A Method to minimize spoofing in palmprint identification system

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Abstract:

Region of interest (ROI) derived palmprint images have higher entropy and require less processing and storage, they considerably improve the effectiveness of identification systems. Using image processing methods like dynamic thresholding for binarization, centroid determination, boundary extraction using morphological operations, Euclidean distance calculations from the centroid, valley point determination after smoothing the Euclidean distance plot, and from which the ROI is ultimately extracted, the technique used here calculates distances between points using geometry. Using this technique, ROIs for the datasets of sizes 128 x 128 and 256 x 256 have been extracted.

Introduction:

Biometric systems are a helpful feature for authenticating and differentiating people from other people. Its primary characteristics or properties, which include universality, distinctiveness, permanence, and collectability, make it a potent biometric for recognition. These make sure that the feature is present in everyone, that it has enough variation, and that it does not change drastically over time. The issue about these traits is acceptability, performance, and risk of circumvention.

Execution:

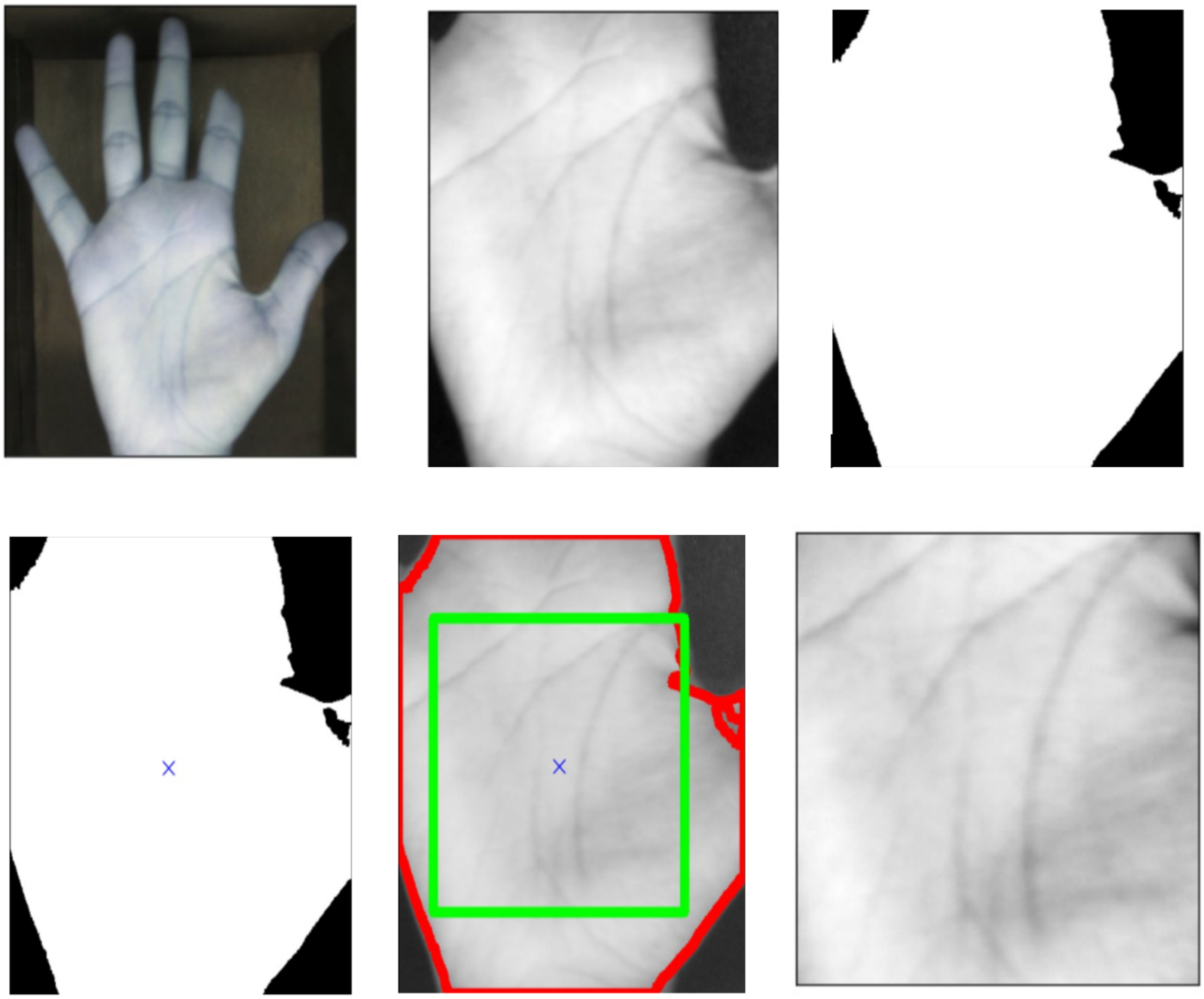


Fig 1: a. Original Palmprint, b. Cropped Palmprint mask, c. Palm center detected from mask, d. Region of extraction marked, e. Region of extraction.

