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Method for authentication of handwritten suicide note

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Abstract
Aspects of linguistics plays important role when it deals with legal texts such as suicide note. A person who has committed suicide often experienced a cumulative psychological process which ultimately led to the decision of ending his/her own life. The suicide note provides us with the firsthand information about that person's particular mind status and mind logic. In our approach we consider suicide note as text. Then approaches have been proposed for analyzing text as part of suicide note.

Keywords: Scaling, ITA (Image Thinning Algorithm), ROI (Region of Interest).

Introduction
Handwritten suicide note is often referred to as indication of personality trait represented by neurological patterns in the brain. In other words our brain or subconscious mind actually forms the characters as a result of habit. Handwritten analysis is also known as Graphology, which is a pseudoscientific study of Handwritten in relation to human psychology. Graphology can be used for identifying, evaluating and understanding personality of a person through the strokes and patterns revealed by Handwritten. The main applications of Graphology include behaviour analysis, forensic evidence and disease diagnosis. Handwritten reveals the true personality including emotional outlay, fears, honesty, defences and many other individual personality traits [1].

Using computational methods to study suicide notes is not new, but applying advanced algorithms to clinical care of suicidal patients is. Recent computer analysis compared structural characteristics (average sentence length, parts of speech) with content variables (length of communication, instructions, active state, explanation provided, locus of control) in their predictive values. Another approach focused on semantic content of words used in suicide notes by grouping words into linguistic variables (e.g. positive words and negative words).

There are so many cases which involved suicide notes in people's death all over the world. We assume that suicide letter is also being an important subdivision of legal text. When dealing with forensic linguistics means that we connect ourselves with legal text and context. Legal text is a kind of text which is used for legal purposes in legal system. Legal text is the textual material concerned with the criminal case. Legal texts including ordinance, letter of contract, suicide letter, government regulation, etc.

Image can be represented morphologically, using Image Dilation and Erodes. The fundamental operations associated with an object are the standard set operations union, intersection, and complement plus translation, and Boolean Convolution [1]. Binary Image Morphology is taken into account based on behavior of Binary Images, Erosion and Dilation, consideration of foreground and background of images, Blur, Effect of addition of noise, translation ally invariant methods for pattern matching [2].

Morphological Filtering of image, a theory introduced in 1988 in the context of mathematical morphology. Research on lattice framework. The emphasis is put on the lattices of numerical functions in digital and continuous spaces and Morphological Filters [3]. The usefulness of the hit-miss transform (HMT) and related transforms for pattern matching in document image application is examined. HMT is sensitive to the types of noise found in scanned images, including both boundary and random noise, a simple extension, the Blur HMT, is relatively robust. The noise immunity of the Blur HMT derives from its ability to treat both types of noise together, and to remove them by appropriate dilations [4].

The adaptation is achieved using a tradeoff parameter in the form of a nonlinear function of the local saturation. To evaluate the performance of the proposed algorithm, a deigned psychophysical experiment is used to derive a metric denoted as the average value for the psychophysical evaluation in percent (APE%). Results of implementing the proposed APE show that an APE=73 to 96% can be achieved for basic morphological operators, i.e., dilation, erosion, opening, and closing. APE value depends on the size and shape of the structuring element as well as on the image details. The proposed algorithm has also been extended to other morphological operators, such as image smoothing (noise suppression), top hat, gradient, and Laplacian operators. In the case of a smoothing operation, an average peak signal-tonoise ratio (PSNR)=31 to 37 dB is achieved at various structuring elements and applied noise variances, while good results are achieved with the proposed top-hat operators [5].

Whenever an image is digitized, i.e., converted from one form to another some form of degradation occurs at output [6]. There is no image processing system which can produce an ideal image. Image enhancement is the improvement of the appearance of the image.

Enhancement can be done via, contrast intensification, smoothing and edge sharpening. Algorithm for spatial domain and frequency domain techniques are used widely. Spatial domain is dealt with neighborhood of single pixel and frequency domain dealt with global filters (masks) [6].

