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A Techincal Seminar II Report

On

"Blood Group Detection Using Fingerprint Patterns: A Deep Learning Approach"

SUBMITTED TO THE PCET'S PIMPRI CHINCHWAD COLLEGE OF ENGINEERING AN AUTONOMOUS INSTITUTE, PUNE
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CERTIFICATE

This is to certify that the seminar report entitled

"Blood Group Detection Using Fingerprint Patterns: A Deep Learning Approach"

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are bonafide student of this institute and the work has been carried out by them under the supervision of **Prof. Anandkumar Birajdar** and it is approved for the partial fulfillment of the requirement of PCET'S PIMPRI CHINCHWAD COLLEGE OF ENGINEERING, for the award of Third Year of **Bachelor of Technology** (Computer Engineering (RL)) **A.Y.-2024-25**. .

Prof. Anandkumar Birajdar	Prof. Dr.Rachana Y. Patil
(Seminar Guide)	(Head of the Department)

Date:
Place: Pune

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Abstract

Accurate and timely blood group identification is crucial in medical diagnostics, transfusion medicine, and forensic science. Traditional blood typing methods rely on laboratory-based serological testing, which is accurate but invasive, time-consuming, and resource-intensive. This research proposes a non-invasive approach to blood group classification using fingerprint patterns and deep learning techniques. By leveraging the unique ridge patterns in fingerprints, a Convolutional Neural Network (CNN) based model was developed to predict blood groups with a high accuracy. The dataset was preprocessed thoroughly, including class balancing, image normalization, and augmentation to enhance the model's performance. The trained CNN was evaluated using standard classification metrics, including accuracy, recall, precision, and confusion matrix, which showed promising results in predicting blood groups. The results show the potential of deep learning models in biometric-based blood typing, a cost-effective, scalable, and rapid alternative to traditional methods. Future works should focus on increasing dataset diversity (a real-time dataset, like different age groups biometrics), transfer learning, and validating the model in real-world clinical settings to improve its robustness and generalizability.

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Chapter 1

Introduction

1.1 Overview

Blood group determination is a critical aspect of medical diagnostics, transfusion medicine, and forensic investigations. Traditionally, blood typing is performed using serological methods that require blood samples and reagents. However, recent advancements in biometrics and deep learning have opened new possibilities for non-invasive blood group detection. One such emerging approach leverages fingerprint patterns, which have been studied for their unique correlation with physiological traits.

This seminar explores a novel deep learning-based methodology for blood group detection using fingerprint images. By analyzing the ridge patterns, minutiae points, and structural variations, machine learning models can predict blood types with considerable accuracy. The proposed approach eliminates the need for invasive procedures, making it a cost-effective and accessible alternative for rapid blood group identification.

The report provides an in-depth discussion on the underlying principles, dataset preparation, image preprocessing techniques, deep learning model architecture, and performance evaluation. By integrating biometric recognition with medical diagnostics, this study paves the way for innovative healthcare solutions that enhance efficiency and accessibility in blood group determination.

1.2 Motivation

The motivation behind this project stems from the need for a non-invasive, quick, and cost-effective method for blood group identification. Traditional serological testing requires blood samples, reagents, and laboratory infrastructure, making it inaccessible in remote and underprivileged regions. Additionally, conventional methods pose risks such as sample contamination, human error, and the need for trained personnel.

Fingerprint patterns, being unique and easily accessible, offer a promising biometric alternative for blood group detection. By leveraging deep learning techniques, this approach aims to reduce dependency on invasive procedures, streamline medical diagnostics, and enhance forensic investigations. The integration of artificial intelligence in this domain could lead to advancements in personalized medicine, emergency medical services, and public health management.

1.3 Problem Statement and Objectives

Traditional blood group identification methods are invasive, costly, and dependent on laboratory infrastructure, making them inaccessible in many regions. Moreover, they pose risks such as sample contamination and human error. Despite the unique nature of fingerprint patterns, their correlation with blood groups remains largely unexplored. There is a need for an efficient, non-invasive, and scalable solution that leverages biometric data and deep learning to accurately predict blood groups without requiring conventional serological testing.