1. Our dataset consists of seven images of each of the 230 participants right and left hand while sampling a dataset consisting of only left hand of each participant.
2. Each of these images are displayed on 2560-by-1600, 227ppi screen with 500 nits of brightness and captured using a phone camera, 48MP quad pixel sensor (fuses 4 pixels into 1 to give output of 12MP), 24mm lens at aperture of 1.7 to generate the data of spoofed palm images captured from the screen.
3. We printed these 115 of these images at random and then captured those using the same camera to simulate spoofed images captured from printed sheet.
4. The images were cropped manually to only contain the palm and then further to crop finger by considering the bottom 55% of the image and cropping 25% from the side.

5. A mask is generated with thresholds of 200,255 and combining THRESH_BINARY and THRESH_OTSU type. Also, a kernel of size 3x3 is initialized.
6. Gaussian blur is applied on the masks to reduce high frequency components with standard deviation in X and Y direction of 2.29.
7. Then the mask is normalized, and then morphological transformations are applied to remove any of the area that have passed into the mask that are not needed.
8. Using cv2. findContours contours are selected (which are the points with same intensity) and the one with the biggest area among these is selected.
9. An epsilon is calculated which is used in the approxpolyDP function to approximate the shape of the region. The epsilon is the perimeter with precision value of 10^(-31).
10. This approximated shape is passed in the Moments function to calculate the moments of the contour from the moments the center of the area is generated using x co-ordinate = M['m10'] // M['m00'] and y co-ordinate = M['m01'] // M['m00'].
11. A rectangle with these x and y points as center is selected as the region of interest and saved.
12. These saved ROI are loaded and using createCLAHE which normalized the histogram of the image, enhances the quality of image as resizing to size of 150-by-150.
13. Features such as 'mean', 'pixel_intensity_variance', '10th_percentile', '50th_percentile', '90th_percentile', 'skewness', 'kurtosis', 'median', 'mode' are extracted directly from the image.
14. 'contrast', 'correlation', 'energy', 'homogeneity', 'entropy' is extracted after calculating a gray level comatrix of 256 levels.
15. DWT is applied on the images and is split into 4 bands, ll,lh,hl,hh. These bands are then split into several sub-bands of 75-by-75 size and on each of them dct is applied followed by pca to get 2 variance ratio values and 2 singular values.
16. All the above values are inserted into a data frame.
17. So, the total number of features is 350.
18. The dataframes of all the three; original, spoofed-print and spoofed-display are merged and shuffled. With the class values of original as 1 and spoofed as 0.
19. Only half of the spoofed-print and half of three spoofed-display data is selected at random to avoid bias issues.
20. SVM is applied on the dataset after splitting data int train and test with ratio of 4:1 and the test into test and validation with ratio of 7:3.
21. XGBoost is applied on the train data and with the model obtained the important features were extracted and ROC curve was plotted.
22. Both the models were saved for further use.

Database link:
http://www4.comp.polyu.edu.hk/~csajaykr/IITD/Database_Palm.htm

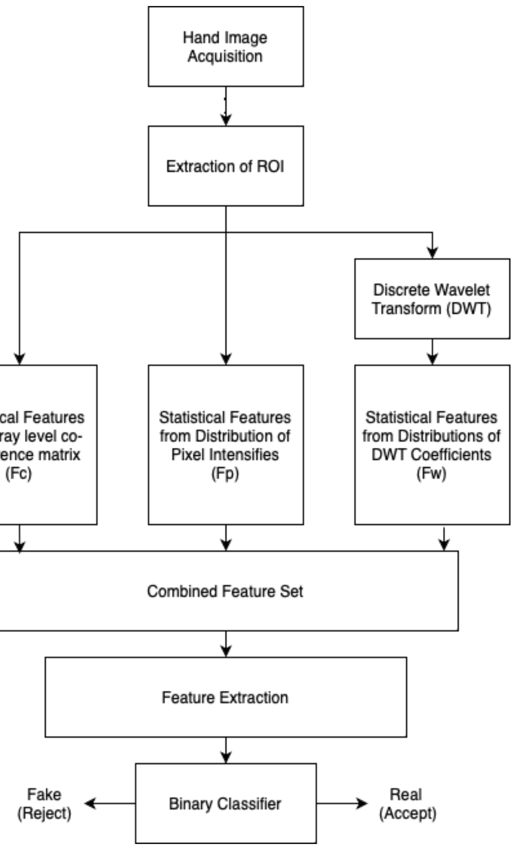


Figure 2: Process Outline

Significance of your work:

In our approach, we will combine the most effective techniques from the studies we cited in our approach. Using a dataset from the Indian Institute of Technology, New Delhi that comprises of 230 people, 1300 photos of the right and left hands. Since the right hand is the one that recognition algorithms most frequently utilize to generate spoof photos, we will only use photographs of either hand in most cases. Since the reference articles show that it leads to a high mistake rate, we won't be using photos of one hand for training and the other hand for testing. For display spoof images, we will use the photos from the dataset and show them on a monitor consecutively while capturing pictures of the monitor with a phone or a webcam when each image is presented. A Python script will be used to automatically show the photographs on the screen, automating the entire process. The photos from the dataset are initially printed on an A4-sized sheet of paper for the print-based spoof image production. A 720-pixel image with a 1200 dpi resolution is taken using a camera.

We will first extract a 150 by 150-pixel section from the collected dataset, which is typically the center of the palm. Then, three sets of statistical characteristics obtained from the distribution of pixel densities, the Discrete Wavelet Transform (DWT) coefficient, and the grey-level co-occurrence matrix will be concatenated to construct the dataset of multi-dimensional features.

Novelty:

People have made attempts to stop spoofing in contactless palmprint photos, and they have had some success in doing so, but switching between training on the left hand and testing on the right hand has significantly reduced the number of errors.
Combining DWT and DCT allows redundancy that cannot be recovered using DCT alone to be extracted using DWT first, and then the local correlation is used by DCT later. DWT aids in the extraction of the facial image's general features.

Literature Search:

1. Attack presentation classification error rate (APCER) and normal presentation classification error rate (NPCER) are the two error rates that are employed. Performance in cross-device, print, and single device scenarios is improved by combining the characteristics of the three categories. When trained using display artefact1 and tested using display artefact2, the error rates (APCER and NPCER) were greatly reduced, coming in at 0.93 and 0.88, respectively. One problem with this is that no new database needs to be made because the fake images will be the real ones on a phone or piece of paper. Changing the training and test datasets considerably raises both error rates.

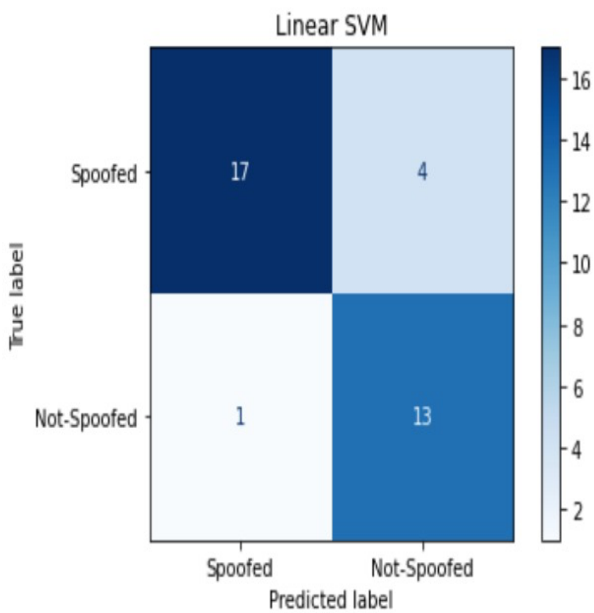
2. The LBP based approach is quite effective at identifying fake palm prints, often known as prints and display assaults. The traditional method, which employed conventional texture descriptors, is innovative compared to the surface reflection-based approach. This technique exclusively uses the reflection of perfect spheres or convex surfaces on the picture surface.

3. This study analyzes how well each of these representations performs individually and tries to enhance the performance with the use of a multilevel matcher that combines the data using a predefined score combination strategy. When 3D characteristics are merged with 2D palmprint features alone, performance is noticeably improved. When compared to the present system suggested in the literature, the proposed biometric system is shown in the paper to be difficult to defeat using the experimental data.

4. The unique subspace learning technique described in this research is directly applicable to picture pixels. Dimensionality has an impact on the performances of conventional subspace methods. While a high dimensionality may lead to overfitting, which can be removed via RSM, a low dimensionality subspace may lose discriminative information. The experimental outcomes as demonstrated by this methodology outperform the contemporary approach. It turns out that for this kind of data, weak classifiers developed over almost incoherent features work well.

Results:

Print-based attacks and display-based assaults are the two forms of sensor level attacks that we take into consideration. The suggested method for calculating surface reflectance is based on the analysis of acquired hand pictures. The feature set is composed of first and higher order statistical features derived using sub-band wavelet coefficients and pixel intensity distributions. These features are used by a trained binary classifier to identify whether the hand shown to the sensor is real or false. Promising findings from tests on a database of 1300 hand photos from 230 participants show that the suggested technique is successful in identifying high quality palmprint spoof images. We obtained an accuracy of 85% using SVM and XGBoost.



