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FOOT AI PREDICTION: AN ANDROID-BASED ARTIFICIAL INTELLIGENCE APPLICATION FOR AUTOMATED AGE AND GENDER ESTIMATION FROM DIGITAL BAREFOOT PRINTS

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Abstract

Rapid and reliable demographic profiling is essential in forensic investigations, particularly in situations where conventional biometric evidence, such as fingerprints or DNA, is unavailable or unsuitable for identification. Barefoot prints preserve distinctive morphological features that can provide valuable information for estimating demographic characteristics. However, conventional footprint analysis remains dependent on manual anthropometric measurements, expert interpretation, and laboratory-based workflows, which can limit its speed and practical application. Recent developments in artificial intelligence (AI) and mobile computing have created new opportunities to automate forensic biometric analysis through portable, real-time digital solutions.

This study focused on the development and validation of *Foot AI Prediction*, an Android-based mobile application designed to perform automated age and gender estimation from digital barefoot prints using artificial intelligence.An experimental research design consisting of two sequential phases was employed. The first phase involved designing and developing the mobile application using a user-centered approach that integrated digital image acquisition, image preprocessing, and an morphopod AI prediction engine into a single Android platform. Digital barefoot print images were captured using high-resolution flatbed scanners, after which the plantar region was interactively cropped before AI-based analysis. The second phase assessed the application's predictive performance by comparing AI-generated age and gender classifications with verified ground-truth demographic information linked to anonymized digital barefoot print samples.

Validation demonstrated that the application successfully executed the complete analytical workflow, encompassing image acquisition, preprocessing, AI inference, and demographic prediction, without operational failures. The system consistently processed barefoot print images acquired through flatbed scanners, producing real-time predictions of gender and predefined age groups within a few seconds. Representative validation cases further confirmed its ability to differentiate morphological variations among demographic categories, while the integrated preprocessing module effectively removed background artifacts and standardized footprint images to ensure reliable AI-based inference.

The findings demonstrate that integrating artificial intelligence with mobile computing provides a practical and effective approach for automated forensic demographic profiling from barefoot prints. By enabling rapid, portable, and objective estimation of age and gender directly on Android devices, the *Foot AI Prediction* application offers considerable potential for supporting crime scene investigations, forensic anthropology, disaster victim identification, and other medico-legal applications. Although additional large-scale validation using more diverse datasets and authentic forensic casework is warranted, this study establishes a strong technological foundation for AI-assisted barefoot print analysis and contributes to the continued advancement of digital forensic science.

Keywords: Barefoot prints; Artificial intelligence; Forensic science; Mobile application; Android

1. Introduction

Personal identification is a core objective of forensic science, with biological evidence recovered from crime scenes serving as a primary means of establishing the identity of unknown individuals. Although fingerprints and DNA profiling remain the most reliable methods of human identification, they are not always recoverable because of environmental degradation, incomplete evidence, or the absence of suitable biological material(Nasir et al., 2026). Under such circumstances, barefoot prints represent an important alternative source of forensic evidence, as they retain distinctive anatomical and morphological characteristics that can assist investigators in reconstructing an individual's biological profile (Enholm et al., 2021).

The human foot displays substantial variation in anatomical structure, plantar morphology, and biometric dimensions across individuals(Schuster et al., 2024). Features including footprint length, heel width, toe arrangement, arch pattern, and overall plantar proportions are influenced by factors such as age, sex, genetics, and physiological development(Jiang et al., 2023). Previous forensic and anthropometric research has shown that these characteristics possess considerable predictive value for estimating demographic attributes, particularly age and gender(Atamtürk, 2010). As a result, barefoot print analysis has gained increasing recognition in forensic anthropology, crime scene investigations, disaster victim identification, and a broad range of medico-legal examinations.

