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Segmentation of Arabic Words Using Area Voronoi Diagrams and Neighbours Graph

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Abstract: The Voronoi neighbourhood comes from the Graphs (G), accompanied with the details concerning the correlations and neighbouring Gs lower, upper and centre points, with regards to the word group is performed. The problem entails determining the neighbours for segmenting G to Voronoi Diagrams' (VD) usage for acquisition of Voronoi Edge (VE) which with the help of neighbours sets apart components. Importantly, VE effectively segments fully neighbours however, it does not effectively segment partly neighbour. In this paper the issues addressed by the neighbourhood comprise the graph's VD area together with the VE function as non-linear segmentation. Later, segmentation is carried out by choosing appropriate sites bordering the Voronoi. This makes the G information alongside the candidate character recognition distance to be used. Certain Arabic datasets including APTI, AHDB and IFN-ENIT applies the process of segmentation. The appropriate technique has been analysed on various Arabic font images. The experiment finally gives results that indicate right outcomes with considerable precision which is strong on varying text orientation, skew angles, types and sizes.

Key words: APTI, AHDB, IFN-ENIT, experiment, Malaysia

INTRODUCTION

In various image assessment application for instance, VD, labeling of graphs is a very important step. There are four phases that characterises such logarithms. In the first phase, the input (grey or color scale) image is assessed and needed to perform segmentation from the base. Second, each site is assigned a unique label by labeling the G, allowing for the identifications of unique objects. In the third phase, processing is done in each site with an aim of extracting object's characteristics such as average color, pixel value, bounding box, area and center of gravity among others. In the final phase, each site is classified into single or multiple groups using characteristics obtained in earlier phase (Bailey *et al*., 2008).

For the purpose of allocating a unique label per every connected site within an image, Graph Labelling (GL) is utilized. GL comprises of a crucial activity used comprehensively during pattern recognition, image processing and computer vision. In the 1990s, there was an extensive examination of Parallel GL algorithms. However, it was impossible for the algorithm to apply the rapid shared memory provided by a multipurpose graphic processing.

One important task during pattern recognition and image processing is the labelling of graphs within a binary image. Nevertheless, due to the complicated connectivity possibility for the Gs in the image, labelling turns out to be a problematic process; therefore it may not be segmented simply into parallel local functions without global consideration.

In the event that the component boundary has equal G colour line, it means that the boundary for the background have white space, therefore it is taken as a complete neighbour graph. In case the lies have two colours which are black colour and same G colour line, it is then acknowledged as partly neighbour. The reason for this is due to some additional G point boundary traversing between them as well as other scenario when the lines have colours that are similar to black lines and graph lines; they are then not recognised as neighbours. For example, the second component transverses through the first component and the third component. Apparently, in fourth and fifth components, there is a separation of a small portion from the fourth component. The first, third, fourth and fifth components are therefore termed as partly neighbours (Ramdan and Omar, 2011).

The VE separating two closer Gs (elements) represents the Voronoi neighbourhoods. Likewise, every word component is represented as a number of Voronoi tessellations lying near to each other. In case that two elements ei and aj share VE parts, they are termed as Voronoi neighbours. Considering this, it can be declared

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that the Voronoi dual tessellation and the Delaunay triangulation can infer the correlations in Voronoi neighbours. This enables the construction of a neighbourhood graph derived from the Voronoi tessellation site. In the neighbourhood graph, each node represents an element of the image, with every edge connecting the neighbouring feature. The edge weight linking them is also referred as the distance separating two Voronoi neighbours (Lu *et al*., 2004).

Using Dakstran technique, through grouping K-Nearest Neighbour, characters are characterised as text lines and text blocks which is the technique for structural page layout analysis depending on the bottom-up, adjacent-neighbour page component bunching. It produces a perfect skew measure, in line, including between line spaces and recognises text blocks as well as text lines (O'Gorman, 1993).

To determine the neighbors as complete to closest neighbors in establishing the part of neighbors is important in this study for good outcomes to segment the G using VD.

