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Foot Boundary Analysis for Crime Investigation

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ABSTRACT
In this paper we present initially pre-processing of footprint image after digitization and then segmentation of Region of Interest (ROI) is used. Further we use Divide and Conquer Homogeneity algorithm, followed by edge detection. We obtain the boundary of foot print image by using proposed algorithm.
Keywords:- Footprints, Identification, Shoeprints

I. INTRODUCTION

Crime scene investigation is the meeting point of science, logic and law. Processing a crime scene is a long, tedious process that involves purposeful documentation of the conditions at the scene and the collection of any physical evidence that could possibly illuminate what happened and point to who did it. Among the numerous biometric techniques used for human identification, foot biometry has been largely neglected so far.

Even though the human foot has been extensively studied in medical and forensic research and obviously bears similar distinctive properties like the human hand, its use in commercial biometric systems is considered complicated. A RGB image taken as an input, but here the methods deals with gray image, thus input RGB image converted into gray image first. Binarization is very effective pre-processing methods for most of the segmentation. Due to large variation on background and foreground of MRI images maximum binarization fails but here a binarization method has been proposed and a global threshold value has been selected by standard deviation of the image. Global thresholding using standard deviation gives very good results and binarize each component of the image.

Among the numerous biometric techniques used for human identification, foot biometry has been largely neglected so far. Even though the human foot has been extensively studied in medical and forensic research [1] and obviously bears similar distinctive properties like the human hand, its use in commercial biometric systems is considered complicated. Reasons include a non-habituated environment, user-unfriendly data acquisition (due to the practice of wearing shoes) and, last, uncomfortable associations at the acquisition step.

By tradition in Arab countries, it is considered offensive to show someone the sole of your foot. Most access control systems rely on face, fingerprint, hand geometry, iris, palm print and signature features [2]. While some biometric features are not secret and may be generated out of publicly available data, it is in each user's interest that private biometric features such as retina or even fingerprints are not compromised. However, precisely because foot biometry is not and probably will never be a suitable authentication mechanism for high-security applications, storage of foot biometric features does not necessarily imply security threats. If the environment allows user-friendly data acquisition, e.g., thermal baths, or security issues demand uncritical features, foot biometry may be considered as a useful alternative. Within special environments, foot biometry might even be implemented as a covert system in contrast to hand biometric techniques. Therefore, the image acquisition step used in this work is inherently simple, and it does not employ any special illumination, nor does it use pegs to cause any further inconvenience. The first footprint-based recognition dates back to Kennedy [1] in the late 1980s, who used inked bare- foot impressions to extract 38 local geometrical features, such as length between heel and tips of toes, optical centers of heel and toes or width of ball and heel. Some work concentrated on forensic applications, the first scheme concentrating on footprint-based authentication using simple Euclidian distance between foot-prints was introduced by researchers [3].

Operating on pressure distribution data and simple Euclidian distance, recognition rates of 85% could be achieved. Further work concentrates on static and dynamic foot print based recognition models [4, 5] with recognition rates of about 80 to 97.8% dependent on feature selection and database size. Since neither taking ink-based impressions in the first case nor recognition rates of 80 to 85% are suitable for commercial security applications, we investigate more elaborate approaches to foot biometrics. While the idea of using shape and skin texture information of the human hand is not new and numerous biometric features are described in detail in [6-8], it will be more specific for identification the application of some of these features are used in foot biometrics. Traditional hand biometric features are most likely to be applicable to foot biometrics; thus, we investigate their discriminative properties. However, techniques also used in face recognition (e.g. Eigen faces as described in [9]) can be successfully implemented. Second, a goal of this project is the introduction of a prototype footprint verification system. Thus if following biometric measurements can be used for identification:

1. Shape and geometrical information focusing on characteristics such as length, shape and area of the silhouette curve, local foot widths, lengths of toes, and angles of inter-toe valleys;
2. soleprint features analogous to palm print-based verification extracting texture-based information of the sole of the foot;
3. minutiae-based ball print features employing different techniques used in fingerprint verification systems;
4. Eigen feet feature (corresponding to Eigen faces in traditional face recognition) in the principal component subspace for recognition of both shape and textural information.