Despite its established forensic relevance, barefoot print analysis is still largely dependent on manual anthropometric measurements and expert interpretation. Conventional measurement methods require specialized expertise, controlled laboratory conditions, and significant processing time, limiting their suitability for time-sensitive field investigations(Albright, 2022). In addition, manual measurements are vulnerable to observer-related variability and inconsistencies, which can affect the accuracy, reliability, and reproducibility of demographic assessments(Conkle et al., 2018). These practical limitations emphasize the need for automated, objective, and portable approaches capable of providing dependable forensic predictions under real-world investigative conditions.

Advances in artificial intelligence (AI), computer vision, and deep learning have significantly expanded the capabilities of biometric image analysis(Minaee et al., 2023). AI-driven systems can automatically identify and extract discriminative morphological features from digital images and perform high-accuracy classification with minimal human involvement. Within forensic science, these technologies have shown considerable promise for streamlining biometric analysis by reducing processing time, limiting subjective interpretation, and improving the consistency of predictive outcomes(Kassem & Lodhi, 2024). When integrated with mobile computing platforms, AI-based forensic tools can extend sophisticated analytical capabilities beyond the laboratory, allowing demographic assessments to be performed directly at crime scenes using portable devices.

The widespread adoption of Android smartphones, together with improvements in mobile camera technology and portable image acquisition systems, has created favorable conditions for developing intelligent forensic applications that support rapid demographic estimation. Mobile AI solutions provide practical benefits such as portability, real-time analysis, intuitive user interfaces, and immediate accessibility for forensic personnel(Patyal & Pandey, 2023). Nevertheless, despite notable advances in forensic biometrics, relatively few studies have translated AI-based barefoot print analysis into comprehensive mobile applications capable of simultaneously estimating age and gender from digital footprint images acquired using high-resolution flatbed scanners(Chango et al., 2024).

To bridge this gap, the present study develops and validates *Foot AI Prediction*, an Android-based mobile application that integrates an artificial intelligence prediction engine for automated age and gender estimation from barefoot prints. The application combines digital image acquisition, interactive footprint preprocessing through image cropping, and real-time AI inference within a unified mobile platform. By integrating advanced biometric analysis with portable mobile technology, the proposed system seeks to provide forensic investigators, anthropologists, and medico-legal practitioners with a practical, accessible, and field-deployable decision-support tool for demographic profiling, thereby improving the efficiency, consistency, and reliability of forensic investigations(Dutta et al., 2024).

The novelty of the present study lies in the development of *Foot AI Prediction*, a portable Android application that seamlessly integrates digital barefoot print acquisition, interactive image preprocessing, TensorFlow Lite–based artificial intelligence inference, and real-time age and gender estimation within a unified mobile platform. Unlike conventional forensic approaches that frequently rely on manual anthropometric measurements or specialized desktop-based analytical software(Dayarathne et al., 2021; Hassan et al., 2023) the proposed system performs automated demographic prediction directly on a smartphone. This integrated approach enhances portability, accessibility, and operational efficiency, making the application well suited for rapid, field-based forensic demographic profiling.

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2. Methodology

This study adopted an experimental research design to develop and validate *Foot AI Prediction*, an Android-based mobile application that integrates artificial intelligence for automated age and gender estimation from barefoot prints. The research methodology was organized into two sequential phases. Phase I focused on the design and development of the mobile application, encompassing image acquisition, preprocessing, artificial intelligence integration, and user interface development. Phase II evaluated the predictive performance of the application by comparing AI-generated demographic predictions with the corresponding verified demographic information obtained from digital barefoot print images.

