IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# BIOMETRIC HUMAN FOOTPRINT DETECTION

[1]Prof. Somashekhar B M, [2]Lavanya G, [3]Pallavi T, [4]Pooja C C

[1]Assistant Professor, [2]Student, [3]Student, [4]Student
Department of Information Science and Engineering,
Maharaja Institute of Technology Mysore, Karnataka, India

***Abstract:*** Biometric human footprint detection refers to the process of identifying and analyzing unique characteristics present in the footprints of individuals for the purpose of identification and recognition. Footprints, as biometric traits, offer advantages such as being non-invasive, difficult to counterfeit, and relatively stable over time. This paper presents a comprehensive review of the existing methodologies and technologies employed in biometric human footprint detection. The review encompasses various aspects, including data acquisition techniques, feature extraction methods, and recognition algorithms. Additionally, the challenges associated with footprint analysis, such as variations due to different surfaces, foot positions, and deformations, are discussed. The study highlights the potential applications of biometric footprint detection across several domains, including forensic investigations, security systems, and healthcare. Furthermore, the paper discusses the advantages and limitations of using footprints as a biometric modality, comparing them with other commonly used biometric identifiers. Various case studies and experimental results are presented to illustrate the performance and accuracy of different footprint detection approaches. The analysis includes metrics such as false acceptance rate (FAR), false rejection rate (FRR), and receiver operating characteristic (ROC) curves, providing insights into the effectiveness and reliability of the proposed techniques.

***Index Terms*** **- Biometrics, Footprint analysis, Human identification, Footprint recognition, False acceptance rate (FAR), False rejection rate (FRR), Inception V3**

## I. INTRODUCTION

The biometric systems are the task to use individual identity based on differentiating physiological and behavioral features. These features are used for verifying the right and presence, such as fingerprint, palmprint, iris, and footprint. This technology is seen in films. Fingerprint scanning in investigation films based on actual use with Central Intelligence Agency (CIA) and Federal Bureau of Investigation (FBI), which has been operating under the name is called Automated Fingerprint Identification System (AFIS). In addition, the retina and footprint scanning has been used more widely for personal confirmation in the security system. So the biometric systems have more advantages than the traditional systems such as the password based confirmation.

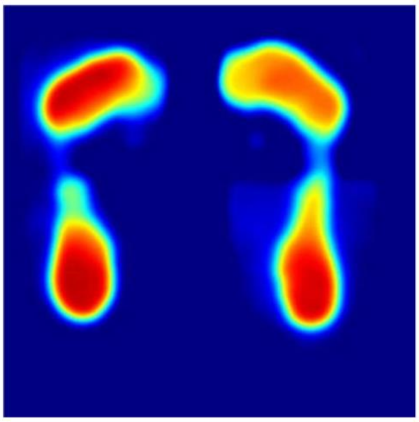
**Fig. 1** Simple ink impression on a paper

Palmprint is defined as the measurement of the features to recognize the identity of the individual person. The features in palmprint include principal lines, wrinkles, and ridges. Palmprint does not change much across time. It is easy to capture using a digital camera. However, the line structure feature does not contain the thickness and width information so this method cannot identify the different palmprint with similar line structure. Iris scanning system can provide a high accuracy but the cost of devices is high. The footprint is a feature of the biometric systems. They have the distinctive properties of the individual person like the human hand. So the footprint is used to identify the individual person as well.

The footprints are occurred by foot pressure when standing or walking, so the foot pressure has the distinctive properties of the individual person like the others too. During the past decade, foot plantar pressure measurement technologies have become interested. A simple ink impression on a paper is a simple method that has been used for a long time. The sample result as shown in Fig. 1. However, it's still quite limited because of their pressure density cannot give the distinguishing pressure in each position and this method must require fresh materials in each test.

The optical sensor is the efficient method for foot pressure measurement, which gives a high accuracy and reliability, low cost, and suitable for local clinics and small hospitals. This system uses a reflected and scattered light by the glossy white paper on the sensitive area when the system has pressure on the platform. The color coding image of foot pressure result is shown in Fig. 2. , The intensities are in the range of [0, 1] i.e. the red area correspond to the high pressure area and the blue area to the low pressure area.