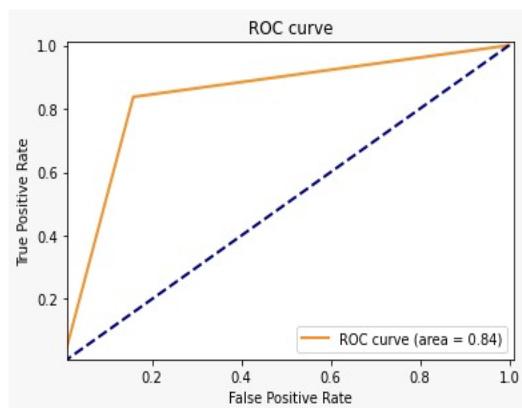


Figure 3: SVM confusion matrix
Figure 4: ROCfor XGBoost model

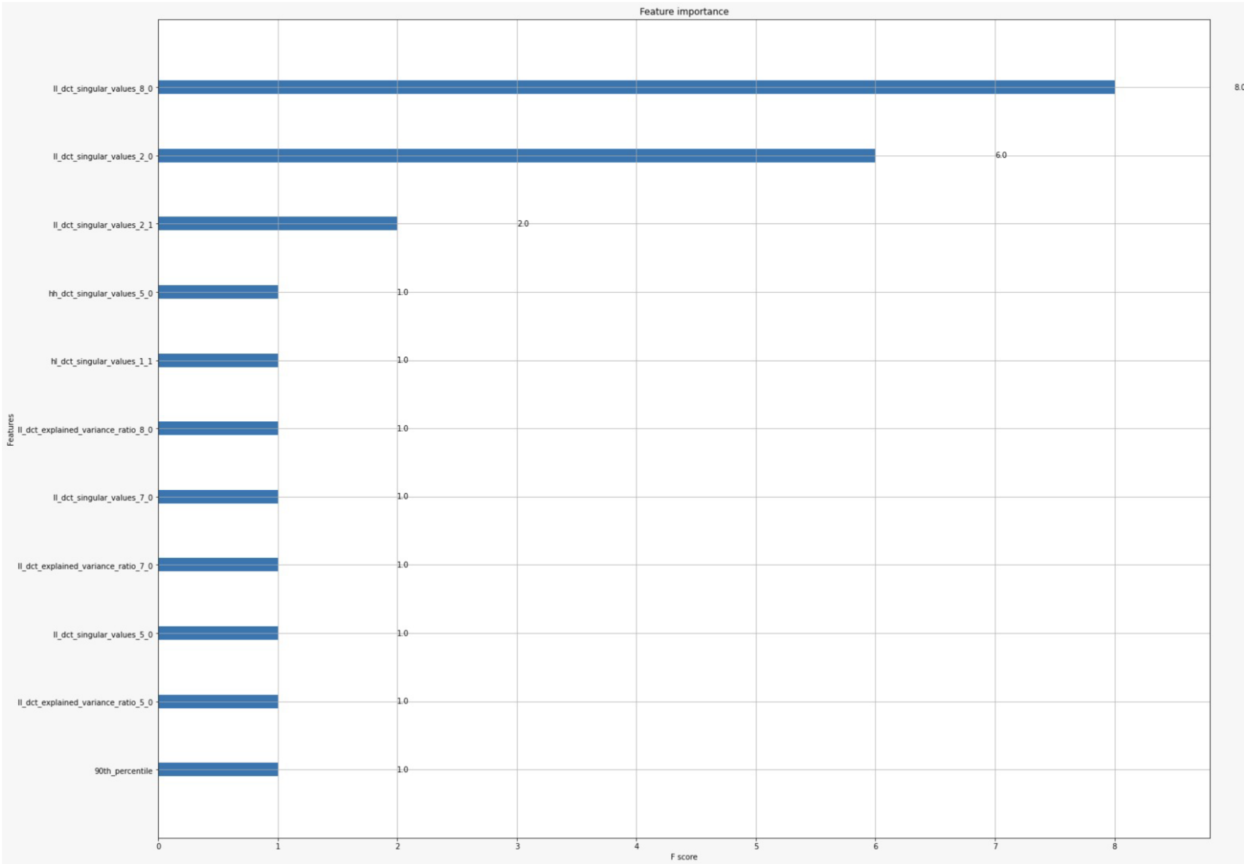


Figure 5: important features according to XGBOOST

Challenges:

Generating spoofed dataset. -
Solution: sampling dataset and taking prints, and from screen display.

Model accuracy was very low initially:
Solution- tuning and hyper parametrization of XGBoost model

Extracting contours: as the images were extremely noisy so we were getting contours of weird shape.
Solution: Cropping out unwanted parts of the image. Adjusting threshold levels. Applying morphological transformation

References:

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