Literature review: The G centers were located according to (Kise *et al*., 1999) and later connected the centers using lines to identify the neighborhoods. It is then utilized for characters and printed in Latin. The Text segmentation algorithm on VD is viewed as an upper-bottom algorithm. In the first step, the algorithm finds the borders sample point through the rate of selection. Later, applying the maximum noise-region size threshold, noise is eradicated for the attained VD area.

The method for extracting Gs in a binary image is a important and essential exercise for examining various image applications. The utmost prolonged part in the segmentation algorithm together with other same algorithms revolves about Gs tag marking and clustering. According to the Gs analysis technique, image pixels can be characterised to Gs and converted and enjoined with adjacent rectangles and later to graphic text sequences which are lastly adapted to site (region) blocks (Askarpour *et al*., 2014).

In regard that this research follows the many steps to acknowledge neighbours as a fully neighbours and partly neighbours as labelling of Gs, constructed of VD using DAC algorithm, then determine of centroid Gs, upper and lower points. It then follows that, mathematical model can be used to draw straight line using slop between two points from centre to upper, centre and lower points to others and Gs. These lines are drawn to determine the full or partial neighbours.

MATERIALS AND METHODS

Proposed technique: There are different phases for determining the Gs that can be considered as neighbours in this task (Fig. 1). Demonstrates six phases. In fazeone; there is filtration of input white and black and elimination of noise. Next, G labelling is done, whereby every site is given a unique tag. Edges for each G are extracted during the third phase, basing on the assigned tags. The fourth phase involves input extraction from sample points. Fifth phase is characterized by sampling points meant for generating VD points to acquire Vertexes and VD edges. In the final phase the edges should segment the Gs in a process referred as neighbour graph segmentation.

Graphslabelling: Gs labelling process was undertaken by following the Gs points for sequential images starting from left side and commencing to the right.

Pixel connectivity for 2D image is characterized as Correlation in pixel neighbourhoods. An ordinary rectangular inspecting example generating a limited math grid {(x,y): x-1,...,X-1; y = 0,1,...,Y-1} supporting advanced images allows us to change neighbourhood sorts for neighbourhood encompassing of An pixel. A

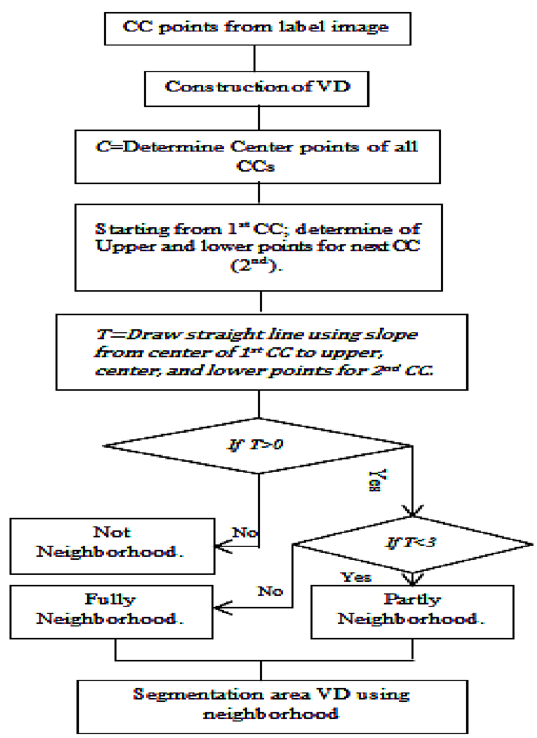

Fig. 1: The architecture of the frame work for determine neighbours

4-neighbourhood{(x-1,y, (x,y+1), (x,y-1)} contains only the pixels above, below, to the left and to the right of the central pixel (x,y). An 8-neighbourhood adds to the 4-neighbourhood four diagonal neighbours:{(x-1, y-1),(x-1,y),(x-1,y),(x-1,y+1),(x,y+1),(x+1, y-1),(x,y-1)} (Efford, 2000) . Progressing from 1 to n, whereby n constitutes the last number of the last G for every image using 8- neighbourhood for pixel connectivity.