II. LITERATURE SURVEY

Pre-processing is important for reliable foot recognition. Some researchers [3] could improve their Euclidian-distance-based footprint recognition method on raw images from roughly 30% to 85% by just achieving normalization in direction and position. While for unconstrained hand images a re-alignment of individual fingers using texture blending [7] is promising, an adaption to foot biometrics is considered complicated due to close-fitting toes and has not yet been implemented. However, a successful alignment of toes could further increase recognition rates of global features. Some researchers [10] proposed the following steps as pre-processing:

1. Binarization using Canny edge detection [11] and thresholding.
2. Rotational alignment using statistical moments.
3. Displacement alignment restricting the image to the bounding box of the footprint.
4. Background pixels are masked and the processed footprint is scaled to provide each of feature extractors with appropriate resolution input.

In the case of hand recognition there also need of image pre-processing. The hand images are first pre-processed in order to extract the hand silhouette and eliminate artifacts such as the guidance pins, user rings, overlapping cuffs or creases around the contour due to too light or too heavy hand pressing. The pre-processing step can range from simple image thresholding [12] and filtering to sophisticate gray-level segmentation or edge detection. Possible dents at the artifact location are smoothed by linear interpolation and/or morphologic operators [12] or are simply not used in the feature extraction process.

III. PROPOSED METHOD

Footwear impressions are among the most commonly found evidence at crime scenes and present more frequently than finger prints. Identification is based on the physical match of random individual characteristics of the shoe has acquired during its life. The only thing consistent about crime scenes is their inconsistency. Because of their diversity, crime scenes can be classified in many ways. First, crime scenes can be classified according to the location of the original criminal activity. This classification of the crime scene labels the site of the original or first criminal activity as the primary crime scene and any subsequent crime scenes as secondary. This classification does not infer any priority or importance to the scene, but is simply a designation of sequence of locations. Evidence provided by a positively identified shoe mark is as strong as the evidence from fingerprints, tool marks, and typewritten impressions [1-3].

The edge detection process is done in three passes. In the first pass the scanning of image is done horizontally in the x direction i.e. in a row major order. The algorithms start from the leftmost pixel of the first row and traverse all pixels on the first row to reach the last pixel of the first row. Then we repeat the scanning of pixel from the next row and continue to subsequent rows till we reach the last pixel in the last row of the two dimensional image data array. Once the images have been processed and the features detected, standard classification techniques can be used to identify potential matches against the database mentioned above. Similarity between features will be computed and all the samples with a similarity above a certain threshold will be considered candidates. Currently, the automation of shoe print recognition goes this far and no further. The set of potential matches is then analysed by a forensic Sample shoe prints and features (Image from [3]. There have been some attempts to improve this process by sorting the result matches according to some similarity measure, and in [4-5]a technique for this is outlined which uses the
Fourier transform to sort candidate images.

An interesting convenience having extracted the length of the big toe and its neighbouring one is a pre classification of feet. Just as fingerprints can be separated into basic pattern-level classes known as arch, left loop, right loop, scar, tented arch, and whorl [13], it is possible to classify feet according to the differences in length of hallux and second toe into Egyptian (hallux longer than second toe), Greek (second toe longer than hallux) and square (both toes have almost the same length) feet. The following algorithm will detect footprint boundary.

Step 1. Scan the image from the Left side of the image to locate the leftmost pixel of the image region.
Step 2. Draw a vertical line along this pixel from top to bottom representing the Left baseline or boundary.
Step 3. Scan the edge map from the right side to left, from the first row.
Step 4. Obtain a pixel that is black indicating an edge path, traverse the pixel path by considering all the surrounding pixels in a clockwise priority and consider the pixel with the highest priority.
Step 5. The pixels that surrounded the edge pixel, but are of lower priority are stored in a Backtrack Stack to be used only if the traversal process reaches a dead end.
Step 6. If a dead end is reached, pop out from the Backtrack stack a lesser priority pixel and continue with the traversal process.
Step 7. Store the pixels traversed in a Plotting List to be used later for drawing the footprint boundary.
Step 8. Traversal continues to the next pixel till it reaches the left baseline or the bottom of the image.
Step 9. If the bottom of the image or the left baseline is not reached the path is discarded, the plot list is erased and continue from Step4.Else Get pixels from the Plotting List at a discrete interval.
Step 10. Plot the first pixel.
Step 11. Draw a simple curve between two consecutive pixel positions separated by the discrete interval.
Continue plotting till the last pixel in the Plotting List is plotted. The following outputs are obtained by using the proposed algorithm.