Alessandro Zimmer, Lee Luan Ling, 2003, proposed a new hybrid handwritten signature verification system, where the on-line reference data acquired through a digitizing tablet serves as the basis for the segmentation process of the corresponding scanned off-line data. Local foci of attention over the image were determined through a self-adjustable learning process in order to pinpoint the feature extraction process. Both local and global primitives were processed and the decision about the authenticity of the specimen defined through similarity measurements. The global performance of the system was measured using two different classifiers [7].

Firstly, Pixel clustering is used to transform the signature image into bi-colour image. Then secondly, instead of considering the whole image, only signature area is extracted. Thirdly, by using Image scaling technique the signature image resized along the coordinate directions. As different techniques are used to subsample (image after transformation) which will be discussed in turn. Fourthly, a different technique is used for thinning to reduce the threshold output of an edge detector algorithm is used to lines of a single pixel thickness. In this paper we propose the above mentioned series of techniques as the preprocessing analysis part of Handwritten Signature Recognition.

Proposed Method

The image is stored in JPEG format. The region of interest is cropped and the image is the input to algorithm. The region of interest is segregated from the suicide note after applying a sufficient RGB (Red, Green Blue) threshold. The characteristic traits are quantified by comparing them with extremities. Words are also isolated from the sentences.

The Sentiment analysis is done on suicide note. The words in each sentence are compared with those words that have been previously labeled as “positive”, or “negative”.

After looking at these words, the algorithm then judges whether the text in the note is positive or negative based on the likelihood for each possibility. The overall objective of this paper is to determine the sentiment of the text, whether it is positive or negative, which is extended to strength of polarity. Also this approach is used to obtain the significant features and to analyzing the overall sentiment for each object by computing the weighted average for all the sentiments in the textual data.

There are many features of suicide note like the baseline, slant, pressure, letter, size, letter spacing, word spacing, margin etc. that can be used to reveal the personality of a person [2]. Various writing features used to predict personality traits are explained below.

Baseline is pre-printed or imaginary line on which letters reside. If the paper is with no pre-printed line, then writer assumes their own baseline according to his/her writing style. Even on the pre-printed page writer is not adhere to the line during the writing. Hence, writing can be straight, ascending, true ascending, descending, concave, suicidal or erratic. These baselines help to find out the emotional control and the reliability of the writer.

When writer writes assuming imaginary line, each letter in the sentence can be at 90 degree, below 90 degree or above 90 degree. If each letter in the sentence is at 90 degree then writing is considered as vertical slant. If it is below, then considered as rightward slant and if above 90 degree, then considered as leftward slant.

Sometimes, writing may contain combination of above three slants and it is known as unstable slant or variant slant. The slant of the writing convey about emotions of the writer. Handwriting with vertical slant defines the writer as having positive qualities of independence, cool judgment and controlled emotions. The rightward slant depicts initiative character, social achievements, intense bonding of emotion. The leftward writing depicts selfish, introversion and inexpressive emotion character of the writer and the variant slant shows the unstable nature.

The size of letters can be large, medium or small. These three types of size define the concentration of writer. The large handwriting tells less concentration and extrovert. Actors, politicians and salespersons have large handwriting. The medium handwriting tells ability of writer to concentrate on things and maintaining them. The writer having small handwriting is introvert, have more ability to concentrate. Scientists, authors, composers have small writing.

The layout of the page can be considered as margin. When writer writes on the blank page, they assume margin and writes. The written page when we see, there is blank space on left, right, top and on bottom. These are margins.

Margin can define the past and future, intelligence, adjustments, truthfulness and fastness. If there is constant left margin, then writer should have the good manners and constant behavior. If it is irregular, then writer is careless about their dressing and behavior. Constant right margin shows good judgment and the ability to take decision. Top margin tells about convention. Less space on bottom side shows laziness and indecision of writer.

