Evidence Collection & Detection of Footwear Impression
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ABSTRACT
Impressions of footwear are usually found in crime scenes. the standard and wide variability of those impressions makes their analysis is extremely tough. This analysis can develop new process ways to help the rhetorical footwear examiner within the U.S. during this analysis work involves developing a info of representative footwear print pictures in order that acceptable algorithms may be developed and their error rates may be determined. Algorithms for characteristic special options such as wear marks and embedded pebbles will be developed. Matching algorithms to be developed will be for both the tasks of verification, wherever the goal is to work out whether or not the footwear evidence is from a particular suspect’s shoe, or that of identification, wherever the goal is to work out the brand of the shoe from a acknowledged set of brands. In every case a quantitative measure of the result of matching will be provided. In the identification mode, the tools will allow the narrowing down of prospects in an exceedingly information of noted prints. Another goal here is to assist the U.S. footwear examiner homicides and get assaults wherever there aren’t any noted prints to match. For the purpose a classification tool is to be developed, wherever the target is to generate from the evidence a collection of characteristics, e.g., gender, shape, texture, size and brand. This work will be extended by following guidelines of SWGTREAD and in shut consultation with forensic footwear and/or tire tread examiners.

KeyWords
morphology, footwear matching, indexing clustering & classification, enhancement, etc.
INTRODUCTION
Shoe marks- the mark created by the outside surface of the sole of a shoe (the outsole) are distinctive patterns that are often found at crime scenes. Shoe marks may be generally broken into two classes:
1. Shoe impressions which contain three-dimensional info (e.g., shoe impression at the beach) and
2. Shoeprints which contain 2-dimensional info (e.g., shoeprint on a floor).

Shoe mark is common at crime scenes and is believed to be present a lot more frequently than fingerprints [1]. The study of several jurisdictions in European nation disclosed that 35 percent of crime scenes had shoeprints usable in forensic investigations, while [2], Girod found that 30 percent of all burglaries offer usable shoeprints. More generally, footwear impressions are created when footwear is ironed or stamped against a surface like a floor or piece of furniture in which method the characteristics of the shoe is transferred to the surface. The tasks for the forensic footwear examiner are:
- Verification: where a bearing is to be matched against a suspect’s print.
- Identification: matching the print evidence against a presumably massive set of glorious prints.
- Classification: determinant the generic characteristics of the footwear, such as whole, gender and size.

The variability of prints comes concerning thanks to the variety of surfaces on that the impressions are created (Fig). Footwear marks offer valuable forensic evidence. In several instances, shoe marks may be positively identified as having been created by a selected shoe to the exclusion of all other shoes. Identification is predicated on the physical match of random individual characteristics the shoe has noninherita-ble during its life. Evidence provided by a positively known shoe mark is as sturdy because the evidence from fingerprints, tool marks and written impressions [1]. In other instances, detail retained in an exceedingly shoe mark may be short to uniquely determine an individual shoe however remains very valuable. Due to the big variety of shoes on the market on the market, with most having distinctive out sole patterns, this implies that any specific model of shoe are going to be closely-held by a very small fraction of the final population. If the model of a shoe can be determined from its mark, then this can significantly slim the search for a specific suspect. A picture of a shoe mark can be obtained using photography, gel, or electricity lifting or by creating a cast when the impression is in soil. Subsequently, within the forensic laboratory, the pictures of the shoe mark are compared with the shoeprints and shoe impressions of well-known shoe samples. A method of detection and recovery of footwear impression proof and of comparison of the impressions with suspect shoes is described in [1].