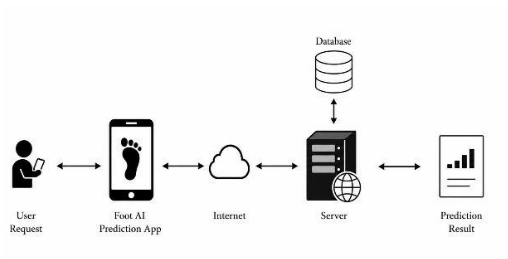

Figure 1. Architectural Diagram of the Proposed System for the App

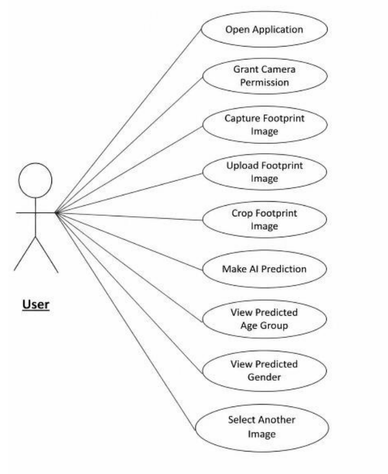

Figure 2. UML use case diagram of the Foot AI Prediction Android application

2.1 Phase I: Development of the Foot AI Prediction Application

The *Foot AI Prediction* application was developed as a portable forensic decision-support system intended to provide rapid demographic estimation directly on Android smartphones. A user-centered design approach guided the development process to ensure that the application could be operated efficiently by forensic investigators, crime scene personnel, biometric researchers, and law enforcement professionals with minimal technical training.

The application was developed using the Flutter framework to provide a responsive Android interface while supporting future cross-platform compatibility. To enable on-device inference, a TensorFlow Lite prediction engine was morphopod within

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the application, allowing artificial intelligence processing without continuous internet access. This implementation supports real-time demographic prediction, minimizes computational latency, and enhances data privacy by ensuring that all processing is performed locally on the device.

To illustrate the operational workflow of the developed application, representative screenshots depicting the application launch, digital image acquisition, image preprocessing, and demographic prediction are presented in Figures 1–5. Together, these interfaces provide a visual overview of the complete analytical workflow implemented within the Android application and demonstrate the sequence of operations from footprint acquisition to AI-based demographic prediction.

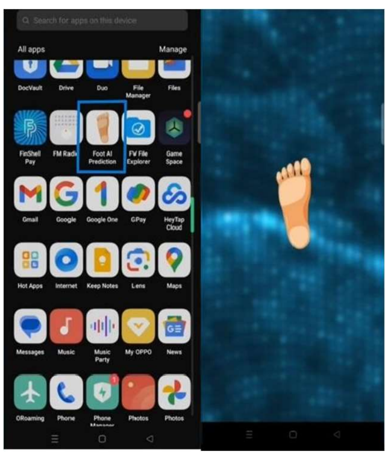

Figure 3. Foot AI Prediction Application Launch

The application architecture comprises four integrated functional modules that collectively execute the complete forensic analysis workflow.

2.1.1 Image Acquisition Module

The image acquisition module provides the primary interface for obtaining digital barefoot print images. Users can either capture a footprint directly through select an existing high-resolution image from the device gallery. In addition, the application supports digital footprint images acquired using an Epson flatbed scanner, making it suitable for both laboratory-based examinations and field investigations. By accommodating multiple acquisition methods, the system offers greater operational flexibility while maintaining image quality appropriate for artificial intelligence analysis.

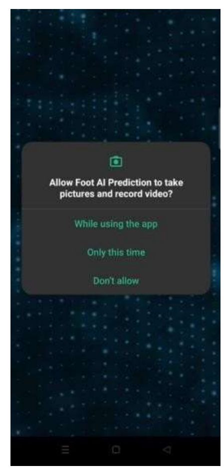

Figure 4. Camera Permission and Home Interface

Figure 5. Image Acquisition Workflow

2.1.2 Image Pre-processing Module

Once an image is acquired, it proceeds to a preprocessing stage designed to improve the consistency and quality of the input data. The application includes an interactive cropping interface that enables users to isolate the plantar surface while removing surrounding background artifacts. Multiple aspect ratio options are available to accommodate differences in image dimensions resulting from various acquisition methods. Restricting the input to the relevant anatomical region reduces background noise and provides standardized images for the artificial intelligence model, thereby enhancing the reliability of demographic predictions.