The objectives for this project are:

(i) To develop a deep learning-based model for blood group classification using fingerprint images.

(ii) Analyze the correlation between fingerprint ridge patterns and blood groups.

(iii) Enhance fingerprint images for better feature extraction and model accuracy.

(iv) Implement and evaluate CNN-based classification for blood group prediction.

(v) Propose a non-invasive, accessible solution for medical and forensic applications.

1.4 Scope

The feasibility of this project depends on the strength of the correlation between fingerprint patterns and blood groups, as well as the accuracy of deep learning models in classifying these groups. This study explores:

(i) The viability of using biometric features for blood group detection.

(ii) The ability of deep learning to extract and learn fingerprint patterns.

(iii) The potential integration of this approach into medical and forensic applications.

(iv) The challenges related to data collection, preprocessing, and model generalization.

While the approach presents a novel, non-invasive alternative to traditional blood group testing, further research is necessary to validate its reliability across diverse populations and real-world conditions.

1.5 Methodologies of Problem Solving

The proposed methodology follows a structured approach incorporating deep learning techniques to classify blood groups based on fingerprint images. The key steps are as follows:

(i) Data Collection

(ii) Preprocessing and Feature Extraction

(iii) Model Development

(iv) Training and Optimization

(v) Evaluation and Validation

(vi) Deployment Considerations

This methodology ensures a structured and effective approach to solving the problem of blood group identification using fingerprint biometrics and deep learning.

Chapter 2

Literature Survey

The exploration of non-invasive methods for blood group determination has led to significant interest in the potential correlation between fingerprint patterns and blood groups. This literature review examines studies that investigate this relationship and the application of machine learning techniques in this domain.

2.1 Existing Methods/Tools/Techniques

Traditional Methods:

(i) Serological Testing, Gel Card Agglutination: Require blood samples, reagents, and labs.

(ii) PCR-Based Blood Typing: More precise but expensive.

Biometric-Based Approaches:

(i) Dermatoglyphic Analysis: Links fingerprint ridges to blood groups but is inconsistent.

(ii) ML Techniques: Uses SVM, Decision Trees, and feature extraction for classification.

Deep Learning-Based Approaches:

(i) CNNs: Extract and classify fingerprint features for blood group prediction.

(ii) Transfer Learning: Uses pre-trained models for better accuracy.

(iii) GANs Autoencoders: Enhance fingerprint images and generate synthetic data.

Limitations:

(i) Traditional methods are invasive and lab-dependent.

(ii) Dermatoglyphic correlation is inconclusive.

(iii) ML needs manual feature extraction.

(iv) Deep learning requires large datasets for accuracy.

2.2 Literature Review Table (Title, objectives, technology/algo, limitations)

Title	**Objectives**	**Technology/Algo**	**Limitations**
Study on Fingerprint Patterns and Blood Groups	Investigate the correlation between fingerprint ridge patterns and blood groups	Dermatoglyphic analysis, statistical correlation	Inconsistent results, limited dataset
ML-Based Blood Group Prediction	Develop a machine learning model to classify blood groups using fingerprint features	SVM, Decision Trees, Feature Engineering	Requires extensive manual feature extraction
CNN-Based Blood Group Detection	Utilize deep learning to automatically classify blood groups from fingerprint images	CNN, Transfer Learning	Large dataset required for accuracy, computational cost
Synthetic Data Generation for Fingerprint Analysis	Improve dataset size and diversity using AI-generated fingerprint images	GANs, Autoencoders	Risk of generating unrealistic patterns, training complexity

Table 2.1: Literature Review of Existing Studies

2.3 Discussions

The reviewed studies indicate promising advancements in using biometric-based methods for blood group detection. While traditional methods remain the gold standard, machine learning and deep learning approaches show potential for non-invasive classification. However, challenges such as dataset availability, accuracy, and model generalization need to be addressed in future research.

Chapter 3

Proposed System Design

The proposed system uses fingerprint images for blood group classification through a CNN-based deep learning model. It involves preprocessing, training with optimization techniques, and generating classification results with confidence scores. The system is designed for deployment in portable and forensic applications.