**Fig. 2** The color coding image of foot pressure



## II. Literature Survey

In this paper [1], they developed a privacy-aware user tracking system that can track users by using their footprint data measured across spatially disjoint pressure sensor sheets. The main task in the system is to recognize correspondence between footprints measured across pressure sensor sheets, i.e., it needs to recognize a single user walking across pressure sensor sheets as an instance and different users as different ones. In this paper, we propose a footprint matching method designed for walking users. It mainly consists of two steps: i.e., footprint averaging and similarity calculating, in order to handle footprint data recorded as a time series for a walking user. Moreover, we have conducted a basic evaluation to confirm the effectiveness of the proposed footprint matching method. The footprint averaging is the simple average of a footprint image over a number of time periods. More specifically, it averages the footprint images over n frames from the beginning to the end. Similarity Calculating: In the footprint matching, the server calculates the similarities between input footprint image and ones stored in the footprint database. The similarity between two footprints is calculated. They have developed a privacy-aware user tracking system using footprints. In the proposed system, footprint data are used to distinguish instances. The footprint data are collected from multiple pressure sensor sheets put on significant locations in a target area. The trajectory of a specific user is estimated by extracting locations of the sensor sheets that can observe the user's footprint.

In this paper [2], Gait Recognition is a technique to identify the people by the way they walk. The science of identifying people by physical characteristics is called biometrics. Biometrics is inherently a substantial field of science and technology for many reasons, not the least of which is the heightened need for security in ubiquitous applications. In the recent past, biometrics has been exploited for avant-garde explosive device forensics and for identifying suspected insurgents and terrorists. One of the most indispensable forms of biometrics is the recognition of gait and footprints of people. Footprint recognition can be carried out by using any one of the two important features namely static and dynamic. In our proposed method, the footprint images are acquired using web Camera. Dynamic footprint Images can also be obtained using mat-type pressure sensor. Static feature requires stand-up posture at fixed position every time from the subject, whereas the dynamic feature deals. with the walking behavior. Fusion is the process of combining two feature vectors using Discrete Stationary Wavelet Transform (DSWT). It fuses two multi-focused images into a single band. The Stationary Wavelet Transform (SWT) is a wavelet transform algorithm founded to compensate for the void of translation invariance of the DWT. Shift-invariance is substantial to correlate and combine wavelet coefficient images. Without shift- invariance, slight shifts in the input signal will invoke variations in the wavelet coefficients that might introduce artifacts in the reconstruction.

In this study [3], developed a privacy-aware user tracking system that can track users by using their footprint data measured across spatially disjoint pressure sensor sheets. The main task in the system is to recognize correspondence between footprints measured across pressure sensor sheets, i.e., it needs to recognize a single user walking across pressure sensor sheets as an instance and different users as different ones. In this paper, we propose a footprint matching method designed for walking users. It mainly consists of two steps: i.e., footprint averaging and similarity calculating, in order to handle footprint data recorded as a time series for a walking user. Moreover, we have conducted a basic evaluation to confirm the effectiveness of the proposed footprint matching method. They have developed a privacy-aware user tracking system using footprints. In the proposed system, footprint data are used to distinguish instances. The footprint data are collected from multiple pressure sensor sheets put on significant locations in a target area. The trajectory of a specific user is estimated by extracting locations of the sensor sheets that can observe the user's footprint.

In this study [4], in automated biometrics-based identification, many elastic methods are being developed that uses various biometric traits of person permanence and distinctiveness. The identification and applicability of particular biometric feature depends essentially on the extent to which distinctiveness and permanence hold true for the subjects used for the study. In commercial biometric systems: fingerprint, palm, retina, iris, face, handwriting recognition, speaker recognition, hand geometry, and gait recognition. A wide variety of biometric characteristics have been discovered and tested in recent decades. In this study, they have proposed a personal recognition method based on footprint and tested its reliability by measuring the performance and correlation parameters of foot of an individual. The images of footprints of 94 individuals of different age groups and gender of different region of north India have been taken using Scanning technique. The results show good accuracy to be used for a biometric system.

In this analytical study [5], the password based authorization scheme for all available security systems can effortlessly be hacked by the hacker or a malicious user. One might not be able to guarantee that the person who is using the password is authentic or not. Only biometric systems are one which make offered automated authentication. There are very exceptional chances of losing the biometric identity, only if the accident of an individual may persists. Footprint based biometric system has been evaluated so far. In this paper a number of approaches of footprint recognition have been deliberated. The influence area in 3-D footprint surface is called as the heavy pressure surface It exposes individual with the pressure distribution on medium. Since the substantial pressure surfaces are decided by human physical appearances, we can understand the personality recognition through the abstracting of heavy pressure surfaces and analyzing their shape features.