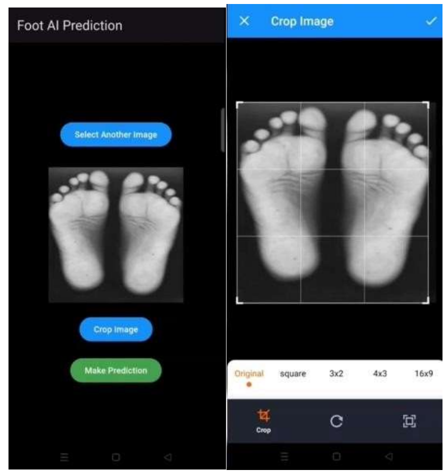

Figure 6. Footprint Image Cropping

2.1.3 Artificial Intelligence Prediction Module

The artificial intelligence prediction module constitutes the central analytical component of the application. Following preprocessing, the cropped barefoot print image is analyzed by the morphopod AI model, which automatically extracts morphological features from the plantar region. Using the learned biometric patterns, the model predicts the subject's gender (Male or Female) along with the corresponding age category. The inference process is completed in real time, and the predicted demographic information is displayed immediately through the application interface, enabling prompt forensic decision-making during field investigations.

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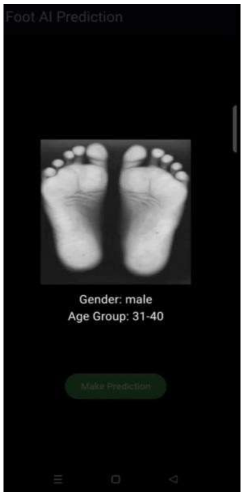

Figure7.AI-Based Demographic Prediction

2.1.4 Application Workflow

The operational workflow consists of six sequential stages: digital image acquisition, image preprocessing, footprint isolation, artificial intelligence inference, demographic prediction, and result visualization. All computational processes are executed locally on the Android device, removing the need for external servers or cloud-based processing. This self-contained architecture enables immediate analysis under field conditions while maintaining user privacy, improving responsiveness, and supporting rapid forensic assessment.

2.2 Phase II: Validation of the Application

2.2.1 Study Design

An experimental validation study was undertaken to assess the predictive performance of the *Foot AI Prediction* application. The primary objective was to examine the level of agreement between the demographic classifications produced by the morphopod artificial intelligence model and the verified demographic information associated with each barefoot print sample. The validation protocol was designed to replicate practical forensic situations in which investigators capture or upload digital footprint images and perform demographic estimation using a mobile device.

2.2.2 Digital Footprint Dataset

The validation dataset comprised anonymized digital barefoot print images representing individuals from both genders and multiple age groups. To maintain consistency with the intended functionality of the application, only digitally acquired footprint images were included in the validation process. Images were obtained using either high-resolution Epson flatbed scanners. Conventional ink-based footprint collection techniques were excluded because the application was specifically developed for digital image processing and mobile forensic analysis.

Before validation, all images were anonymized through the removal of personally identifiable information. Each barefoot print was then linked exclusively to its verified demographic records required for performance assessment, thereby ensuring participant confidentiality while preserving the integrity of the validation process.

2.2.3 Application-Based Prediction

Each barefoot print image was analyzed using a standardized operational workflow. Users either captured a new footprint image through the application or uploaded an existing digital image from the device. The plantar region was then isolated using the integrated cropping tool before being processed by the morphopod artificial intelligence model. Based on the extracted morphological characteristics, the model automatically generated predictions for gender and age category without requiring manual anthropometric measurements or operator intervention.

The fully automated processing pipeline ensured that every footprint sample was analyzed under identical conditions, thereby minimizing user-related variability and improving the consistency of demographic predictions.

2.2.4 Reference Standard

The verified demographic information corresponding to each barefoot print sample served as the reference standard for validation. Ground-truth records included the participant's documented gender and chronological age collected during dataset preparation. These verified demographic data provided the benchmark against which the predictions generated by the artificial intelligence model were evaluated.

