Journal of Image Processing and Artificial Intelligence
Volume 3 Issue 1

A Literature on Handwritten Signature Extraction Techniques

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Abstract
Signature is a special case of handwriting which includes special characters and flourishes. Many signatures can be unreadable. They are a kind of artistic handwriting objects [1]. Often stylized depiction of someone's name, nickname, or other mark that a person writes on documents as a proof of identity and intent, hence it is articulated as a behavioural biometric. Signature is socially accepted and extensively used means for authentication in our daily life. It is widely used to recognize a person delivering out daily procedures for example in bank operations, document analysis, electronic funds transfer and access control. Signature can be handled as an image, and hence, it can be recognized using computer vision. Signature that has been transformed to electronic form can therefore be termed as an electronic signature. Electronic signature capturing is classified into two broad categories namely on-line and off-line. With off-line technique, signature is signed on a piece of paper and scanned to a computer system while in on-line technique, signature is signed on a digitizer and dynamic information like speed, pressure is captured in addition to a static image of signature.

Keywords: *Electronic signature, binarization, capture, colorization, component, handwritten signature, offline, pixel, vectorization*

INTRODUCTION

In the last two decades, the advancement in the sensor technology has given rise to some major successful online signature capturing technique while the offline signature capturing remained dormant [1–3]. Researches in on-line signature verification have been reported with high success rates. However, off-line signature verification researches are relatively unexplored although; off-line signature systems are still largely in use. Applications of off-line signature verification systems include: authentication of bank cheques, attendance register monitoring and visa application [4].

Handwriting varies in slant and skew as well as the amount of noise and ornamentation that may be introduced through individual writing style and context so also is signature [5]. The study showed that a small percentage of word images were skewed and contained underlines amongst other variations [6]. Further research has indicated that the effect of the aberrations mentioned above impacted highly on the success handwritten signature recognition and extraction. There are different handwriting styles. An example is the cursive handwritings in offline signature. This contributes to the difficulties faced in offline signature capturing.

The concept of signature has been with us for centuries as a means to establish the authenticity of documents. Electronic versions of traditional signatures and watermarks provide some benefits in the areas of electronic documenting but

experiencing a lagging in the use of handwritten signatures and where it is available, it requires tedious processes and so is gradually being taken over by digital signatures. But the generality and acceptability of handwritten signatures are higher and therefore requires greater attention. A wider use of signature is seen in virtually every department of an organisation that deals with paper works this therefore make the system to be of great benefits to virtually every industry and necessitates the development of the proposed system.

Signature is widely accepted as a proof of agreeing or consenting to an agreement. The need to therefore automate the use and transfer of signature has led to an increase and influx of many techniques/methods in the system.

Signature capturing involves Image Segmentation which is one of the most crucial parts of image processing. Its applications include image visualization, image coding, image synthesis, pattern recognition, rendering displacement estimation [7]. The effectiveness of the technique used in the segmentation of offline signature capturing determines how accurate the resulting product would be. When considering the difficult problem of automated extraction of off-line handwritten signatures, many phases need to be implemented in order to achieve high accuracy. Several researches proposing different techniques for processing captured signature images exists. This chapter reviews some of the works proposed and implemented on signature capture systems.

HISTORY

Electronic signatures have become a ubiquitous and yet most times unchecked part of daily life for most people today. With the ability to accept electronically signed documents, businesses now function at the speed and efficiency to which consumers has now become accustomed to. Long before e-signature became a norm, the history of signature dated back to the inventors of writing, the Sumerians who were also the inventors of authentication mechanism. The Sumerians used intricate seals, applied into their clay cuneiform tablets using rollers to authenticate their writings [8]. Seals continued to be used as the primary authentication mechanism until recent times that saw the introduction of paper and ink. Paper signatures were considered to be the best standard when the need to sign important documents and contracts arise. Handwritten signatures were considered to be a logical extension of fingerprints, a unique authorization that cannot be duplicated and was therefore an excellent way to ensure authenticity when making agreements on paper. As businesses grew, it became necessary to formalize documents without physical attendance. To solve the issue, technology companies in the 80s and 90s created instruments that let businesses send signed contracts across the globe in seconds, those technologies include fax machine email and World Wide Web [9]. These technologies were vulnerable to manipulations, hence improvement which included document image analysers, text extraction techniques were introduced to ascertain the validity of the documents transferred.

Electronic signature capturing has been around the corner for about 30 years, since signature became the accepted method of authenticating document

PICTURE THRESHOLDING USING AN ITERATIVE SELECTION METHOD

A study to extract handwritten text from background using threshold selection [10]. The effect of threshold produced a white image on a black background or a black

image on a white background. In this study, a determination of the background and the image was used to generate the threshold. The threshold selection is an iterative process that converges at an optimum value. The process assumed that an Image having an object for example, a handwritten text or a signature that is to be extracted has four boxed corners, which is the background and the remaining part of the image is the object itself. This was used as the first iteration.