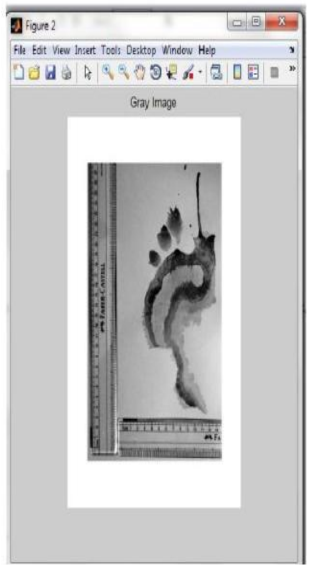

Figure 5: Input Image Figure 6: Gray Scale

Image

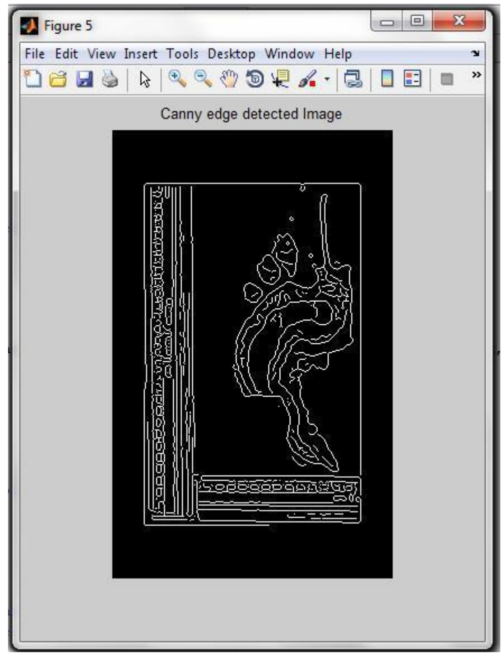

Figure 8: Foot Boundary using proposed algorithm

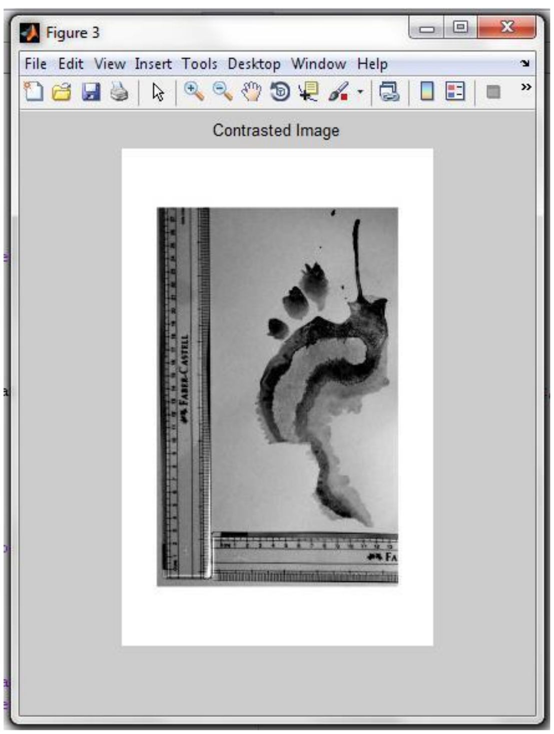

Figure 7: Contrasted Image

IV. CONCLUSIONS

Among the numerous biometric techniques used for human identification, foot biometry has been largely neglected so far. Even though the human foot has been extensively studied in medical and forensic research and obviously bears similar distinctive properties like the human hand, its use in commercial biometric systems is considered complicated. In this paper foot print boundary analysis is made and proposed method is illustrated.

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