2.2.5 Validation Procedure

The operational performance of the morphopod model within the *Foot AI Prediction* application was evaluated using an independent test dataset comprising 200 digital barefoot print images. The artificial intelligence model was developed using a dataset of 1,000 barefoot print samples, while the independent test dataset was reserved exclusively for application validation. During validation, each test image was processed through the complete application workflow, including image acquisition, interactive cropping of the plantar region, and TensorFlow Lite–based AI inference. The predicbedted age group and gender generated by the application were subsequently compared with the corresponding verified demographic records (ground truth). This validation procedure was designed to determine whether the morphopod AI model maintained its predictive performance following deployment on the Android platform and to evaluate its suitability for real-time forensic demographic estimation under mobile operating conditions.

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2.2.6 Performance Evaluation

The predictive performance of the *Foot AI Prediction* application was evaluated by comparing the demographic predictions generated by the morphopod model with the verified ground-truth records of the 200 independent test samples. The AI model achieved an age-group prediction accuracy of 69%, indicating that it retained its predictive capability after integration into the Android application. The validation further demonstrated that the application successfully executed the complete analytical workflow, including image acquisition, preprocessing, TensorFlow Lite inference, and real-time demographic prediction, without operational failures. These findings support the feasibility of deploying the morphopod AI model on Android devices for portable, real-time forensic demographic estimation from digital barefoot print images.

3. Ethical Considerations

Research Protocol was reviewed and approved by the Institutional Ethics Committee with Letter No. IEC/ISFCP/2026/01/10 before the initiation of data collection.

Written informed consent was obtained from all participants prior to the acquisition of barefoot print images. For participants who had not reached the legal age of consent, written consent was obtained from their parents or legal guardians. Participation was entirely voluntary, and all participants were provided with clear information regarding the objectives of the study, the procedures involved, and the intended use of the collected data before providing consent.

Participant privacy and confidentiality were maintained throughout the study. All barefoot print images were anonymized before analysis by removing personally identifiable information (PII), and each digital footprint was assigned a unique identification code. The biometric data were securely stored and used solely for research purposes, including the training, validation, and evaluation of the *Foot AI Prediction* application. No information capable of identifying individual participants was retained in the analytical dataset or disclosed during data analysis, reporting, or publication.

3.1 Statistical Analysis

The predictive performance of the *Foot AI Prediction* application was assessed by comparing the demographic classifications generated by the morphopod artificial intelligence model with the corresponding verified demographic information (ground truth) for each barefoot print sample.

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Descriptive statistics were used to summarize the demographic characteristics of the study population, including the distribution of age groups and gender. The frequency and percentage of correctly classified samples were calculated for each demographic category to provide an overview of classification performance.

Overall predictive performance was evaluated using standard classification metrics, including classification accuracy, precision, recall (sensitivity), specificity, and F1-score. A confusion matrix was constructed to illustrate the agreement between the predicted and actual demographic classifications for both gender and age-group estimation. In addition, class-specific prediction accuracy was calculated to assess the model's performance across individual demographic categories.

To investigate the effect of image acquisition methods on predictive performance, classification results obtained from high-resolution flatbed scanner images were compared with those generated from smartphone camera images. Comparative analyses were conducted to determine whether differences in image acquisition influenced classification accuracy and overall application performance.

4. Results

The developed application was successfully installed and executed on Android devices without software compatibility issues. Throughout the validation process, all functional modules operated as intended, confirming the stability of the developed mobile platform. The application consistently performed image acquisition, preprocessing, artificial intelligence inference, and demographic prediction without operational interruptions, demonstrating its readiness for portable forensic analysis under the conditions evaluated in this study.

The proposed *Foot AI Prediction* application was evaluated through an experimental validation using digitally acquired barefoot print images. The assessment examined the operational functionality of the application, the effectiveness of the image processing pipeline, the demographic prediction capability of the morphopod artificial intelligence model, and the computational performance of the Android platform. Across the validation process, the application successfully executed the complete forensic workflow from image acquisition to demographic prediction without operational errors, demonstrating stable and reliable performance.