## III. METHODOLOGY

The methodology of biometric human footprint detection is as follows:

- ***Data Collection***

Collecting a dataset for biometric human footprint detection involves acquiring and curating a set of footprints that can be used for research, algorithm development, and performance evaluation. Footprint data is collected using various techniques and devices. Some common methods include ink-based footprint impressions, digital imaging using high-resolution cameras, pressure-sensitive platforms, and 3D scanning devices. The choice of data acquisition method depends on the specific research goals and the desired level of detail and accuracy. Here, we are using 200 footprint images. In fig 3, it contains the images of footprint data.

**Fig. 3** Dataset Images

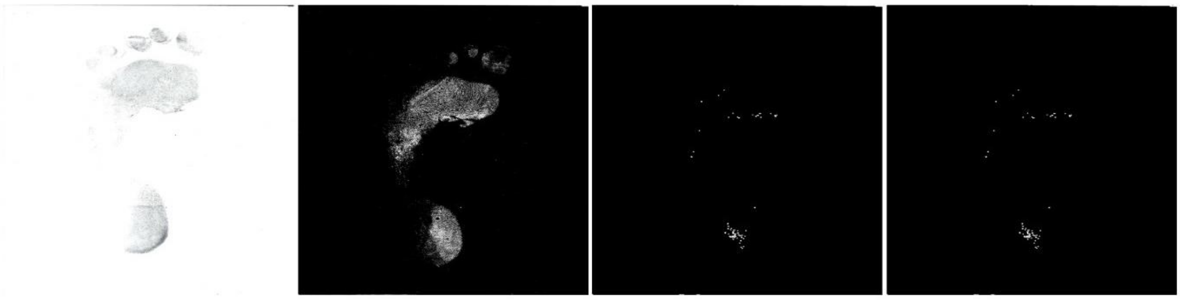
- ***Preprocessing***

○ Image enhancement: Apply techniques such as noise reduction, contrast enhancement, and image normalization to improve the quality and clarity of the captured footprint images.

○ Segmentation: Separate the foreground (footprint) from the background in the acquired images to isolate the footprint region for further analysis.

○ Calibration: Adjust and normalize the pressure data obtained from pressure-sensitive platforms to ensure consistency and accuracy in pressure distribution measurements.

**Fig. 4** Preprocessing of human footprint images

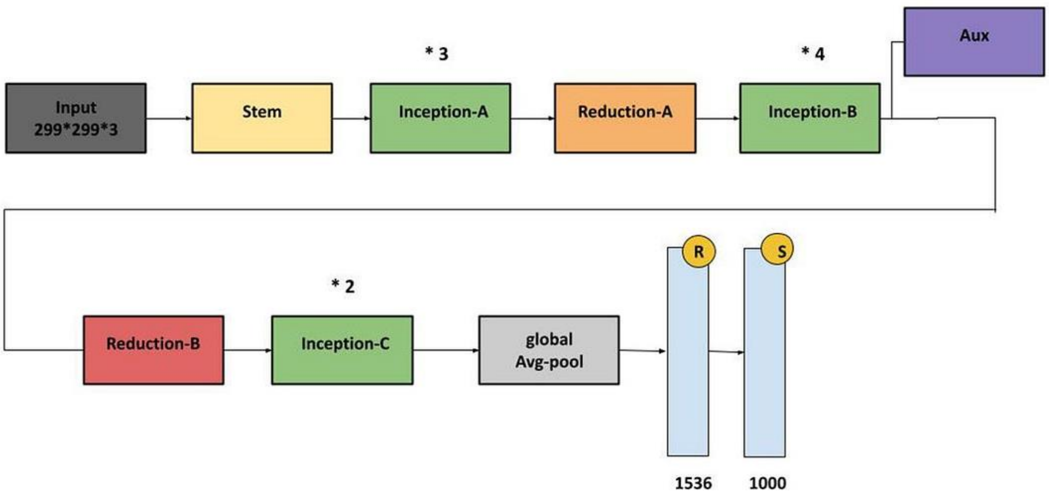


In fig 4, footprint images may vary in size and resolution. Resizing the images to a consistent and appropriate input size is important to ensure compatibility with the model's architecture. This usually involves scaling the images while maintaining the aspect ratio. Common input sizes for models like Inception V3 are typically of 299x299 pixels. Normalizing the pixel values of the footprint images helps to standardize the data and improve model performance. This involves rescaling the pixel values to a common range, such as [0, 1] or [-1, 1]. Normalization ensures that the input data has similar magnitudes and prevents certain features from dominating the learning process.