The amount of the force exerted at the time of writing is considered as pressure of pen. Pen pressure may be heavy, light or medium. The pen pressure shows the mental energy of the writer. The medium pressure depicts the feeling not so intense. The heavy pressure shows self-assertive, dynamic, heavy in everything, angry, energetic, active, anxious, alert and punctuate. The light pressure shows passivity, calmness, lack of intensity and illness.

The speed shows how quickly or slowly the writer writes. It shows thinking ability of writer. Fast writing shows that writer dislike to wait for anything, having large imaginary power and slow writing shows response to a greater degree, less imaginary power and thinks slowly. In graphology spacing implies the distance maintained between the lines, words and letters by the writer. Spacing can reveal various personality constructs like the writers closeness with people, and also his intelligence.

We propose following four algorithms to achieve our goal. Those algorithms are:

Transform Gray Signature Image to Bi-Color Signature Image

Input: Gray scale Signature Image.

Output: Bi-Color Signature Image.

a. Open Gray scale Signature Image in Read Mode.
b. Read the Pixel.
c. Check the Pixel intensity value: if the value is less than 255 (gray value for white color) Then convert it to 0 Else no modification in the Pixel value.
d. Rewrite the Pixel with changed intensity value
e. If not 'end of file' Then go to Step-b.
f. Close image file.

Extracting Region of Interest (ROI)

Input: Bi-Color Signature Image (Output of 3.1 Algorithm).

Output: Image only with Signature Region.

a. Open Image1 (Bi-Color Signature Image) File in Input Mode.
b. Open Image2 File in Output Mode.
c. Declare an Integer 2D Matrix of [n x m], where, n and m are width and height of Image1.
d. Get RGB Value [i, j] of Image1 and store it to Matrix[i, j] position.
e. GotoStep-4 until end of Image1 File Matrix [n, m] is generated with RGB Weight of Image1.
f. Identify First row where First Black RGB Color is occurred in Matrix [n, m], i.e., p.
g. Identify First column where First Black RGB Color is occurred in Matrix [n, m], i.e., q.
h. Here, Matrix [p, q] is the starting position of Signature Region of Image1.
i. Identify Last row where Last Black RGB Color is occurred in Matrix [n, m], i.e., x.
j. Identify Last column where Last Black RGB Color is occurred in Matrix [n, m], i.e., y.
k. Here, Matrix[x, y] is the end position of Signature Region of Image1.
l. Get RGB Values of the Matrix…..[p, q] to [x, y] Position and Write into Image2 File.

Scaling

Considering the resultant bi-color signature image from the algorithm mentioned in Mathematics behind the scaling we used and tested randomly as given below:

a. Input image is loaded via Toolkit and Media-Tracker.
b. Four (4) arguments contain the maximum size of the Image to be created. The actual size of the Image will be computed from that maximum size and the actual size of the image (all sizes are given as pixels). The code will scale the Input Image correctly.
c. If the two arguments for the maximum Image size are both 100 and the image that was loaded is 400 times 200 pixels large, we want the image to be 100 times 50 pixels large, not 100 times 100, because the original image is twice as wide as it is high. A 100 times 100 pixel image would contain a very skewed version of the original image.
d. Now that we have determined the size of the image we create a Buffered Image of that size, named iImage. We have taken another object for that new image and call its draw Image method to draw the original image on that new image. The call to draw Image does the actual scaling.
e. The rendering and bilinear interpolation can be used (performance will slowdown) and speed more important. For nicer results (at least in some cases) we have used Interpolation Bicubic Instead Of Interpolation Bilinear.
f. In order to save the scaled-down image to a file, we have created a buffered File Output Stream with the second argument as name and initialize the necessary objects. The quality argument from the command line is converted from the interval 0 to 100 to the interval 0.0f to 1.0f, because that's what the codec expects (I mostly used 0.75f). The higher that quality number is, the better the resulting image quality, but also the larger the resulting file.