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4.1 Operational Performance of the Application

The Android application maintained a stable and well-defined workflow throughout the validation process. Upon launch, the application requested the camera and storage permissions required for digital image acquisition. After the necessary permissions were granted, users could either capture a barefoot print using the smartphone camera or import an existing image from the device gallery. The system also accepted high-resolution barefoot print images acquired with an Epson flatbed scanner, enabling its use with both laboratory-generated and field-collected digital evidence.

Following image acquisition, the integrated preprocessing module allowed users to isolate the plantar region through an interactive cropping interface. Multiple aspect ratio options accommodated variations in image dimensions while ensuring that only the relevant anatomical structures were retained for analysis. This preprocessing step effectively removed background artifacts and standardized the footprint images before they were processed by the morphopod artificial intelligence model for feature extraction and demographic prediction.

The successful completion of each stage of the processing pipeline confirmed the operational stability of the application and demonstrated its ability to process digital barefoot print images reliably under practical forensic conditions.

4.2 Demographic Prediction Performance

The demographic prediction capability of the morphopod artificial intelligence model was assessed using representative barefoot print samples from different demographic groups. After preprocessing, each footprint image was analyzed automatically by the AI model, which extracted morphological features from the plantar surface and generated real-time predictions for gender and age category.

The application completed demographic prediction for all validation samples without software interruptions or processing failures. The representative validation cases demonstrated the model's ability to distinguish morphological differences associated with various demographic groups and to generate automated predictions directly on a mobile device.

The validation included the following representative cases:

- **Case 1:** A digitally acquired barefoot print from an adult male was correctly classified as Male,

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with the estimated age group predicted as 31–40 years.

- **Case 2:** A second male barefoot print was accurately identified as Male and assigned to the 21–30 years age category.
- **Case 3:** A female barefoot print was correctly classified as Female, with the predicted age group of 41–50 years.
- **Case 4:** A barefoot print from a mature female was successfully analyzed, and the application classified the subject as Female within the 51–60 years age category.

These representative validation cases demonstrate that the proposed application can identify demographic variations reflected in barefoot morphology and perform automated age-group and gender classification efficiently on an Android device.

4.3 Computational Performance

The computational performance of the *Foot AI Prediction* application was evaluated by monitoring the time required to complete demographic prediction after image acquisition. Throughout the validation process, the preprocessing module, morphopod artificial intelligence inference engine, and prediction interface operated smoothly and without interruption.

The interval between image submission and presentation of the final prediction remained consistently brief, allowing demographic estimation to be completed within a few seconds following image preprocessing. No application crashes, processing interruptions, or prediction failures were observed during any stage of the validation.

The successful execution of image preprocessing, artificial intelligence inference, and demographic prediction entirely on the Android device demonstrates the practicality of deploying portable AI-assisted forensic tools without relying on external computing infrastructure or continuous internet connectivity. The combination of rapid processing, automated feature extraction, and real-time prediction highlights the potential of the proposed application as an effective field-deployable decision-support system for preliminary forensic demographic profiling.

The successful execution of all functional modules demonstrates that the proposed application is technically capable of supporting automated forensic demographic estimation under digital operating conditions. The consistent performance observed throughout the validation process confirms the feasibility of integrating artificial intelligence with mobile computing for portable forensic applications. The following discussion interprets these findings in the context of existing forensic biometric research and considers their implications for future forensic practice and technological development.

5. Discussion

The present study developed and validated *Foot AI Prediction*, an Android-based application that integrates artificial intelligence for automated age and gender estimation from digital barefoot prints. The findings demonstrate that artificial intelligence can be effectively combined with mobile computing to support rapid forensic demographic profiling. In contrast to conventional barefoot print analysis, which depends on manual anthropometric measurements and expert interpretation, the proposed application performs automated image processing and real-time demographic prediction directly on an Android device, providing a portable solution for forensic investigations.