- ***Model Architecture***

Convolutional Neural Networks (CNNs) are a type of deep neural network commonly used in image recognition and computer vision tasks. The key feature of CNNs is their ability to automatically extract relevant features from images, without the need for manual feature engineering. CNNs are made up of multiple layers, including convolutional layers, pooling layers, and fully connected layers. In the convolutional layer, the network performs a mathematical operation called convolution, which applies a set of filters to the input image to extract features. Each filter is a small matrix of values that slides across the input image, performing element-wise multiplication and summation at each location. The pooling layer then down samples the output of the convolutional layer, reducing the spatial dimensions of the features while retaining their essential information. Common types of pooling layers include max pooling and average pooling.

**Fig. 5** Inception V3 Model




In fig 5, Inception V3 is a pre-trained model initially trained on a large-scale dataset (e.g., ImageNet), it is common to leverage transfer learning. Transfer learning involves using the pre-trained model's learned features as a starting point and fine-tuning the model on the specific task and dataset at hand. This step helps in leveraging the knowledge gained from a large dataset to improve the performance of the model on the footprint recognition task.

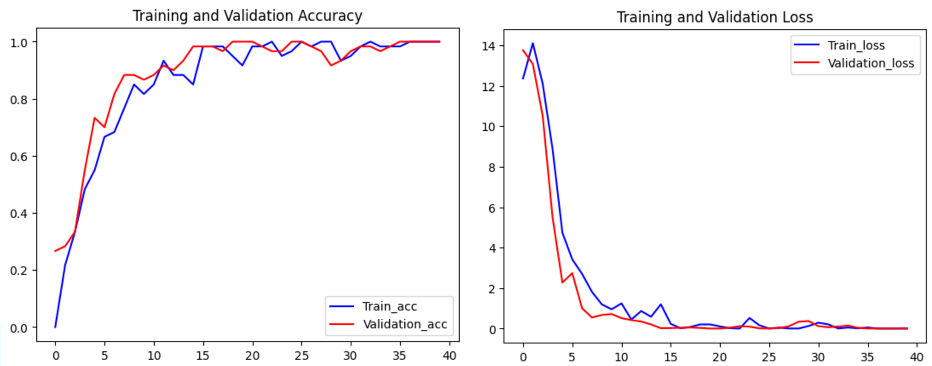
The footprints dataset is typically divided into three subsets: training, validation, and testing sets. The training set is used to update the model's parameters during the training process. The validation set is used to monitor the model's performance and tune hyperparameters. The testing set is kept separate and is used only for the final evaluation after the model training is complete. A loss function is selected to quantify the discrepancy between the predicted identities and the ground truth labels in the training set. Commonly used loss functions for classification tasks include cross-entropy loss. The choice of the loss function depends on the specific requirements of the biometric footprint detection task.

- ***Training***

The learning rate is a hyperparameter that determines the step size at each iteration during parameter updates. It controls the trade-off between faster convergence and overshooting the optimal parameters. The learning rate is often adjusted during training, such as by using learning rate schedules or adaptive learning rate algorithms, to optimize model performance. Regularization techniques, such as L1 or L2 regularization or dropout, can be applied to prevent overfitting. Overfitting occurs when the model becomes too specialized in the training data and performs poorly on unseen data. Regularization techniques help in reducing model complexity and improving generalization capabilities.

The training process involves iterating over the training dataset in mini-batches. For each mini-batch, the model performs forward propagation to make predictions, computes the loss, and then performs backpropagation to update the model's parameters. This process is repeated for multiple epochs, where each epoch represents a complete pass through the entire training dataset.

**Fig. 6** Accuracy and Loss Plot versus Epochs of Inception V3 Model




In fig 6, the accuracy and loss plot versus epochs is a common way to visualize the performance of a fully connected neural network (FCN) model during training. The plot shows how the accuracy and loss metrics change as the model is trained over a series of epochs, where each epoch represents one complete pass through the training data.