Next, a digitization of the image is sent into a mechanism which has a switching function f(s). The mechanism has two integrators, the image integrator and the background integrator. The switching function alters between values '1' for the background and '0' for the object. The switching function is an array of colour pixels (black and white). If the input signal f(s) is 0, the image is fed into integrator 1 and if it is 0 it is fed into integrator 2, when the full image has been received, the output of the integrators which comprises of the density of pixels are averaged to select a definite threshold and given a value called L1. The image is then processed according to the value of L1, The result of the processed image is then resent into the mechanism, and this procedure is repeated until the value of L1 is constant in the next iteration. This technique proved to be effective for images with even low contrast.

The technique could only be effective, provided that the image contains an object and background occupying different average grey levels, Furthermore, the technique might not be able to totally remove the noise from the image background which might lead to poor finished extracted signature.

AUTOMATIC EXTRACTION OF SIGNATURE FROM BANK CHEQUES AND OTHER DOCUMENTS

Developed an innovative technique for the extraction of signatures from bank cheque images and other documents [11]. Based on the integration of a crop method and sliding window technique whereby the document from which image is to be extracted from would have been fed into the system to train the system on the approximation area and pre-processed before extraction can be done.

This approach was carried out by using cropping method, which is the mapping out of the area which an object is to be extracted from, followed by the use of sliding window technique. The scanned document is first pre-processed by binarization this is where a desirable threshold level is selected to separate the image from it background to remove noise.

After the image has been pre-processed, it is then followed by the extraction stage, in this stage, a sliding window which is one pixel wide is ran across the height of the approximation area of the object (this approximation area would have been previously fed into the system for the system to get familiar with it through a virgin document of the same type), the density of the pixel In the sliding window is then calculated as it moves one pixel at a time horizontally across the approximation area, same sliding window movement is also done vertically downwards, then the sliding window would remove the four vectors (up, bottom, right and left) from the image, then the process is carried out again to remove the object from it background. As noted, this process would only be effective if the system has been introduced to the Virgin document of which object are to be

extracted from. The limitation of this work could arise from the dependency of the technique on previous knowledge of the document that would be worked on.

DETECTING HANDWRITTEN SIGNATURE IN SCANNED DOCUMENTS

Discriminative framework to extract signature from a bank service application document of any type which is based on the classification of segmented image region using a set of representative features [12]. An automated framework to extract handwritten signatures from multipage bank application documents assuming that the customer has no previous sign in the current database. The technique starts from the pre-processing stage to get better view of the image. This deals with acquiring of the input image and extracting single page samples from multi-page layout. Simple dilation operator is applied to make the lines more visible and some measure of noise is removed.

Secondly, this is followed by image segmentation to obtain the properties of the documents that are images. The segmentation stage follows a two scan connected component labelling approach which involved 3 processes:

(i) Assigning each pixel a provisional label by a 4 neighbour mask.

(ii) Reading equivalent labels and finding a representation label for each equivalent provisional label.

The image pixels and lines were processed two by two as opposed to conventional methods. After connected components labelling, the segments involving less than 350 pixels were removed since the signature regions were often larger, each segment was then vectorized to be fed into a machine learning classifier. The vectorization is made by selecting and extracting a set of content based feature to represents the segment as being a signature or not.

It is shown that gradient-based and LTP features are more useful in classifying signature segments in their single uses. In some cases, and combining feature representation schemes can enhance the reliability of the predictions. In that sense, global features such as the aspect ratio, energy and entropy of the candidate segments serve as lucrative complementary properties. The limitation of this work as seen by the review also involve the need for a sample of the cheque format to be studied by the system which also make it dependent and as such cannot be applied to foreign documents.

A TYPED AND HANDWRITTEN TEXT BLOCK SEGMENTATION SYSTEM FOR HETEROGENEOUS AND COMPLEX DOCUMENTS

A document image analysis system able to extract homogenous typed and handwritten text region from complex layout documents of various types, which is based on two connected component classification stages that successfully discriminate text from non-text and also on white rectangle detection [13].

In this work, document image analysis was divided into five subtasks respectively namely. Segmentation, writing type identification, Language identification, Text recognition for each language, Information retrieval, Segmentation of documents into 8 classes of homogeneous areas. Texts, photographic image, hand written drawn line area, graph area, table area, edge line area, spectra and material damage area proposed.

