENTATIONSteps: 1. Derive surface image: A variance image is derived from each image layer. Centred at every pixel, a 3x3 moving window is used to derive its variance for that pixel. The surface image for watershed delineation is a weighted average of all variance images from all image layers. Equal weight is assumed in this study.

- Segmentation Approaches
- . Delineate watershed sFrom the surface image, pixels within a homogeneous region form a watershed3. Merge Segments Adjacent watershed may be merged to form a new segment with larger size according to their spectral similarity and a given generalization level
- Segmentation Approaches Initial Image Topographic Surface Final watersheds
- Segmentation Approaches Quick Bird multispectral satellite imagery was used.
- The image consisted of four bands, at the waves of blue, green, red and near infra-red.
- Segmentation Approaches
- Segmentation Approaches
- B. REGION-GROW APPROACH
- This approach relies on the homogeneity of spatially localized features
- It is a well-developed technique for image segmentation. It postulates that neighbouring pixels within the same region have similar intensity values. □
- The general idea of this method is to group pixels with the same or similar intensities to one region according to a given homogeneity criterion.
- Segmentation Approaches The region growing algorithm of the image which was shown on the next slide.

- Segmentation Approaches
- Segmentation result of region growing algorithm compared with other results like IV. Original Image V. Region growing based on algorithmVI. Mean Shift based on algorithm I II III
- Segmentation Approaches
- C. EDGE-BASED METHODS
- Edge-based methods center around contour detection: their weakness in connecting together broken contour lines make them, too, prone to failure in the presence of blurring.
- Segmentation Approaches
- D. EDGE-BASED METHODS
- Segmentation Approaches
- E. CONNECTIVITY-PRESERVING RELAXATION- BASED METHOD
- Referred as active contour model
- The main idea is to start with some initial boundary shape represented in the form of spline curves, and iteratively modify it by applying various shrink/expansion operations according to some energy function.
- Segmentation Approaches Partial Differential Equation (PDE) has been used for segmenting medical images active contour model (snake)

- • **Automatic thresholding** - To make segmentation more robust, the threshold should be automatically selected by the system. - Knowledge about the objects, the application, the environment should be used to choose the threshold automatically: * Intensity characteristics of the objects * Sizes of the objects * Fractions of an image occupied by the objects * Number of different types of objects appearing in an image
- Hysteresis thresholding - If there is no clear valley in the histogram of an image, it means that there are several background pixels that have similar gray level value with object pixels and vice versa. - Hystreresis thresholding (i.e., two thresholds, one at each side of the valley) can be used in this case. - Pixels above the high threshold are classified as object and below the low threshold as background. - Pixels between the low and high thresholds are classified as object only if they are adjacent to other object pixels.

- • Using prior knowledge: the P-Tile method - This method requires knowledge about the area or size of the objects present in the image - Let us assume that we have dark objects against a light background. - If, for example, the objects occupy p% of the image area, an appropriate threshold can be chosen by partitioning the histogram
- • Optimal thresholding - Suppose that an image contains only two principal regions (e.g., object and background) - We can minimize the number of misclassified pixels if we have some prior knowledge about the distributions of the gray level values that make up the object and the background. - Assume that the distribution of gray-level values in each region follows a Gaussian distribution

- - The probability of a pixel value is then given by the following mixture: P(z) = p(z/background) P(background) + p(z/object) P(object) or P(z) = Pb 1 √ b e − (z− b) 2 22 b + Po 1 √2 o e − (z− o) 2 22 o or P(z) = Pb pb (z) + Po po (z) pb (z), po (z), prob. distributions of background, object pixels b , o : the means of the distributions b , o : the standard deviations of the distributions Pb , Po : the a-priori probabilities of background, object pixel.
- Drawbacks of the Otsu's method - The method assumes that the histogram of the image is bimodal (i.e., two classes). - The method breaks down when the two classes are very unequal (i.e., the classes have very different sizes). * In this case, 2 B may have two maxima. * The correct maximum is not necessary the global one. * The selected threshold should correspond to a valley of the histogram. - The method does not work well with variable illumination.

- • Handling nonunform illumination: variable thresholding - In case of uneven illumination, another useful technique is to approximate the values of the image by a simple function (i.e., plane). - Thersholding can be done relative to the plane (e.g., points above the plane will be part of the object and anything below will be part of the background).

- • Drawbacks of thresholding - Pixels assigned to a single class need not form coherent regions as the spatial locations of pixels are completely ignored (Note: Only hysteresis thresholding considers some form of spatial proximity). - Threshold selection is not always straightforard.

THANK YOU

This content is taken from the text books and reference books prescribed in the syllabus.