## IV. Conclusion

This paper presents the footprint recognition for personal identification using deep learning. It's an alternative method to using the footprint which is the biometric feature in individual identity based on differentiating physiological and behavioral features because they have the distinctive properties of the individual person. The footprints are occurred by foot pressure, so we use the optical sensor for footprint image acquiring. The optical sensor is the efficient method for foot pressure measurement, which gives a high accuracy and reliability, low cost and suitable for local clinics and small hospitals. In image acquiring, the convolutional neural networks are used for footprint classification. They are essential tools for deep learning and especially for image recognition. The color coding images of foot pressure are used in the convolutional neural network. The training and validation test was done among 30 people with footprint images from the Inception-V3 system and 92.69% recognition rate was observed.

Future work includes personal confirmation algorithms into the footprint identification for the authentication system. In addition, footprint images from more people should be added to the convolutional neural network. They can increase the efficiency of the system.

## V. Acknowledgment

We are thankful to Dr. Naresh Kumar B G, Principal, Maharaja Institute of Technology Mysore for having supported us in our academic endeavors by granting us permission and extended full use of the college facilities to carry out this project successfully. We are extremely thankful to Dr. Sharath Kumar Y H, Head of the Department, Department of Information Science and Engineering, for his valuable support and his timely inquiries into the progress of the work.

We express our earnest gratitude towards our guide Prof. Somashekhar B M, Assistant Professor, Department of Information Science and Engineering, for his consistent cooperation and support in getting things done. We are obliged to all teaching and non-teaching staff members of Department of Computer Science and Engineering for the valuable information provided by them in their respective fields. Lastly, we thank almighty, our parents and friends for their constant encouragement and courage, for helping us in completing the project report successfully.

## REFERENCES

**[1]** R. Plamondon and G. Lorette, "Automatic signature verification and writer identification–The state of the art," Pattern Recogn., vol. 22, pp. 107–131, 1989.
**[2]** F. Bimbot, H. P. Hutter, C. Jaboulet, J. Koolwaaij, J. Lindberg, and J. B. Pierrot, "Speaker verification in the telephone network: Research activities in the CAVE project," in Proc. 5th Int.. Conf. Speech Communication and Technology, Rhodes, Greece, Sept. 1997, pp. 971–974.
**[3]** L. C. Jain et al., Ed., Intelligent Biometric Techniques in Fingerprint and Face Recognition. Boca Raton, FL: CRC Press, 1999.
**[4]** B. D. Ripley, Pattern Recognition and Neural Networks. New York: Cambridge Univ. Press, 1996.
**[5]** D. G. Armstrong, E. J. G. Peters, P. K. A. Athanasiou, and L. A. Lavery, "Is there a critical level of plantar foot pressure to identify patients at risk for neuropathic foot ulceration?," J. Foot Ankle Surg., vol. 37, pp. 303– 307, 1998.
**[6]** T. Y. Shiang, S. H. Lee, S. J. Lee, and W. C. Chu, "Evaluation of different footprint parameters as a predictor of arch height," IEEE Eng. Med. Biol., vol. 17, no. 6, pp. 62–66, 1998.
**[7]** A. Kelly and I. Winson, "Use of ready-made insoles in the treatment of lesser metatarsalgia: A prospective randomized controlled trial," Foot Ankle Int., vol. 19, pp. 217–220, 1998.
**[8]** Y. Bengio, A. Courville, and P. Vincent. Representation learning: A review and new perspectives. IEEE Transactions on Pattern Analysis and Machine Intelligence, 35(8):1798– 1828, Aug 2013.
**[9]** L. Hong, Y. Wan, and A. Jain. Fingerprint image enhancement: algorithm and performance evaluation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 20(8):777–789, 1998. A. K. Jain, S. S. Arora, L. Best-Rowden, K. Cao, P. S. Sudhish, A. Bhatnagar, and Y. Koda.
**[10]** Giving infants an identity: Fingerprint sensing and recognition. In the 8th International Conference on Information and Communication Technologies and Development (ICTD). ACM, 2016.
**[11]** A. K. Jain, K. Cao, and S. S. Arora. Recognizing infants and toddlers using fingerprints: Increasing the vaccination coverage. In IEEE International Joint Conference on Biometrics (IJCB), pages 1–8. IEEE, 2014.
**[12]** A. K. Jain and J. Feng. Latent palmprint matching. IEEE Transactions on Pattern Analysis and Machine Intelligence, 31(6):1032–1047, 2009.
**[13]** J. Kotzerke, S. Davis, K. Horadam, and J. McVernon. Newborn and infant footprint crease pattern extraction. In the 20th IEEE International Conference on Image Processing (ICIP), pages 4181–4185. IEEE, 2013.