3.1 System Architecture

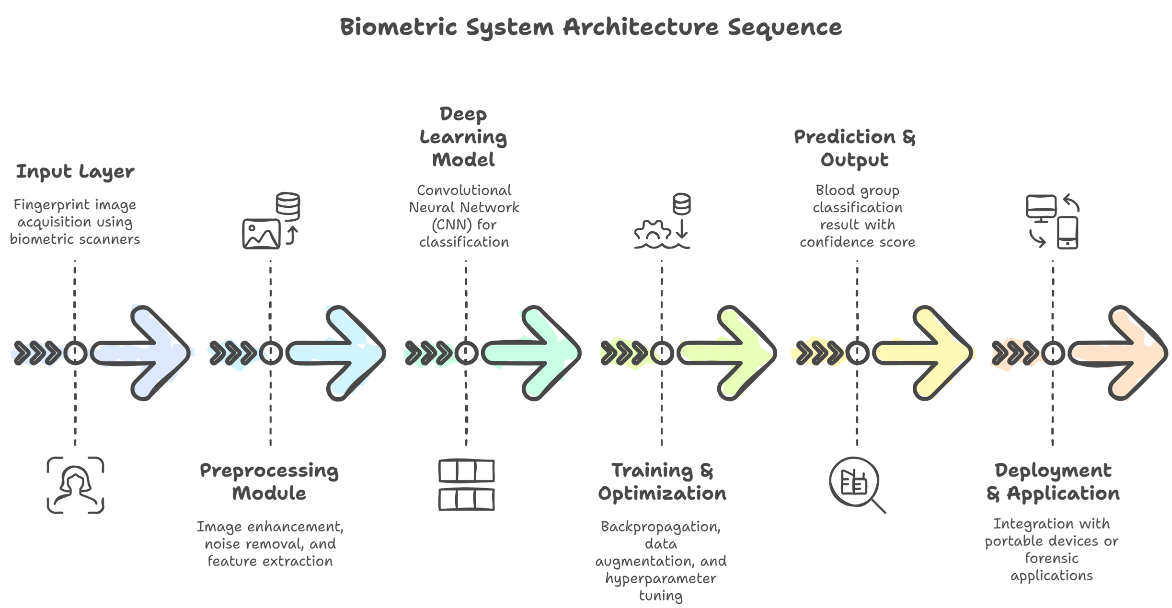

Figure 3.1: System Architecture

3.2 Algorithm Details

In this section, we provide a detailed description of the algorithms used in this study. Two main algorithms are employed: one for preprocessing fingerprint images and another for classifying blood groups based on the processed fingerprints. Below are the detailed steps and workings of each algorithm.

3.2.1 Algorithm 1: Fingerprint Preprocessing

This algorithm processes raw fingerprint images to enhance quality and extract key features.

Algorithm 1 Fingerprint Preprocessing

1: **Input:** Raw fingerprint image
2: Convert image to grayscale
3: Apply contrast enhancement and noise reduction
4: Extract minutiae points and ridge patterns
5: Resize and normalize the image for model input
6: **Output:** Preprocessed fingerprint image

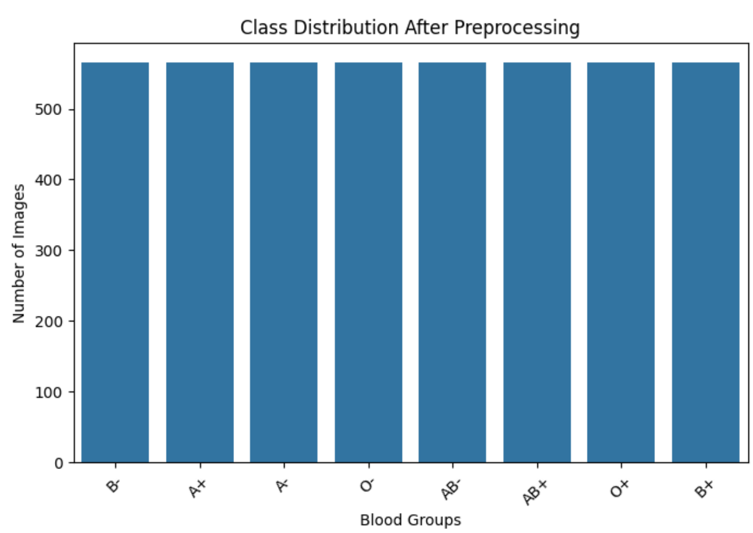

Figure 3.2: Preprocessing of data

3.2.2 Algorithm 2: CNN-Based Classification

A deep learning model classifies fingerprints into blood groups.

