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Image Segmentation by using Histogram Thresholding

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Abstract: Segmentation refers to the process of partitioning a digital image into the multiple segments(set of pixels as known as super pixels) the goal of segmentation is to simplify and or change the representation of an image into something that is more meaningful and easier to analyze. Development of an accurate image segmentation algorithm can be most demanding part of a computer vision system their is not a panacean method that can be work with several different types of images in the segmentation approach is usually designed for solving a specific problem.
In this work, histogram thresholding is proposed in order to help the segmentation step in what was found to be robust way regardless of the segmentation approach used semi atomic algorithm for histogram thresholding are discussed. Examples using different histogram thresholding Methods are shown.

Keywords: Image segmentation, Histogram Thresholding, Methods in Histogram Thresholding, Thresholding foundation

1. INTRODUCTION

We designed and implemented an image segmentation method based on region-growing techniques. The algorithm has been implemented in C, and the program is run through a Mat lab interface. We chose to study the interesting problem of Image Segmentation. We discovered a sufficient amount of literature to provide us with a suitable background. In addition, we were given the opportunity to work with a leader in the image processing field, Dr. Kenneth Castle man. He provided us with expert advice and direction, and gave us some real medical images for testing our algorithms.Image Segmentation is a subset of an expansive field of Computer Vision which deals with the analysis of the spatial content of an image. In particular, it is used to separate regions from the rest of the image, in order to recognize them as objects. It is a method used in the vast field of Artificial Intelligence. Region Growing is an approach to image segmentation in which neighboring pixels are examined and added to a region class if no edges are detected. This process is iterated for each boundary pixel in the region. If adjacent regions are found, a region-merging algorithm is used in which weak edges are dissolved and strong edges are left intact. Region Growing offers several advantages over conventional segmentation techniques. Unlike gradient and Laplacian methods, the borders of regions found by region growing are perfectly thin (since we only add pixels to the exterior of our region) and connected. The algorithm is also very stable with respect to noise. Our region will never contain too much of the background, so long as the parameters are defined correctly. Other techniques that produce connected edges, like boundary tracking, are very unstable. Most importantly, membership in a region can be based on multiple criteria. We can take advantage of several image properties, such as low gradient or gray level intensity value, at once. There are, however, several disadvantages to region growing. First and foremost, it is very expensive computationally. It takes both serious computing power (processing power and memory usage) and a decent amount of time to implement the algorithms efficiently.

2. DIFFERENT HISTOGRAM THRESHOLDING METHODS

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images.

Threshold selection:

The key parameter in the thresholding process is the choice of the threshold value (or values as mentioned earlier). Several different methods for choosing a threshold exist; users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding A simple method would be to choose the mean or median value, the rationale being that if the object pixels are brighter than the background, they should also be brighter than the average. In a noiseless image with uniform background and object values, the mean or median will work well as the threshold, however, this will generally not be the case. A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values. However, this may be computationally expensive, and image histograms may not have clearly defined valley points, often making the selection of an accurate threshold difficult. One method that is relatively simple, does not require much specific knowledge of the image, and is robust against image noise, is the following iterative method.

1. An initial threshold (T) is chosen; this can be done randomly or according to any other method desired.
2. The image is segmented into object and background pixels as described above, creating two sets:
   1. G_1 = {f(m,n):f(m,n)>T} (object pixels)
   2. G_2 = {f(m,n):f(m,n)$\leq$T} (background pixels) (note, f(m,n) is the value of the pixel located in the m^{th} column, n^{th} row)
3. The average of each set is computed.
   1. m_1 = average value of G_1
   2. m_2 = average value of G_2
4. A new threshold is created that is the average of m_1 and m_2
   1. T' = $(m_1 + m_2)/2$
5. Go back to step two, now using the new threshold computed in step four, keep repeating until the new threshold matches the one before it (i.e. until convergence has been reached).

Adaptive thresholding

Thresholding is called adaptive thresholding when a different threshold is used for different regions in the image. This may also be known as local or dynamic thresholding

Image Segmentation

Segmentation divides an image into its constituent regions or objects.

Segmentation of non trivial images is one of the difficult task in image processing. Still under research.

Segmentation accuracy determines the eventual success or failure of computerized analysis procedure.

Example Application: Automated inspection of electronic assemblies. (Mother boards)

Segmentation Algorithms

Segmentation algorithms are based on one of two basic properties of intensity values discontinuity and similarity.

First category is to partition an image based on abrupt changes in intensity, such as edges in an image.

Second category is based on partitioning an image into regions that are similar according to a predefined criterion. Histogram Thresholding approach falls under this category.

Histograms

Histogram are constructed by splitting the range of the data into equal-sized bins (called classes). Then for each bin, the numbers of points from the data set that fall into each bin are counted.

Vertical axis: Frequency (i.e., counts for each bin)

Horizontal axis: Response variable

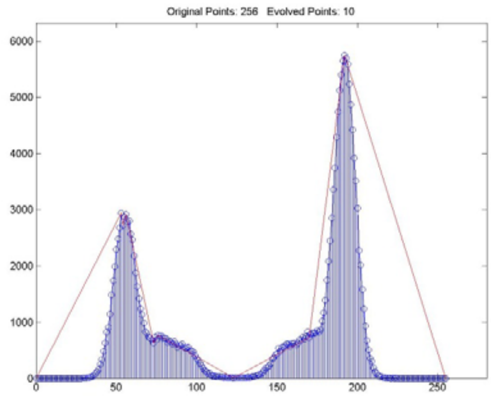
In image histograms the pixels form the horizontal axis

In Matlab histograms for images can be constructed using the imhist command.