Image Thinning Algorithm (ITA)

Input: Resultant Signature Image from 3.3 Algorithm

Output: Thinned Signature Image

a. Take the surrounding pixels of foreground.
b. Foreground points must have at least a single background neighbor.
c. Reject points that with more than one foreground neighbor.
d. Continue Steps [b to d] until locally disconnect (divided into 2 parts) region with Pixel iterate until convergence.

Implemented pseudocode

```
BufferedImage bi = ImageIO. Read (new File ("Signature_Image")); int [] [] matrix = new int[bi.getWidth()][bi.getHeight()];
For (inti=0; i<bi.getWidth (); ++i)
{For (int j=0;j<bi.getHeight();++j) {Matrix [i][j] = bi.getRGB(i,j);}}
Introws = bi. get Width (), columns = bi. Get Height ();
For (inti = 0; i< rows; ++i)
{For (int j = 0; j < columns; ++j) {If ((i==0) || (j==0) || (i==(rows-1)) || (j==(columns-1))) matrix[i][j] = 0;}}
For (int r = 1; r < rows-1; r++)
{For (int c = 1; c < columns-1; c++) {if ((matrix[r][c] == 1) && (matrix[r][c+1] == 1) (matrix[r+1][c] == 1) && (matrix[r+1][c+1] == 1)) matrix[r][c] = 0;}}
For (int r = 1; r < rows-1; r++)
{For (int c = 1; c < columns-1; c++) {if ((matrix[r][c] == 1) && ((matrix[r][c-1] == 0) (matrix[r-1][c] == 0) && (matrix[r][c+1] == 0) (matrix[r+1][c] == 0))) Matrix [r][c] = 0;}}
```

Result

Extensive testing has been done with a Signature Database composed of 131 users (individuals) Signatures, each user with 24 Handwritten Signatures and 10-trained forgery Signatures [Handwriting Databases: http://www.gpds.ulpgc.es/download/].

One such testing result is taken and shown here in this paper. Fig. 1 shows a user signature in original 256-color image and different ink color is used, but, other than black. Bi-Color clustered image is the output image shown in Fig. 2, and this is the output of our Transform Gray Signature Image to Bi-Color Signature Image" algorithm. The one more advantage of this algorithm is that it is very much useful for noise reduction; this can be achieved by tuning the threshold value during conversion to Bi- Color Image. The resultant image is passed through our "Extracting Region of Interest (ROI)" algorithm. Then the Resultant Signature Image is passed through our Scaling algorithm. Then the image is passed through our ITA algorithm. Fig 3 and Fig 4 show suicide note and cropped note.

Fig 1: 256 BMP Image (Gray) [246 x 146], Before Pixel Clustering

Fig 2: Bi-Color Image [246 x 146], after Pixel Clustering

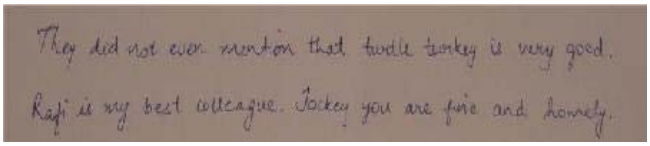

Fig 3: Handwriting Suicide Note

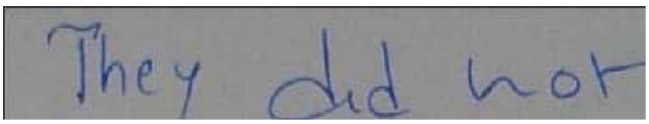

Fig 4: Cropped image from the note

Conclusion

This paper is emphasized on various Image Processing algorithms. These are preprocessing art of Signature Images required for future authentication and recognition. In this paper we propose four different algorithms very newly. Initially, gray scale signature image has been taken and gradually through four different algorithms final output is extracted. The result derived finally, has been outlined in term of times consumed.

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