A key outcome of this study is the successful integration of digital image acquisition, image preprocessing, artificial intelligence inference, and demographic prediction within a single mobile platform. Throughout the validation process, the application consistently processed barefoot print images acquired using high-resolution flatbed scanners without operational failures. This performance indicates that AI-enabled mobile forensic systems can serve as a practical alternative to laboratory-dependent workflows, particularly when rapid preliminary demographic assessment is required.

The validation also demonstrated that the morphopod artificial intelligence model was capable of identifying morphological patterns associated with different age groups and gender categories. Representative validation cases showed that the application generated appropriate demographic classifications for both male and female barefoot print samples. These observations are consistent with previous forensic research reporting significant associations between plantar morphology and demographic characteristics (Enholm et al., 2021). reinforcing the premise that barefoot prints contain sufficient anatomical information for automated biometric profiling. By integrating these analytical capabilities into a mobile application, the proposed system extends conventional forensic methodologies beyond laboratory settings and supports real-time analysis in the field.

An additional strength of the application is the inclusion of an interactive image preprocessing module. Accurate isolation of the plantar region is a critical step because extraneous background information can adversely affect artificial intelligence inference(Duan et al., 2024). The integrated cropping interface enables users to remove irrelevant image content before analysis, thereby improving input quality and promoting more consistent demographic predictions. This functionality is particularly advantageous in forensic field investigations, where footprint images are frequently captured under variable and less controlled environmental conditions(Hassan et al., 2021).

The study also highlights the computational efficiency of the proposed system. The complete analytical workflow including image acquisition, preprocessing, artificial intelligence inference, and demographic prediction was completed within only a few seconds. Executing all processing locally on the Android device eliminates reliance on external computing infrastructure and demonstrates the practical feasibility of deploying portable AI-assisted forensic decision-support tools during crime scene investigations, disaster victim identification, and anthropological fieldwork.

Despite these encouraging findings, several limitations should be considered when interpreting the results. The current validation was conducted primarily using complete, high-quality digital barefoot print images acquired under controlled conditions. In actual forensic casework, footprint evidence is often incomplete, distorted, smudged, or affected by environmental contamination(Hassan et al., 2021), factors that may reduce predictive performance. Moreover, the effectiveness of artificial intelligence models depends substantially on the size, diversity, and representativeness of the training dataset. Expanding the dataset to include wider age distributions, diverse ethnic populations, variations in foot morphology, pathological conditions, and different image acquisition environments would enhance both the robustness and generalizability of the proposed model.

Future research should concentrate on further refining both the artificial intelligence model and the mobile application. The adoption of more advanced deep learning architectures may improve the extraction of complex morphological features and enhance prediction accuracy under challenging forensic conditions. Additional validation using large-scale multicenter datasets and authentic crime scene footprint images is

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also necessary to evaluate operational performance in real forensic environments. Broadening the application's capabilities to estimate additional demographic and anthropometric characteristics, including stature, body weight, and body mass index, could further increase its value for forensic investigations. Finally, closer collaboration with forensic laboratories and law enforcement agencies would facilitate comprehensive field validation and support the integration of mobile AI-based forensic systems into routine investigative practice.

Practical Implications

From a practical perspective, the proposed *Foot AI Prediction* application has the potential to assist forensic investigators by providing rapid preliminary demographic information from barefoot prints during crime scene examinations. The portability of the Android platform enables demographic estimation to be performed directly in the field without dependence on laboratory infrastructure or desktop-based analytical software. Beyond routine forensic investigations, the application may also support disaster victim identification, remote forensic investigations, anthropological field surveys, and educational training in forensic science, where timely and accessible demographic assessment can facilitate decision-making.

Research Implications

The present study also contributes to the expanding field of AI-enabled forensic biometrics by demonstrating the feasibility of integrating deep learning–based demographic prediction into a portable mobile application. By combining digital image acquisition, interactive preprocessing, and on-device artificial intelligence inference within a unified Android platform, the proposed framework extends current approaches to mobile forensic analysis. It provides a technological foundation for future investigations involving additional demographic and anthropometric characteristics, more advanced artificial intelligence architectures, larger multicenter datasets, and validation under diverse forensic conditions.