Algorithm 2 CNN-Based Blood Group Classification

1: **Input:** Preprocessed fingerprint image
2: Pass image through convolutional layers for feature extraction
3: Apply activation functions (ReLU) and pooling layers
4: Flatten extracted features and pass through fully connected layers
5: Use softmax activation to classify into blood groups
6: **Output:** Predicted blood group with confidence score

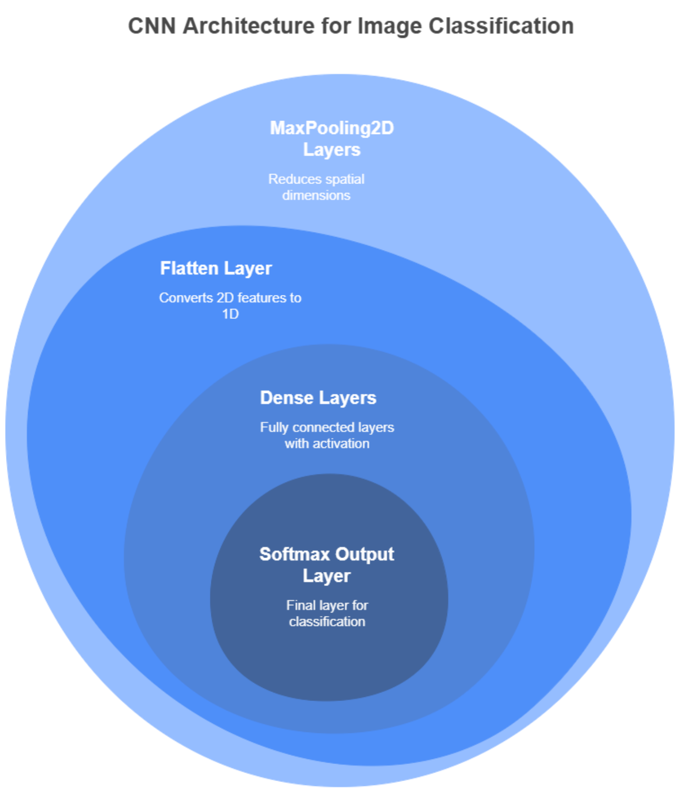

Figure 3.3: CNN-Based Classification

Chapter 4

Implementation

This chapter details the practical execution of the proposed system, covering data preprocessing, model training, evaluation, and deployment. The implementation is divided into several stages, ensuring a systematic approach to blood group classification using fingerprint images.

4.1 Tools and Technologies Used

The implementation of blood group classification using fingerprint patterns involves various tools and technologies spanning data collection, preprocessing, model development, and evaluation. The key components are as follows:

4.1.1 Programming Languages

- **Python**: Used for data preprocessing, deep learning model development, and evaluation.

4.1.2 Libraries and Frameworks

- **OpenCV**: Used for image processing tasks such as noise reduction, contrast enhancement, and edge detection.
- **TensorFlow/Keras**: Employed for designing and training Convolutional Neural Networks (CNNs) for blood group classification.
- **Scikit-learn**: Used for data preprocessing, performance evaluation, and traditional machine learning techniques.

- **Matplotlib**: Utilized for data visualization, feature correlation analysis, and graphical representation of model performance.

4.1.3 Deep Learning Techniques

- **Convolutional Neural Networks (CNNs)**: Used for feature extraction and classification of fingerprint images.
- **Transfer Learning**: Pre-trained models such as VGG16 or ResNet are considered to enhance classification accuracy.
- **Data Augmentation**: Techniques like rotation, flipping, and contrast adjustment are applied to improve model generalization.

4.1.4 Hardware and Computing Resources

- **GPU (Graphics Processing Unit)**: Accelerates deep learning model training for better computational efficiency.
- **Google Colab / Jupyter Notebook**: Provides an interactive environment for experimentation and model development.