Construction voronoi diagrams: The line segments that separate the Gs is created by Area-VD. The Euclidean distance is used to determine the short distance separating the Gs. Various algorithms have been modelled for generation of planar VD from point set collections. common techniques surveys are demonstrated in Franz (Aurenhammer, 1991) For example, Fortune's algorithm, Lloyd's algorithm, Incremental algorithm, Bowyer -Watson algorithm, half plane intersection algorithm and divided and conquer algorithm. The current research will explain in short the divided and conquer VD construction algorithm.

Based on (Kise *et al*., 1999), to compute integration, the convex hull of each side (left, right) is found. Accordingly, the lower and upper segment lines that connect the left and right hull are determined. Preparata and Hong published the divide-and-conquer algorithm for the convex hull.

In order to sort the remaining points into the upper and lower sets, some function is required that determines whether a point is above or below a line. Provided the set of points on line P_0,P_1 and P_2 when P_0 is at 0,0 then consider the determinant of P_0, P_1 and P_2 The final value will be negative if P_2 angled off in the left direction, positive if it has moved to the right and 0 if it is collinear with the first two points.

$$A = \frac{(Po_x - p1_x)(p2_x - p1_x)}{(p0_x - p1_y)(P2_x - p1_y)} \quad (1)$$

For this 2×2 matrix, the formula for the determinant will be:

$$dt = \left(\left(p0_x - p1_x\right) \times p2_y - p1_y\right) - \left(\left(p2_x - p1_x\right) \times \left(p0_y - p1_y\right)\right) \quad (2)$$

By simply adding left to the output hull the upper or lower hull is initiated. Thereafter, Points are then inputted from the right input source. Each point is added provided the number of points in the working hull is equal to three points or more, an assessment is made to verify whether the last three points have formed a convex angle.

The perpendicular bisector of the lower bridge is traced from -∞ and establish the lowest intersection point with an edge of the left or right VD. The left and right VD is shown overlaid on top of one another in the following Fig. 2. To Merge Vor (SL) and Vor (SR) into the Voronoi diagram of Vor (S) i.e.:

$$Vor(S) = Vor\ (SL) \cup Vor(SR) \quad (3)$$

Straight-line equation using slop: A straight line has one important property which lies in the way it moves from the horizontal. The reflection of this concept exists in its gradient. A straight line graph resembles that shown in Fig. 3. Whereby m = 1 and j = 1(n-line point quantity):

$$Y = 1 \times \left(\frac{dx}{dy}\right) + b(j-1) \quad (4)$$

Where the slope:

$$m = \frac{y_{1-yz}}{X_1 - x_2} \quad (5)$$

The formularyon behalf of the straight line is f(x) = mx + b or y = mx + b where m symbolizes the slope while b denotes the y-intercept.

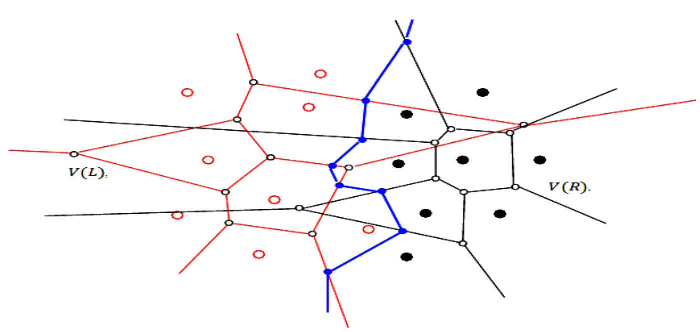

Fig. 2: The merge step

$$\text{Slope} = \frac{(mx_2 + b) - (mx_1 + b)}{x_2 - x_1} = \frac{m(x_2 - x_1)}{x_2 - x_1} = m \qquad (6)$$

Where the Fig. 3 represent the straight line drawing by slope.

Determine of neighborsgraph: In the present research with regard to Fig. 3, the Gs centroids are determined from the circular point followed by a line drawn to identify each G's real centroid, lower and upper vertical boundaries. When the component boundary has a similar G color line, it implies that there is a white space on the boundary background, thus it is called a fully neighbor graph. However, when the line contains two colors, that is, black color and component color line, then they would termed partly neighbors, this is due to the existence of another G point boundary that separates them.