The photograph of the impression or of the lifted impression or forged will be afterward scanned and a digital image created. Forensic analysis needs comparison of this image against specific databases. The databases include: (i) marks made by shoes presently and antecedently out there on the market and (ii) marks found at alternative crime scenes. Scrutiny crime scene shoe mark images to databases are presently a gruelling task and it is ordinarily manually conducted by looking paper catalogues or computer databases. Due to its time consuming nature, shoe mark evidence isn't used as often because it could be. for instance, in 1993, solely five hundred of fourteen,000 recovered prints within the Netherlands were identified [3]. Thus, computer-based strategies that reduce the operator effort for this task provide nice benefit to forensic scientists. Forensic examiners of shoeprints and tire marks area unit a community of regarding 200 professionals in the United States. Shoeprints constitute regarding 80-90% of the case-work of the tread examiner WHO deals with each footwear and tire-marks. guidelines for the profession area unit given on the IAI web site handling the Scientific working group on Shoeprint and Tire Tread evidence (SWGTRREAD). The forensic footwear and/or tire tread examiner collects and preserves footwear and tire tread proof, makes scientific examinations, comparisons and analyses of footwear and/or tire tread impression proof so as to:
- Include, identify, or eliminate a shoe or tire because the supply of associate degree impression;
- Determine the whole or manufacturer of a shoe or tire;
• Link scenes of crime;
• Write reports and supply testimony as needed.

There has been important research conducted in shoeprint analysis in Europe specializing in the needs of the EU community. There are necessary differences for the task in the U.S.A. Homicides and assaults are paid a lot of attention to than burglaries in the U.S. In such cases, shoe prints have a very low probability of appearing in different cases. Due to this reason the classification task, i.e., determinative complete, style, size, gender etc., is of importance. Through such classification, even if the person could not be identified, the search may be narrowed down to a smaller set of suspects. The goal of this analysis is going to be to develop many computational tools to assist the U.S. forensic community in dealing with footwear impressions. Some of the tasks are: rectification of the shoe prints before they're analyzed, extraction of grouping options for the aim of identification or elimination, obtaining the strength of evidence (match score) supported the options extracted from the evidence and famous prints and economical search through a information of prints.

MATCHING AUTOMATIC FOOTWEAR

In automatic footwear identification system, firstly, identified shoe-prints are scanned, processed and indexed into a information (Fig. 2). Associate degree automatic footwear identification system accepts as input shoeprint evidence and retrieves the most probably matching prints. Automatic matching of footwear patterns has been very little explored. Early work [2,4-7] involves semi-automatic methods of manually annotated footwear print descriptions using a codebook of shape primitives, e.g., geometric shapes, wavy patterns and logos. the method is heavy and the source of poor performance due to inconsistent user encoding [17].

In illustrious footwear prints square measure scanned in several angles, like +30, -30, +60, -60, +90, -90, square measure scanned & indexed into a database (Fig). The approach of [3] employs shapes generated from footwear prints using image morphology operators. spacial positioning and frequencies of shapes are used for classification with a neural network. No performance measures are rumored [8, 9] uses fractals to represent prints and mean square noise error classification. Fourier Transforms (FT) are used for classification of full and partial prints [10,11].

In recent times [13] invariant local feature descriptors and spectral matching has been used previous techniques of automatic foot-wear matching can be characterized on four dimensions as follows

1. features Used
   • Fractal patterns [8,9],
   • 2-D separate Fourier Transforms (DFT) [10,11] and
   • Local invariant descriptors [12,13]

2. Feature Similarity/Matching Algorithms Used
   • Mean square Noise Error method [8,9],
   • DFT coefficients [10, 11] and
   • Spectral correspondence matching method [13] for local invariant descriptor matching

3. Databases Tested square measure
   • Database I [8, 9]: 145 full-print images with no abstraction or rotational variations,
- Database II [10]: 503 shoeprint images happiness to 139 pattern groups with each group containing a pair of or additional examples
- Database III [11]: 476 complete images happiness to one hundred forty pattern groups with each group containing 2 or additional examples.
- Database IV [13]: a subset of 368 completely different patterns [14]

4. Footwear Prints utilized in Experiments area unit
- Real footwear prints and generated partials [11] (Fig.)

DIFFERENT TECHNIQUES

Image Retrieval Content Based: There is a significant-sized literature on content-based image retrieval (CBIR). This is as a result of the actual fact that enormous volumes of images square measure being produced, e.g., by NASA and executive department and it is expensive or not possible to annotate each of them by type. Therefore it is a challenge to search out pictures similar to the one at hand.