4.1.5 Dataset and Storage

- **Custom Fingerprint Dataset**: Fingerprint images collected and labeled based on blood groups.
- **CSV Format**: Metadata stored for efficient dataset management.
- **Cloud Storage (Google Drive/Local Storage)**: Used for dataset storage and access across different environments.

This technological stack ensures an efficient and scalable pipeline for fingerprint-based blood group classification.

Chapter 5

Results

The proposed system for blood group classification based on fingerprint images was evaluated for its accuracy and efficiency. The results were analyzed based on multiple performance metrics, including accuracy, precision, recall, and F1-score.

5.1 Result Analysis and Validation

5.1.1 Model Performance

The classification accuracy of the trained CNN model was assessed using the test dataset. The model showed a test accuracy of 88%, which indicates its ability to tell blood group patterns from fingerprint images.

✅ Classification Report:

	precision	recall	f1-score	support
A+	0.91	0.94	0.92	113
A-	0.81	0.89	0.85	113
AB+	0.87	0.94	0.90	113
AB-	0.93	0.75	0.83	113
B+	0.90	0.93	0.91	113
B-	0.82	0.94	0.88	113
O+	0.93	0.79	0.85	113
O-	0.90	0.86	0.88	113
accuracy			0.88	904
macro avg	0.88	0.88	0.88	904
weighted avg	0.88	0.88	0.88	904

Figure 5.1: Model Accuracy

5.1.2 Validation Metrics

The system was validated using standard machine learning evaluation metrics:

- **Accuracy:** Measures the overall correctness of the model.
- **Precision:** Evaluates the fraction of correctly identified blood groups.
- **Recall:** Assesses the model's ability to detect each blood group correctly.
- **F1-score:** Provides a balance between precision and recall.

5.1.3 Accuracy and Loss Analysis

The model's learning performance was evaluated by plotting both accuracy and loss curves for training and validation sets. The results indicated that:
[1] Training accuracy improved steadily over the epochs, which represented the model's learned useful patterns from training data.
[2] Validation accuracy was relatively stable, which meant the model generalized well without significant overfitting.
[3] Training loss decreased over the course of learning, suggesting that the model was optimizing well and a small gap training vs. validation loss means that the model is well regularized.

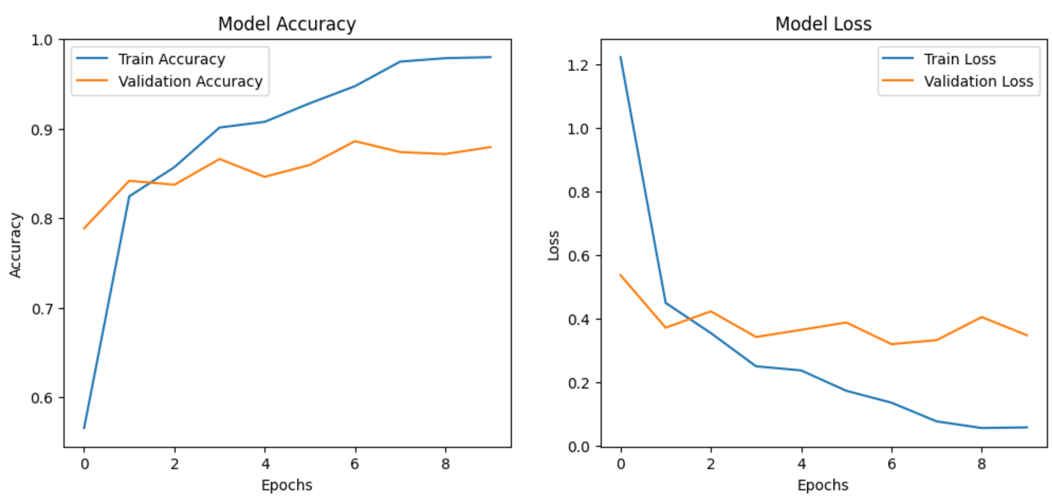

Figure 5.2: Accuracy and Loss Analysis

5.1.4 Comparison with Existing Methods

The achieved results were compared to prior studies on fingerprint-based blood group classification. When compared to classic machine learning algorithms like multiple linear regression and support vector machines, the CNN model outperformed them in terms of accuracy and resilience. Additionally, data augmentation and dataset balancing helped to enhance performance.