Similarly, when the lines contain colors that resemble those of black lines and G lines, then are considered non-neighbors. For instance, the second component cuts across the first component and the third component. However, in fourth and fifth components, a small portion from the fourth component separates them. Therefore, the first, third, fourth and fifth components are called partly neighbors. The classification of neighbors based on colors is illustrated in Fig. 4 (Ramdan and Omar, 2011).

Algorithm: Determine Neighbors graph: For the constants of touch points x_1, x_2, x_3, x_4 are, let

$A \subset F(X)$

Defined as:

$A = \{f(x_3) = mx_3 + b : x^i > 1\}$

and $f\{x_1) = mx_1 + b$, $f(x_2) = mx_2 + b$, $f(x_2) = mx_2 + b$

For I = 1,...,3 and Where i is the number of points, then

$$(x) = \begin{cases} 1 \text{ if } i = 3 \text{ for } f(x_i) = mx_i + b \\ 0 \text{ if } i = 0 \text{ for } f(x_i) = mx_i + b \\ -1 \text{ if } i > 1 \text{ and } i < 3 \text{ for } f(x_1) = mx_i + b \end{cases}$$

Where -1represents partly neighbor G, 0 represents non-neighbor Gand 1 represent fully neighbor G.

Construction area-Voronoi diagrams: The set A generator. The area VD example is illustrated in Fig. 5. According (Zeki *et al*., 2007), Area-VD would draw line segments that separate the *G*. The lines' complete set are capable of segmenting the Gs.

Based on the listed kinds of edges it is apparent that the focus is on type of edges where this type is edges produced from two neighboring Voronoi polygons where

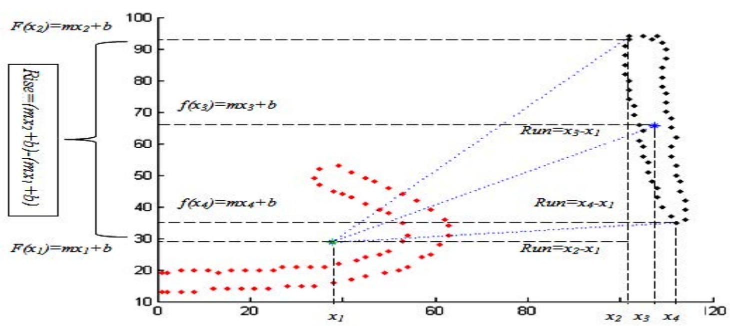

Fig. 3: Illustrate the straight line between center, upper and lower points

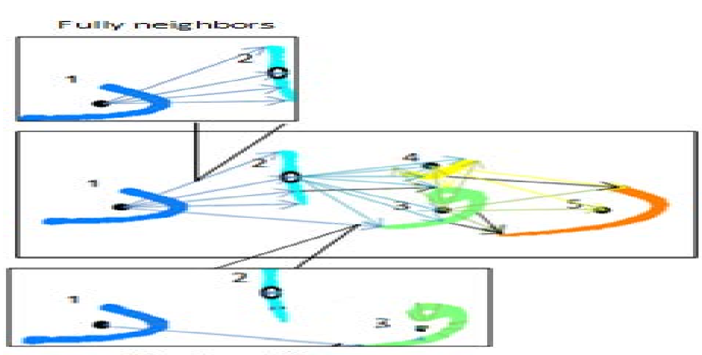

Fig. 4: Shows neighbors by colors

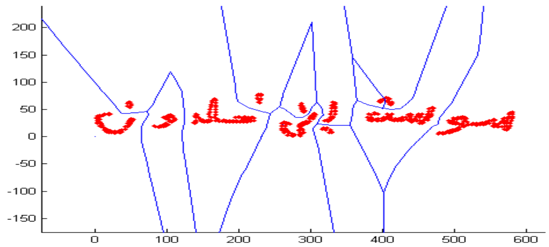

Fig. 5: Area-VD three words

each is coming from a producer falling on a different connected element, since they lie between the Gs. Construction of area-VD is achieved by selecting the algorithm for type edges.