The first stage in this work was to produce a mask of the documents by using a RLSA (Run Length Smooth Algorithms) to

segregate the document using the white spaces between components then next was to separate the connected component on the document into text and non-text by using the fact that textual connected components have regular shape that is, width, height and likes. But graphical ones have irregular shapes. The connected components were separated using this assumption. Then the textual connected components are separated into written and typed by extracting fragment of the external contour of the connected component which is processed by a code book That has been trained with fragment of letters in it data set.

This system relies on a learning based approach that combines the connected components information for the text detection and the white rectangles analysis for the segmentation, this procedure makes it effective enough to segregate the signatures should in case there is noise. The assumption of this work that textual connected components have regular shape is a limitation to this work as recent digital fonts comes in different variant with irregular sizes and so would not be able to work effectively on such document. Also, detection of text blocks in the graphical parts of the documents would also affect the work.

OFFLINE SIGNATURE VERIFICATION AND IDENTIFICATION USING DISTANCE STATISTICS

A novel approach for signature verification and identification in an offline environment based on quasi-multi resolution technique using gsc features for feature extraction [14].

They were able to carry out this work by first: Gathering signatures from over 55 writers, both forged and genuine. The signature image was scanned at m 300dpi resolution and at grey scale effect. Next, the scanned image was pre-processed to extract the feature of the signature. In this work, categories of features were discussed.

These includes:
Global feature: Which would be extracted from every pixel that lies within a rectangle, by extracting this feature they claim to be able to get the transformation, series expansion, image gradient analysis etc.

Statistical feature was also discussed as being the features extracted or derived from the distribution of pixels of a signature which include statistics if high grey level pixels to identify pseudo dynamic characteristics of signatures. In this work, they used a feature extraction called GSC features (gradient, structural & concavity) which measure the image characteristic at local, intermediate and large scales.

The gradient features detect local features of the image and provide much information about stroke shape on small scale. The structural feature extends the gradient features to longer distances and gives information about the stroke trajectories. The concavity features were used to detect stroke relationships at a long distance which spanned across the image.

This work extracts the significant features of a signature at the local, intermediate and large scales for object recognition making it work across all kinds document. The work has some limitations where the signature would be scanned, the colours would have to be altered as it has be converted to grey scale format. And as such could lose it quality on the finished work.

OFFLINE SIGNATURE VERIFICATION SCHEME USING FEATURE EXTRACTION METHOD

An improved offline verification scheme which is based on selecting 60 feature points from geometric centre of the signature and compared them with already trained feature points using statiscal parameters like mean and variance [15].

The work was done by improving on the previous technique based on feature extraction using geometric centres if the image. Before the features of the images are extracted, it was first pre-processed by the following procedures.

Moving the signature into the centre of the image by taking the signature image into a fixed calculated frame and the unnecessary white spaces are removed without affecting the signature image such that the image is in the middle of the frame. Then the whole signature frame is divided into 10 x 10 square row wise and column wise and the variance is being found, prior to this, the signature would have been binarised into two tones, that is, made to have two colour variance of white and black, then, if a square has a zero variance the square is removed, otherwise, the square would be restored, by doing this, squares of in necessary white spaces are removed then the image is restored in a fix frame. Other procedures were discussed which includes horizontal and vertical splitting of the image to obtain the feature points from the centre of the image. Afterwards, the Euclidean distance of the points was calculated before the image is finally extracted.

The Algorithm which is based on the 60 feature points is more efficient and gives more accurate results. The limits of this work is that it requires the sample of the document to be scanned before it can work efficiently and it would also have to lose the original colour of the signature so as to extract it features, more so, there is a probability of rejection of an original signature if user does not sign with utmost care so that there is not a large variation of his signature to his training signatures.

OFFLINE GEOMETRIC PARAMETERS FOR AUTOMATIC SIGNATURE VERIFICATION USING FIXED POINT

A set of geometric signature features for offline automatic signature verification based on the description of the signature envelope and the interior stroke distribution in the polar and Cartesian coordinates [16]. To extract the features of the signature, they divided the work based on two vectors which represent the envelope description and interior stroke distribution in polar and Cartesian coordinate

The first stage is to detect the outlines of the signature. This is calculated by means of morphological operations, the image is first dilated in order to reduce the signature virility and after that it is filled to simplify the extraction process, when many objects are detected after filling, horizontal dilation is performed to connect all the objects. The outline is represented as a sequence of it Cartesian coordinates, the sequence is made to follow the contour counter clockwise and start at the centre of the outline.

Then the next was to represent the signature outline in polar coordinates, to do this, equidistant samples of the envelope is selected and represent each sample as a three component feature vector, this are the functions of the radius, its angle, and the number of black pixels that the radiuses cross when sweeping from one selected point to the next. This step is feature based on Cartesian coordinates of the envelope and the signature strokes and density parameters. In this case, the envelope divided through

the geometric centre into top and bottom halves and then into right and left which would result into four feature vectors, from which the signature would later be extracted.