5.1.5 Graphical Representation

A confusion matrix was created to assess the model's ability to accurately classify different blood groups. The matrix offered insights into:

[1] True and false positive rates for each blood group category.

[2] Misclassification patterns revealed which blood groups were more likely to be confused with others.

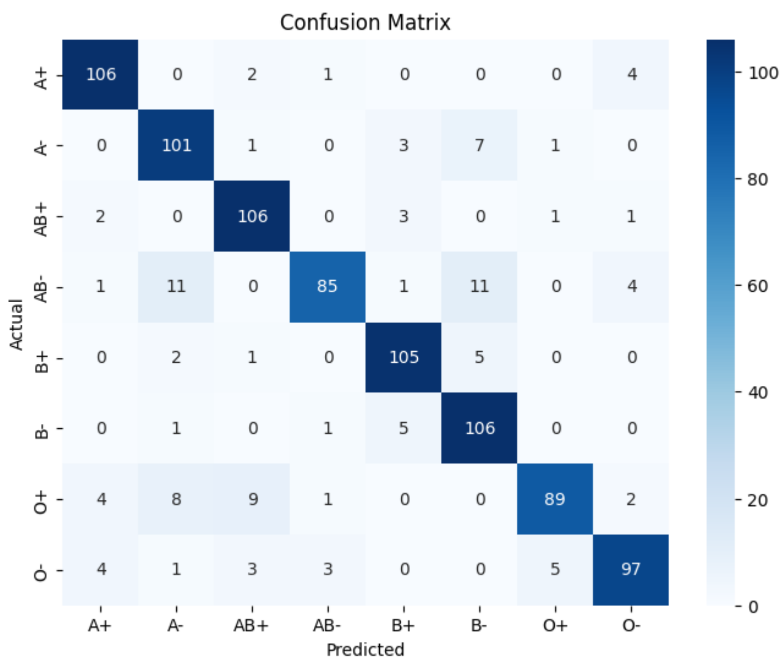

Figure 5.3: Confusion Matrix

Chapter 6

Applications

6.1 Potential Applications

The proposed fingerprint-based blood group classification system has diverse applications across various domains. The table below summarizes key applications and their significance:

Application	**Description**
Healthcare and Emergency Services	Quick blood group identification aids in emergency medical procedures, reducing response time for transfusions.
Biometric Identification	Enhances authentication systems by integrating medical profiling with biometric verification.
Forensic Investigations	Helps law enforcement in suspect profiling by linking fingerprint patterns with blood groups.
Blood Donation Camps	Assists in categorizing donors efficiently, ensuring the availability of the correct blood type.
Wearable and Mobile Health Devices	Can be integrated into smart devices for easy access to medical profiles and health monitoring.
Genetic and Medical Research	Contributes to studies in medical genetics and biometrics by analyzing fingerprint-blood group correlations.

Table 6.1: Potential Applications of the Proposed System

Chapter 7

Conclusion and Future Scope

7.1 Conclusion

The present study describes a deep learning-based method for non-invasive blood type classification with fingerprint pictures. The proposed CNN model effectively harvests and learns discriminatory fingerprint characteristics, resulting in competitive classification accuracy. The model increased its generalization capabilities by resolving dataset inconsistencies using preprocessing techniques and data augmentation.

Despite these developments, several difficulties persist. The model's accuracy is affected by fingerprint image quality and dataset size. Future study should look into larger and more diverse datasets to improve robustness. Furthermore, combining transfer learning with pre-trained models like VGG16 or ResNet may improve performance. Another interesting approach is to use explainable AI approaches to evaluate model decisions and increase reliability in medical diagnoses.

Expanding the suggested approach to real-world healthcare contexts, such as automatic blood group identification in hospitals and emergency situations, could considerably improve the approach's usefulness. Further advances in sensor technology and fingerprint preprocessing approaches can help to boost the precision and uptake of biometric-based blood group classification.

