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Shape Feature Extraction of an Object Usingmaximum Connected Component

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Abstract.

Objects in real world can be detected, classified and recognized using multiple features like color, texture and shape. Shape feature is extracted in this research work to detect and recognize objects. The research work implemented in this paper makes use of maximum connected component algorithm to extract shape feature along with color image segmentation using HSV color space. The objective of including a preprocessing stage where images are segmented using HSV color space is to separate the object to be detected in an image. Hence, in this work, The First phase requires color image segmentation and second phase is to extract the shape feature of the object from it using Maximum connected component.

Keywords: color image segmentation, Maximum connected component and shape feature

INTRODUCTION:

Features play a significant role in the areas of computer vision, image processing, machine learning and pattern recognition12. Any piece of information which is suitable to solve a computational task for any application is a feature. Feature detection and processing has many techniques that range from global level to local level of an image. Image features contains information of an image at pixel level so that it can be helpful for making decisions about the image. Different
features are available in every image and based on the application it can be extracted. The way in which image information is represented is called a feature descriptor. A list of 3-D feature descriptors and image reconstruction techniques are reviewed in4.The categorization of Color, texture, visual and frequencydomain descriptors is reviewed in9. It can be represented as binary numbers, color statistics or even the edges etc.

An image feature that has information at pixel level is called local feature and the one that has information considering the entire image is a global feature. Combining both the features for an application might improve accuracy but it suffers from computational overheads. Human Classification is done in8 by implementing clustering algorithm and fuzzy inference system using SND (Structure, Noise and Diversity) feature space. The authors in8 have implemented SND with various datasets to classify human images.

Local Feature

Local features have information at pixel level such as key points, corners, blobs etc. Few local feature descriptors have already been designed for many areas of research. It includes SIFT3 & SURF6 (Keypoint features), FAST1 (Corner features) and ORB. Local features have precise information about the pixel like structure,color,orientation etc.In10, the key points are used to represent surfaces in 3D modeling of objects.The orientation and the gradients of individual local feature can be described and stored as numeric value to distinguish themselves from other features.In this technique, huge amount of local features are generated for single image which requires computational overheads.

Global Feature

Global features describe an image as a whole to generalize an object.This includes HOG,Color statistics,Texture,Contour and boundary based features.Global features havesingle value for each component which is relatively small compared to that of local features.In11, the author has listed down a variety of shape representations like polygonal approximation,spatial interrelation feature,Moments,Scale-space methods and shape transform domains.These representations are further classified into several categories through which many new insights can be gained. The author in7 has listed down texture extraction methods and techniques for an image. Hence,these feature descriptors are easy to implement which doesn't require computational overheads unless the area of study is a large scale.

Preprocessing & Segmentation

Preprocessing operations for an image is common in digital image processing. The objective of a preprocessing technique is the enhancement of image data that is either distorted or lost. Image restoration, noise elimination, pixel brightness and geometric transformations are some low level preprocessing techniques.

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Morphological operations such as dilation, erosion, closing and opening can be done either to smoothen or sharpen the pixel and foreground object.

Segmentation of an image is extraction of necessary portion of an image for further processing. Color Image Segmentation is done in this research workto extract only the foreground object. An interactive Graphical User Interface custom made to adjust the Hue, Saturation and Value of each image is deployed and when the desired foreground alone is visible, the background is masked2 The interactive process of adjusting the Hue, Saturation and Value is stopped when the foreground object alone is retrieved from the image. After which the extracted foreground object is saved to detect the shape feature using Maximum connected component.

Connected Component

The connected component algorithm is very helpful in digital image processing to separate the foreground objects from background. The connected component algorithm works either with 4-way or 8-way connectivity. The 4-way connectivity checks the pixels in top, bottom, left, and right position and sees if they are connected. The 8-way connectivity checks if any of the eight neighboring pixels are connected. If there are diagonal connections, we will have to use 8-way connectivity else 4-way connectivity is sufficient.

The connected pixel region is the regions of adjacent pixels which has the same set of intensity values. There are three methods of Connected Components Methods like Recursive Tracking, Parallel Growing which needs parallel hardware and the classic method being row-by-row scan. Row-by-row scan is the method based on run-length algorithm that serves most of the industrial applications. This algorithm scans an image from top to bottom and left to right, pixel-by-pixel in order to recognize the connected pixel regions. This algorithm works fine for binary or gray level images.