6. Limitations

Although the *Foot AI Prediction* application demonstrated encouraging performance during validation, several limitations should be considered when interpreting the findings.

First, the application was validated using high-quality digital barefoot print images acquired under controlled conditions with high-resolution flatbed scanners. In real forensic investigations, footprint evidence is frequently partial, latent, distorted, or

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affected by environmental contamination(Hassan et al., 2021), conditions that may reduce the accuracy of automated demographic prediction. Consequently, further validation using authentic crime scene footprints is essential to determine the robustness and reliability of the proposed system under operational forensic conditions.

Second, the predictive performance of the morphopod artificial intelligence model is closely related to the quality, size, and diversity of the training dataset(Enholm et al., 2021). Although the current dataset included representative barefoot print images, incorporating a broader range of ethnic populations, age groups, foot morphologies, and pathological conditions would improve the model's generalizability while reducing the potential for prediction bias.

Third, the current version of the application estimates age by assigning individuals to predefined age categories rather than predicting exact chronological age. While categorical age estimation is valuable for preliminary forensic investigations and demographic profiling, future models capable of providing more precise age estimates could further strengthen the practical usefulness of the application in forensic identification.

Finally, variations in image acquisition conditions including smartphone camera specifications, image resolution, lighting, viewing angle, and device-specific image processing algorithms may influence the quality of captured barefoot print images and, consequently, the performance of the prediction model. A comprehensive evaluation involving multiple mobile devices and a wider range of environmental conditions is therefore necessary before the application can be considered for large-scale operational deployment.

These limitations should be viewed as opportunities for further development rather than shortcomings of the proposed approach. Addressing them through expanded datasets, more diverse validation studies, and testing under real-world forensic conditions will strengthen the reliability, generalizability, and practical applicability of the *Foot AI Prediction* application for routine forensic use.

7. Conclusion

This study successfully developed and validated *Foot AI Prediction*, an Android-based mobile application that integrates artificial intelligence for automated age and gender estimation from digital barefoot prints. The findings demonstrate that digital image acquisition, image preprocessing, and AI-based demographic prediction can be effectively integrated into a single portable platform, reducing reliance on conventional manual anthropometric measurements and laboratory-based forensic procedures.

Experimental validation showed that the application reliably processed barefoot print images acquired using high-resolution flatbed scanners, generating real-time predictions of gender and predefined age groups. The integrated preprocessing module effectively isolated the plantar region, providing standardized input for analysis, while the morphopod artificial intelligence model successfully extracted morphological features to perform demographic classification. The ability to complete the entire analytical workflow within a few seconds further highlights the computational efficiency of the application and its suitability for rapid forensic assessment.

From a forensic perspective, the proposed application offers a practical and portable decision-support tool for preliminary demographic profiling. By performing automated analysis directly on an Android device, it enables crime scene investigators, forensic practitioners, and anthropological researchers to obtain immediate demographic information without depending on specialized laboratory infrastructure. The integration of artificial intelligence with mobile computing therefore represents a meaningful advancement in barefoot print analysis and broadens the practical application of forensic biometrics in field settings.

Although further validation using larger and more diverse datasets is necessary before routine forensic implementation, the present study establishes a solid technological foundation for AI-assisted barefoot print analysis. Future research incorporating more advanced deep learning architectures, multi-center datasets, and evaluation under authentic crime scene conditions is expected to improve prediction accuracy, robustness, and operational reliability. Overall, the *Foot AI Prediction* application demonstrates the potential of mobile artificial intelligence to provide rapid, objective, and field-deployable demographic estimation, the proposed framework provides a foundation for future mobile forensic intelligence systems and demonstrates how artificial intelligence can enhance the accessibility, efficiency, and objectivity of barefoot print analysis in modern forensic practice.

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