This method can only operate on static image data and a plain signature on a noiseless background, trying to compare global features like size of the signature or similarities of the contour.

HANDWRITTEN SIGNATURE VERIFICATION TECHNIQUE BASED ON EXTRACT FEATURE

A method to identify the hand written signature [17]. A robust technique for verifying and identifying human signature images.

After collecting scanned image of the signatures, it was stored in a database in an (n x n) form and each image can represent as array. The determinant value of image is then obtained. This is achieved by obtaining the element of the square matrix enclosed in vertical lines and the value of image represented by that array.
The image was subdivided into blocks where the size of each block are 3 x 3 , then the determinants for each block is then determined. This step was then followed by determining the centric point and distance by using the boundary pixels and the centric point of boundary image centric point. The Euclidean distance between each pixel was also calculated on the boundary and the centric point, these properties were stored and are later extracted. The storing of the image in matrix form would result into loss of image quality that would result bad product.

FEATURE EXTRACTION AND VERIFICATION OF SIGNATURE IMAGE USING CLUSTERING TECHNIQUE

A method for offline handwritten signature verification with higher accuracy [18]. Where they introduced a procedure to extract feature from handwriting signatures using clustering technique.
This is achieved by scanning the signature image at about 500 dpi by a grey scale scanner, the image is first pre-processed by removing the noise that may be associated with the image and also the image is thinned. The goal of thinning is to eliminate the thickness differences of pen by making the image 1 pixel thick. This step is followed immediately by getting the region of interest (ROI). Both the sample and the test signature are resized by shrinking the image to get only the signature. This could involve shrinking or stretching the image to a fixed size.

After the successful resizing of the image, the next thing that was done was to extract the features of the image this being the aspect which this work is interested in. This was done by using the following feature extraction procedures:
1) Signature height and width ratio was obtained.
2) The signature occupancy ratio which is the number of pixels which belong to the signature density is calculated.
3) The distance ratio calculation at the boundary of the image is calculated too. This being the distance between the pixels closest to the boundaries to the edges
4) Afterwards, the length and ratio of adjacency column is calculated.

This work studies an image clustering process based on a k nearest neighbours approach enabling it to handle clusters of different sizes and shapes. This types of Image clustering techniques can also be used in the field of Face recognition and

Thumb impression recognition. The image has to be scanned at grey scale and also will be needed to be thinned which will cause a loss of authenticity of the signature by so doing setting a limit to the technique.

OFFLINE BANGLA SIGNATURE VERIFICATION

A technique which they were able to come up with the extraction and verification of bangla signatures whose script is different from the general well known scripts that are common [19].

To begin the work signature data was collected which would be extracted. Digital image of the signature is obtained by scanning the image at 256 grey scales at 300dpi and stored in tagged image file format for further processing. After the image has been collected, a histogram based threshold technique was applied to binarize the image. Here the image was converted to two tone coloured, then Gaussian grid feature extraction was employed to extract the features of the signature.

The Gaussian grid feature and svm classifiers that were employed gave encouraging results which gave almost accurate result. This work is homogenous as it is only based on Bangla signatures alone and also scanned at grey scale before it can be effective.

PROGRESS IN CAMERA BASED ON DOCUMENT IMAGE ANALYSIS

Document analysis from a single camera captured image as well as multiple frames and highlighted some sample applications under development and feasible ideas [20]. In this work, they discussed the stages which various applications of camera to extract images over scanners and the steps that could be employed. This review only focused on the steps for processing images that was captured using camera.

The process involved in processing captured image were said to include text detection, text extraction, normalization, enhancement and recognition. The process of text detection was considered to be the primary focus on works processing text, location of text was said that it could be performed with global or adaptive thresholding, and could also use the page edge in some cases. Normalization is divided into two stages which include correcting the perspective of the image, then followed by warping, whereby some texts would appear on curved surfaces, in this case, cylindrical model could be used, and if it was also assumed that the text is laid out horizontally as straight, text line features could then be used to recover the change and warp the page back to a plane.

The next step then is enhancement, some scenes of the document could require enhancement in a numbers of ways. The text should be mapped to a binary (black and white) and the size was said not be projected at 12pt 300dpi, text edges should be sharpened and characters is said not be DE blurred when possible. Brightness and contrast enhancement should be employed. Thresholding should be employed but warned against using global thresholding for camera captured images. Afterwards is recognition, as it is difficult to recognize text on image acquired by camera, specialized classifiers have been trained to deal with scene texts in videos and frames. The binarization of the scanned signature image sets a limit to the product of this work.

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