Given an RGB image, it should be converted to Binary image through thresholding technique. A binary image illustrated in Equation (1), will have only 0's and 1's as pixel values. 0's in a binary image represent absence of pixel value (pixel is black). 1's in a binary image represent presence of a pixel value(pixel is white).To find the connectedcomponents(C) present in an image, first start by scanning the first row of an image until a point P is found to be 1. If P is found to be 1, and its Neighbour is 0,increment C to 1.If P is found to be 1, and its Neighbour is 1, move to top or bottom Neighbour based on 4-way or 8-way connectivity. If there are two or more components with different labeling, label the pixel values to 1. If P is found to be 0 label the pixel as 0 which will not be included for C.

$$P=\begin{Bmatrix}1\,,if\ pixel\ is\ white\\0\,,if\ pixel\ is\ black\end{Bmatrix} \quad \text{..... (1)}$$

$$C=\begin{Bmatrix}C+1\,,if\ Pij=1\ and\ Qij\neq 1\\C\quad\ \ ,if\ Pij=1\ and\ \ Qij=1\end{Bmatrix} \quad \text{.....(2)}$$

In Equation 2, Pij is the Pixel at a location in an image, Qij is the neighboring pixel and C is the Connected Component.The algorithm for connected component is given below:

Initialize connectedcomponents(C) to 0.
Scan a row until it comes to a pixel *P*.
if P=1 and found connected:
Move to bottom or top based on 4-way or 8-way connectivity
Check for conflicts and relabel as 1
else if P=1 and not connected:
Increment connectedcomponents and label respectively.
Else if P=0:
label 0

As a result, N number of connected components are found and labeled using the above algorithm for a single image.

Shape Feature Extraction Using Maximum Connected Component

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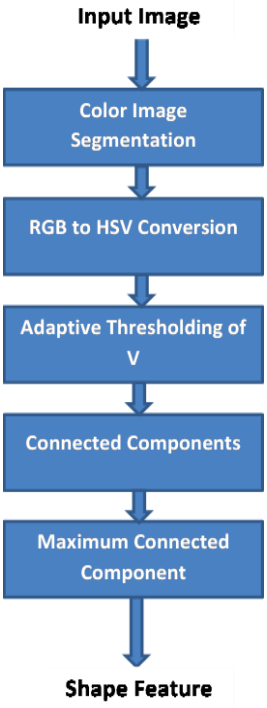

Fig No: 1 Steps to extract shape feature

After finding the list of connected components for an image, now we are in the process of identifying the maximum connected component. This operation is performed by simple sorting algorithm.
For a set of input labels L and connected components C, the sorting is done as :

max_ size=sizes[1]
if sizes[i] > max_ size:
max_ label = i
max_ size = sizes[i]

The sorting is done recursively to check each connected component with the next one. Once, if the sorting is over the Maximum Connected Component will be identified and displayed[13]. The steps to extract shape feature using Maximum Connected Components is given in Fig.1.

RESULTS:

In this experiment, we have considered Color image Segmentation and connected component techniques for shape feature extraction of an object. Having number of unnecessary features may not be helpful for many image processing applications, and hence by concentrating only on necessary features can yield good results in object detection and recognition.

The results of this shape feature extraction technique are experimented for different objects like Water Bottle (Fig.2.a& b), Bird (Fig. 3.a & b) and Human Face(Fig.4.a& b).The figures clearly illustrate the result of thistechnique to extract shape features from an input RGB image. The technique of curvature approximation, crest point classification and crest lines tracing algorithm for shape feature extraction is found in [5]. However, our technique has been proven to extract shapes for all kinds of objects.


Fig. 2. a

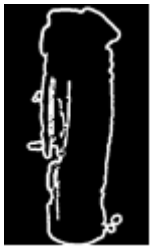
Fig. 2. b

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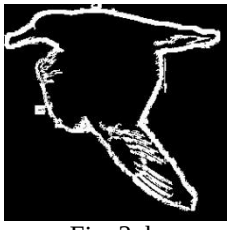
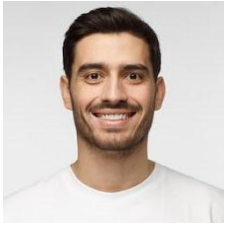
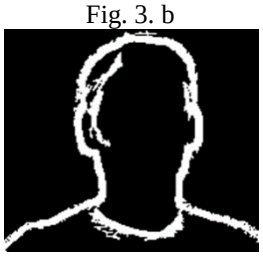


Fig. 3. a Fig. 3. b

CONCLUSION

The Shape feature is considered as a global feature which can be used for object detection,analysis and semantic segmentation.The Shape feature of any object can be retrieved using this algorithm provided the Segmentation and thresholding process are performed accurately.Either of the process if not handled with precise techniques will not result in exact shape feature that is required for any applications. In this research work,we have used Adaptive thresholding of Value component retrieved from the Color image after converting it to HSV image.For this technique to be enhanced, it can be incorporated with other colorspace segmentation and thresholding techniques.

CONFLICTS OF INTEREST:

The author have declared no conflicts of interest

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