Thresholding – Foundation

Suppose that the gray-level histogram corresponds to an image, f(x,y), composed of dark objects in a light background, in such a way that object and background pixels have gray levels grouped into two dominant modes. One obvious way to extract the objects from the background is to select a threshold 'T' that separates these modes. Then any point (x,y) for which f(x,y) > T is called an object point, otherwise, the point is called a background point.

Example:



If two dominant modes characterize the image histogram, it is called a bimodal histogram. Only one threshold is enough for partitioning the image.

If for example an image is composed of two types of light objects on a dark background, three or more dominant modes characterize the image histogram.

Thresholding

Basic Global Thresholding:

1)Select an initial estimate for T

2)Segment the image using T. This will produce two groups of pixels. G1 consisting of all pixels with gray level values >T and G2 consisting of pixels with values <=T.

3)Compute the average gray level values mean1 and mean2 for the pixels in regions G1 and G2.

4)Compute a new threshold value

T=(1/2)(mean1 +mean2)

5)Repeat steps 2 through 4 until difference in T in successive iterations is smaller than a predefined parameter T0.

Basic Adaptive Thresholding: Images having uneven illumination makes it difficult to segment using histogram, this approach is to divide the original image into sub images and use the above said thresholding process to each of the sub images.

Displaying objects in the Segmented Image

The objects can be distinguished by assigning a arbitrary pixel value or average pixel value to the regions separated by thresholds.

3. EXPERIMENTS

Type of images used:

1) Two Gray scale image having bimodal histogram structure.
2) Gray scale image having multi-modal histogram structure.
3) Colour image having bimodal histogram structure.
4) Colour image having multi-modal histogram structure.

Gray Scale Image – bimodal

Fig:image of a fingerprint with light background

Bimodal – Histogram

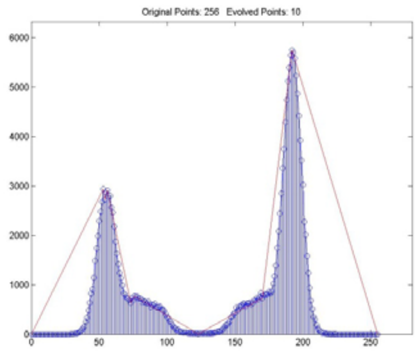


Fig:image histogram of fingerprint

Segmented Image

Fig:image after segmentation

Gray Scale Image (2) – bimodal

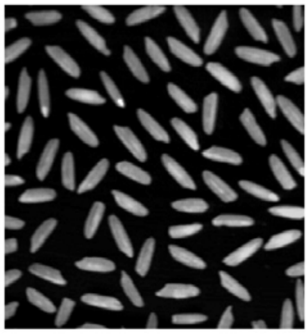


Fig:image of rice with black background

Bimodal – Histogram

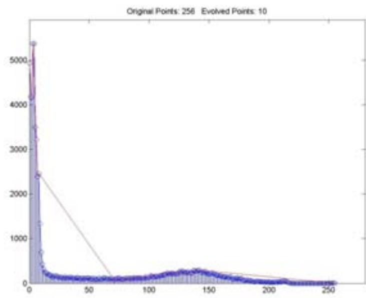


Fig: image histogram of rice

Segmented Image

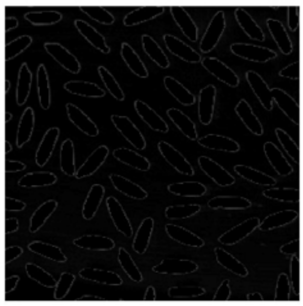


Fig: image after segmentation

Gray Scale Image – Multimodal

Fig: Original image of Lena

Multimodal Histogram

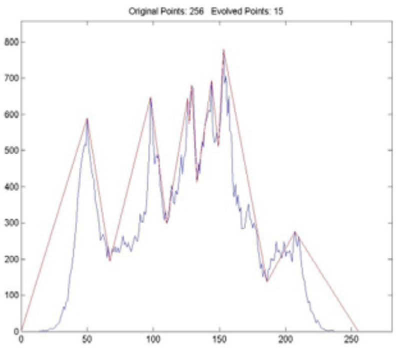


Fig:Histogram of Lena

Segmented Image

Fig: Image after segmentation we get a outline of her face, hat, shadow etc..

4) CONCLUSION:

After segmentation the image objects can be extracted using edge detection techniques or extensively used ion similarly searches(IDB).in this work histogram thresholding was proposed as a way to improve image segmentation thresholding of the final histogram is done relatively easy and all it takes is definition of a low pass filter and the amplification and attenuation of the peaks and valleys respectively or the standard deviation of the assumed Gaussian modes in the final Thresholding. Examples showing better segmentation were presents. The attractive side of the proposed approach is the easy implementation that is needed to obtain considerable better results during the segmentation process. The method has been successfully tested with more segmentation methods and images but because of space these results were omitted.

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