DIGITAL IMAGE ENHANCEMENT

Interactive image enhancement operations are accessible in Photoshop and alternative image process software package that are accessible to the footwear examiner. This effort is to perform such operations automatically in order that searching can be done with efficiency.

FOOTWEAR PRINT DETECTION

Debris and shadows and different artifacts within the crime scene impressions can interfere with true shoe prints. So, the planned task of “shoe print detection” is to mechanically label a print to be a shoe print or not. For this task, not only shoe print pictures are needed, however also different types of prints encountered in crime scenes.

REGION CLASSIFICATION

Debris and shadows and alternative artifacts within the crime scene impressions are troublesome to filter from footwear impressions. They have interfered with makes an attempt to store and search within the info. Therefore, once digital image enhancement, some algorithms are desired to be ready to classify totally different regions of footwear impression to be one in all 2 types: helpful regions (impressed by foot-wear) and discard able regions (impressed by alternative artifacts (noise) like debris).

ROBUST MATCHING ALGORITHMS
To cope with poor image quality strong matching algorithms, that possibly emulate human expert comparisons, ought to be designed to create accurate and fast choices. A comprehensive system needs to integrate 3 levels of analysis: (i) global shoe properties: heavily worn or fresh, shape, size etc., (ii) Shoe classification: whole, style, belongs to male or feminine (iii) Shoe recognition: elaborate and distinctive native options ought to be used to extend the discriminative power so as to verify a match between a shoeprint recovered from the scene of crime and a suspect’s property.

PARTIAL PRINT MATCHING
In some crime scenes, only partial shoeprints (termed as “half prints” and “quarter prints”) are on the market, e.g., the proper column of Fig. when information on the market in partial prints is restricted, effective utilization of the little information on the market could be a challenge.

INDEXING
In a massive shoeprint database, the potency (speed) of retrieving a question print may be vital. Effective categorization techniques ought to be designed for such demand. Categorization technique to enter commonplace shoeprint prototypes ought to even be developed.

CLUSTERING
Clustering of footwear prints into those of similar type can yield not solely faster retrieval but conjointly give taxonomy of footwear print sorts. Bunch will involve extracting discriminating options from footwear prints and determinant their proximity in feature area.

RETRIEVAL
The system should be flexible to allow for probably differing kinds of retrieval. For instance, the task are often that to retrieve all shoe-prints in the information that match a specific region of the shoe-print.

CLASSIFICATION
There are several potential classification tasks, e.g., decisive brand or manufacturer, decisive gender, etc. even though an ideal match does not exist in the example info, a variety of classification algorithms may be relied upon to provide helpful information such as age, gender and shoe size.

FOOTWEAR EVIDENCE SAMPLES
It is proposed to make a knowledge set of foot-wear outer sole impression samples. They are necessary for developing algorithms for this analysis furthermore as for testing. At the present such databases are not in public out there.

SYNERGY WITH OTHER FORENSIC DOMAINS
This project has commonalities with other projects within the analysis of impression evidence, specifically questioned document examination and friction ridge analysis. But there are also major differences. [17,18]

SHOE PRINT EXTRACTION
A crucial step in shoe-print identification is shoe-print extraction—this is the task of extracting the foreground from the background surface. The problem is formulated as a machine learning task that is approached employing a probabilistic model, Conditional Random Fields (CRFs). Since the model exploits the inherent long-range dependencies that exist within the shoe-print it is additionally strong than other approaches, i.e. neural networks & adjustable thresholding of grayscale images into binary [18].

Fig: Example of five shoeprint pattern categories. The left 2 columns show examples of pictures of full-prints and the right column shows examples of pictures of partial-prints.
CONCLUSION AND FUTURE WORK
In this paper we tend to observe & studied varied techniques for identification, classification & verification for shoe-print evidence assortment and detection. Most of researchers are used sweetening, morphological & segmentation techniques, bust the given results aren't satisfied.

In future we tend to use the assorted image processing techniques like segmentation is incredibly helpful to extracting the foreground from the background. The mathematical morphology & another edge based mostly algorithms is incredibly higher to extract the shapes of varied sorts of shoe-patterns like noise, robust with partial & full prints, etc. datasets.

REFERENCES