Algorithm: Area-VD:

Input im(i,j)← 0,1
Point VD im(i,j)←Vi= $\{x \in X/d(x,p_i)<d(x,p^j),i\#j\}$.

$$(x)=\begin{cases}1ifi=3forf(x_i)=mx_i+b\\0ifi=0forf(x_i)=mx_i+b\\-1ifi>1andi<3forf(x_1)=mx_i+b\end{cases}$$

Determine neighbors of G:
if G is neighbors←1 or 0
Apply Euclidean distance

$$\leftarrow d(P,A_i)=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

and draw Area V(A)←(ABS $|d_1\text{-}d_2|$ <0.01) and (ABS $|d_3\text{-}d_4|$ <0.01).

Else delete edges: Based on the algorithm, 0.01 represents the threshold, d_1 represents the distance between the initial component and the vertex, d_2 represents the distance between the second component and the same vertex for representing the initial vertex point that is (x_1, y_1). Similarly, d_3 and d_4 indicate the second vertex point, that is, (x_2, y_2), for representing edge amongst two components. To determine the segmented line of separating it, the new algorithm has been used in identifying neighbors, since the measurement of Euclidean distance is not able to provide the better outcome, particularly with regard to unknown handwritten Arabic neighbor characters.

Datasets: In this research, six datasets were used to estimate the suggested algorithm and separation algorithm, with the IFN/ENIT-database of handwritten Arabic words (Pechwitz *et al*., 2002). and the APTI (Arabic Printed Text Image) database which is a significantstandard for open terminology where is contain many font, size and styles text in Arabic (Slimane *et al*., 2009). The ACDAR database existedtoo used; this database was considered for a common ofsegmentationexperimentations. The databases that were certain for this research contain unlikeexamples of Arabic handwritten words (Hamad and Hamid-cherif, 2012). The AHDB (Arabic Handwritten Database) contains of 3045 words written by 115 dissimilar writers (Al-Ma *et al*., 2004), Zeki dataset (i.e., primary shapes dataset) contains arbitrarilycertain words mainly from two incomes, the Holy Qur'an and the websites of Arabic news agents, such as Al-Jazeera.net (Zeki, 2008) and the AHDB/FTR Arabic handwriting database contains 497 images of the tags of Libyan cities for text recognition (Ramdan *et al*., 2013).

RESULTS AND DISCUSSION

There is probability for segmentation method to vary in terms of size and type through Arabic character segmentation. Furthermore, the performance is dependent upon character grouping, mainly the main shapes. For the area-VD constructed, in Fig. 6a-f from APTI, ACDAR, AHDB, Zeki, AHDB/FTR andIFNENIT dataset. The result from these figures shown in Table 1.

Visual result: The outcome for determining the neighbor graph is a virtual one because it cannot be considered area-VD during the process of segmentation. The outcome from Fig 6d and Table 1 which has outcomes for Fig. 6a-f are presented in this part. The final Graph repeated in each period as it identifies the imaging end alongside.

Analytical result: The experimentation was mostly aimed at representative the determined performance from the recommended approach for several segmentation experiments. Thus, the benchmarking dataset employe dinvolved APTI, AHDB and IFNENIT. The results succeeded after assuming the recommended methodology were utilized for determining sub-words was primarily used on manygroups of data following the split-up algorithm. As declaredprevious, the recommendedmethod seems to producedependableresults if identification of sub-words and Arabic characters is dependent on the amount of Parts of Arabic Words (PAW's) without umlauts or dots. The rates of accuracy for segmentation resultsamid the three approaches of segmentation are shown in Table 2.

