Journal of Industrial Engineering Research, 1(3) March 2015, Pages: 30-34

IWNEST PUBLISHER

Journal of Industrial Engineering Research

(ISSN: 2077-4559)

Journal home page: http://www.iwnest.com/AACE/

Mammogram Image Segmentation Using voronoi Diagram Properties

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ARTICLE INFO

Article history:
Received 22 February 2015
Accepted 20 March 2015

Keywords:
Mammogram
Image Segmentation
Using voronoi Diagram Properties

ABSTRACT

During the segmentation of human faces from still images greedy search algorithm extracts the facial features for grey intensity images based on the voronoi diagram properties. The Voronoi Diagram (VD), a well-known technique in computational geometry, which generates clusters of intensity values using information from the vertices of the external boundary of Delaunay triangulation (DT). In this way, it is possible to produce segmented image regions. A greedy search algorithm looks for a particular face candidate by focusing its action in elliptical-like regions. A Distance Transformation is applied to segment face features. We used the BioID face database to test our algorithm.The Implementation has been done by using MATLAB 7.0.

To Cite This Article: Dr. J. Subash Chandra Bose and D. Sivaselvi, Mammogram Image Segmentation Using voronoi Diagram Properties. **J. Ind. Eng. Res.,** ***1(3)****, 30-34, 2015*

INTRODUCTION

The modified algorithm is used to overcome the two major drawbacks of face recognition technology, maximized computational load and minimal speed. Normally boundary extraction is for the differentiating the background from the facial region. But it requires heavy computational burden. In order to minimize the computational burden few unique features are derived from the image histogram rather than on the points associated with the edges in the special domain.

Related work:

A. Extraction of Facial Regions and Features Using Colour and Shape Information:

Face segmentation has been done using another colour space transformation, namely HSV (Hue, Saturation and Value) and shape information. First, skin-like regions are segmented based on the Hue and Saturation component information, and then a fine search in each of the regions is performed to detect elliptical shapes. This method normally gives large false alarms, which requires further processing either by considering other information or by making additional use of other techniques. Moreover, generating a skin colour model is not a trivial task.

B. Local-Global Graphs for Facial Expression Recognition (LGG):

The proposed novel facial expression recognition method based on Local-Global Graphs (LGG). The LG Graph embeds both the local information (the shape of facial feature is stored within the local graph at each node) and the global information (the topology of the face). Facial expression recognition from the detected face images is obtained by comparing the LG Expression Graphs with the existing LG expression models present in the LGG database. Each facial feature region forms a node which is connected to other neighboring features by means of Delaunay Triangulations

C. Deformable Template Matching:

Two eye templates and one mouth template were used to verify a face and locate its main features; afterwards, two cheek templates and one chin template were employed to extract the face contour. The performance claimed to be favourable; however, it could not detect faces with shadow, rotation or bad lighting conditions.

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D. Eye Detection in a Face Image using Linear and Nonlinear Filters:

Method for extracting the skin area from an image using normalized colour information. Once the flesh region is extracted, its colour distribution is compared with a manually cropped and constructed model.

E. Facial Feature Location with Delaunay Triangulation / Voronoi Diagram Calculation:

The Facial Feature Location suggests a symmetry-based method for face boundary extraction from a binarized facial image. Construction of Delaunay Triangulation from points of an edged images. The property of each triangle was examined geometrically, and the so-called J-Triangle (Junction triangle) was identified. These types of triangles act as linkers to repair the broken edges. The purpose of this is to prevent the face boundary from being merged with the background. This method may experience a heavy computational load if the image size increases.

Proposed Algorithm:

The modified algorithm is used to overcome the two major drawbacks of face recognition technology, maximized computational load and minimal speed. Normally boundary extraction is for the differentiating the background from the facial region. But it requires heavy computational burden. In order to minimize the computational burden few unique features are derived from the image histogram rather than on the points associated with the edges in the special domain in the proposed algorithm.

First step is to perform histogram equalization to reduce the lighting ill effect. This is referred to as pre-processing step. Next, the Voronoi Diagram (VD) is applied. Various literature studies have tended to apply VD on the image itself (after binarizing it and capturing its edges). This is usually time consuming; therefore, VD is applied directly not on the images but instead on a few selected points (<=255). Thus, VD is constructed from feature points (generators) that result from gray intensity frequencies.

The proposed technique resembles the dynamic thresholding method used for segmentation, but it differs in terms of divide and merge-decision making. Human faces have a special color distribution that varies significantly from the background. VD is used to construct Delaunay Triangulations (DT) from points on the image histogram. The outer boundary of DT is simply the Convex Hull (CV) of the set of the feature points. Hence, the two global maxima are obtained by extracting the top two values in the DT list of vertices; which correspond to the peaks in the histogram. In order to get the minima that fall between these two peaks, a new set of points are spawned using the following steps:

- Generate the host image histogram
- Generate VD /DT to obtain the list of vertices and get the two peaks
- Set all points below the first peak to zero, and set all points beyond the second peak to zero
- Set all points that are equal to zeros to be equal to the *argmax (peak1, peak2)*
- Derive the new points using:

Val new(x) =| (Val(x)-max (Val(x))) |

Where *max (Val(x))* denotes the highest frequency in the host image histogram. This process will yield a local flip effect on the image histogram.

Extraction of probable face region:

Below is the pseudo code applied for the extracting unique features from one dimensional images:

```
Input: Host gray scale image Ψ
Input: Vector generated by the previously described procedure V
Initialize a new vector d = []
// The vector 'd' stores a few gray values that represent our
// segmented image. It is used to call homogenous areas that
// share the same gray value to be a binary input for our face
// localization step (best elliptical shape).
Set all pixels in Ψ smaller than V (1,1) to black (0)
Set all pixels in Ψ greater than V(length(V(:)),1) to black (0)
for i = 1 to length(V (:)) −1 do
if i ==1 then
set all ( Ψ >=V (i) AND Ψ <=V (i +1) )
to V (i +1)
d= [d ; V (i +1) ]
else
set all ( Ψ >V(i) AND Ψ <=V (i +1) )
to V (i +1)
d= [d ; V(i +1) ]
end if
```

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end for
Output: Segmented gray scale image Ψ*Segmented*

C. Implementation Using MATLAB 7.0:

The new image segmentation algorithm has been simulated using MATLAB 7.0. First a set of BioID images are extracted from the database and the Voronoi based properties are applied on the images and the results are compared with the other systems as shown in the comparison table.

Training Images:

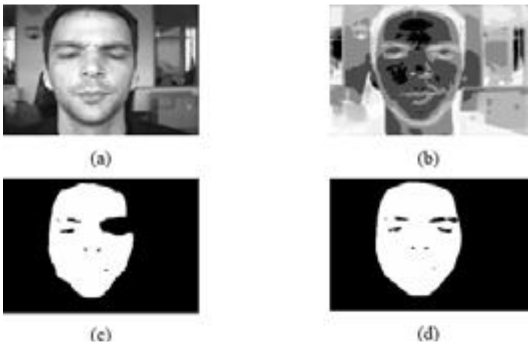

Fig. 1: Face repairing. (a) Original BioID image, (b) image segmented into homogenous regions, (c) face blob Detected but the left eye region is missing, and (d) face boundary repaired thanks to the convex hull a face would consist of at least two holes.

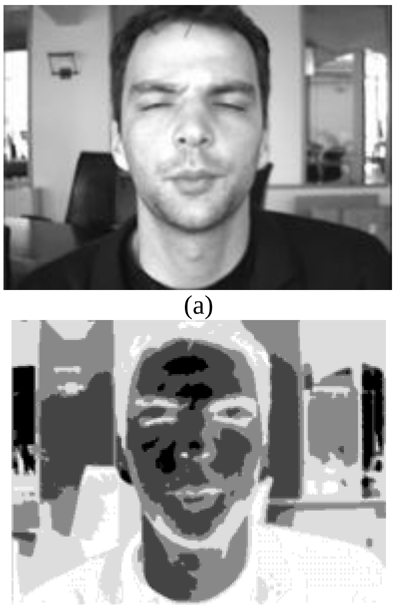

Fig. 2: Applying Distance Transformation to separate the face when it is merged with the background. (a) Original image, (b) Voronoi-based image segmentation.

Fig. 3: An example of test set of BioID database.

Comparison Metrics:

The following are the list of the comparison of performance of our algorithm with other systems,

Face Detection Approach	Average Processing Speed Measured in Seconds for each Image	Success Detection Rate(%)
Fast Face Detection via Morphology	20.5 s	94%
Automatic extraction of head and face boundaries and facial features.	170 s (2min 50s)	Not reported
Automatical Detection of Face Features and Exact Face Contour	37.9s + 26.7s = 64.6s	87.1%
Region-Based Face Detection	408953 PW** = 2100s	90.7%
The Proposed Method	6.7 s	95.14%

Conclusion:

As the proposed algorithm is for extracting a face and its features from a given image. The Voronoi Diagram is used for the face localization by segmenting the image regions into connected homogeneous regions based on their gray values. The proposed method is robust, precise and independent of translation, rotation, and scaling.

However, the presence of background intensities similar to the face intensities in the image may cause problem for segmentation decisions. This was also a major problem in colour-based algorithms. Facial hair is not an obstacle here, but wearing glasses can split the ROI (i.e., face blob) into two blocks, which means each block will be treated as different face candidate.

Proposed algorithm can be injected into many different scientific fields; for example in robotics to recognize specific people or shapes, in criminal investigations at police stations, in surveillance tasks, in driver protection (tracking driver’s eyes), in Steganography and many other examples. The aim of this work is to provide a new feasible prototype, and a note here is that there was little concern given to the speed factor. Hence, the reported speed of less than 16.7s could be brought down to a fraction of a second if the algorithm is implemented to another programming language (e.g., C++, C#, Java, etc). MATLAB, despite its high reputation as a scientific tool, is admittedly slow in handling nested for loops as it is an interpreted language.

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