Two methods were offered in the present study. The originalmethod determined the graph's neighbors,

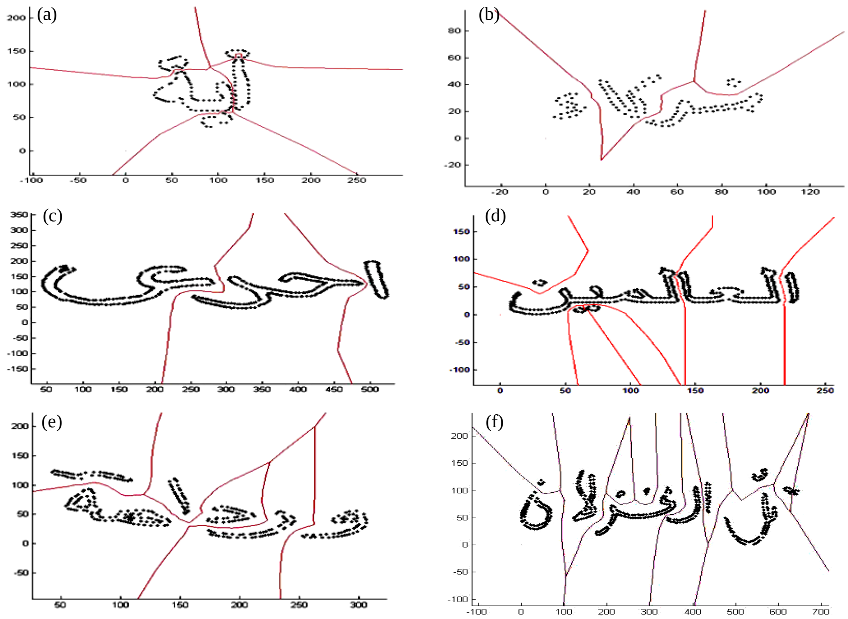

Fig. 6: Separation of graphs using Area-VD. a) APTI, b) ACDAR, c) AHDB, d) Zeki, e) AHDB/FTR and f) IFNENIT datasets

Table 1: Illustrates neighbor graph for fig.6(a-f)

Figure No	No of G	As fully neighbor	As partly neighbor	Not neighbor	Line segment
6a	1	G 2, 3 and 4	G 5	G 4, 5, 6 and 7	OK
6a	2	G5	G 4	G3	OK
6a	3	-	G 4	G5	OK
6a	4	G 5	-	-	OK
6a	5	-		-	-
6b	1	G 2	G 3	G 4	OK
6b	2	G 3 and 4	-	-	OK
6b	3	G4	-	-	OK
6b	4	-	-	-	-
6c	1	G2	-	G 3	OK
6c	2	G 3	-	-	OK
6c	3	-	-	-	-
6d	1	G2	-	G3,4,5 and 6	OK
6d	2	G3,4 and 5	-	G 6	OK
6d	3	G 4	-	G 5 and 6	OK
6d	4	-	-	G 5 and 6	-
6d	5	G 6	-	-	OK
6d	6	-	-	-	-
6e	1	G2 and 3	-	G4, 5 and 6	OK
6e	2	G3	G 4, and 5	G6	OK
6e	3	G 4	G 5	G 6	OK
6e	4	G 5	-	-	OK
6e	5	G6	-	-	OK
6e	6	-	-	-	-
6f	1	G 1,2 and 3	G 4	G 5-G12	OK
6f	2	G 3	-	G 4-G 12	OK
12f	3	G 4, and G 5	-	G 6-G 12	OK
6f	4	G 5, 6 and 7	-	G 8-G 12	OK
6f	5	G 6	_	G 7-G 12	OK
6f	6	-	-	G 7-G 12	-
6f	7	G 8	G 9	G 10 and 12	OK
6f	8	G 9, and G10	G 11	G 12	OK
6f	9	G 10, 11 and G 12	-	-	OK
6f	10	G 11	G 12	-	OK
6f	11	G 12	-	-	OK
6f	12	-	-	-	-

Table 2: Result values for three methods

	Methods		
Variables	Proposed	Zeki	Projection
Overall success rate	96.81	85.81	75.22
Under Segmentation	1.91	4.55	13.56
Over Segmentation	1.28	9.64	11.22

while another one applied the area-VD in the segmentation of Arabic Gs. With regard to the recognized minimum distance and neighbors, the Arabic handwriting together with morphology process was segmented well in this mission.

CONCLUSION

In conclusion, it can be inferred that the VD has showedcapable in showing the Gs neighborhood within digital images.

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