7.2 Future Scope

The proposed system has demonstrated promising results in blood group classification using fingerprint images. However, several areas can be explored to further enhance the model's accuracy and applicability:

Scope	**Description**
Real-time Dataset Collection	Expanding the dataset by collecting real-time fingerprint images can improve model generalization and robustness.
Age-wise Categorization	Investigating the effect of age variations on fingerprint patterns and blood group classification can refine model predictions.
Diversity in Data	Incorporating a more diverse dataset with variations in gender, ethnicity, and environmental conditions can enhance the model's adaptability.
Advanced Deep Learning Techniques	Exploring transformer-based models or hybrid approaches may further improve classification accuracy.
Integration with Portable Devices	Deploying the system on mobile applications or biometric devices for real-world usability in forensic and medical fields.

Table 7.1: Future Scope of the Proposed System

These future improvements can significantly enhance the reliability and practical implementation of the system in real-world applications.

Chapter 8

Appendix A

8.1 Paper Publication Details

The research paper titled "Blood Group Classification Using Fingerprint Images: A Deep Learning Approach" has been submitted to the **9th International Conference on Control Communication, Computing & Automation (ICCUBEA-2025)**. The conference is scheduled to take place on **22nd and 23rd August 2025** at Pimpri Chinchwad College of Engineering (PCCOE), Pune, India.

8.1.1 Reviewer Comments

The paper is currently under review. According to the conference timeline, notifications of acceptance are expected by **30th May 2025**. Detailed feedback from the reviewers will be provided upon acceptance.

8.1.2 Certificate

Upon acceptance and presentation of the paper at ICCUBEA-2025, a certificate acknowledging the contribution to the conference will be awarded.

8.1.3 Paper

The submitted paper focuses on a non-invasive method for blood group classification using fingerprint images and deep learning techniques. It details the methodology, experimental results, and potential applications in medical diagnostics and forensic science.

8.1.4 Participation in Technical Events

Active participation is planned in various technical sessions and workshops during ICCUBEA-2025 to engage with fellow researchers and practitioners in the fields of control, communication, computing, and automation. This engagement aims to provide valuable insights and foster collaborations for future research endeavors.

3/30/25, 9:46 AM Conference Management Toolkit - Submission Summary

Submission Summary

Conference Name	9th International Conference on Control Communication, Computing and Automation
Track Name	Cognitive Computing and Machine Learning
Paper ID	220
Paper Title	Blood Group Detection using Fingerprint Patterns: A Deep Learning Approach
Abstract	Accurate and timely blood group identification is crucial in medical diagnostics, transfusion medicine, and forensic science. Traditional blood typing methods rely on laboratory-based serological testing, which is accurate but invasive, time-consuming, and resource-intensive. This research proposes a non-invasive approach to blood group classification using fingerprint patterns and deep learning techniques. By leveraging the unique ridge patterns in fingerprints, a Convolutional Neural Network (CNN) based model was developed to predict blood groups with a high accuracy. The dataset was preprocessed thoroughly, including class balancing, image normalization, and augmentation to enhance the model's performance. The trained CNN was evaluated using standard classification metrics, including accuracy, recall, precision, and confusion matrix, which showed promising results in predicting blood groups. The results show the potential of deep learning models in biometric-based blood typing, a cost-effective, scalable, and rapid alternative to traditional methods. Future works should focus on increasing dataset diversity (a real-time dataset, like different age groups biometrics), transfer learning, and validating the model in real-world clinical settings to improve its robustness and generalizability.
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https://cmt3.research.microsoft.com/ICCUBEA2025/Submission/Summary/220 1/2

3/30/25, 9:46 AM Conference Management Toolkit - Submission Summary

Authors	**Rohit Kandelkar** (Pimpri Chinchwad College of Engineering) <rohit.kandelkar22@pccoepune.org>
Submission Files	Blood_Group_Detection_using_Fingerprint_patterns__A_Deep_Learning_Approach.pdf (225.9 Kb, 3/30/2025, 9:36:37 AM)

Figure 8.1: Proof of Paper Submission

Chapter 9

Appendix B

9.1 Plagiarism Check

Plagiarism Report of our Paper.

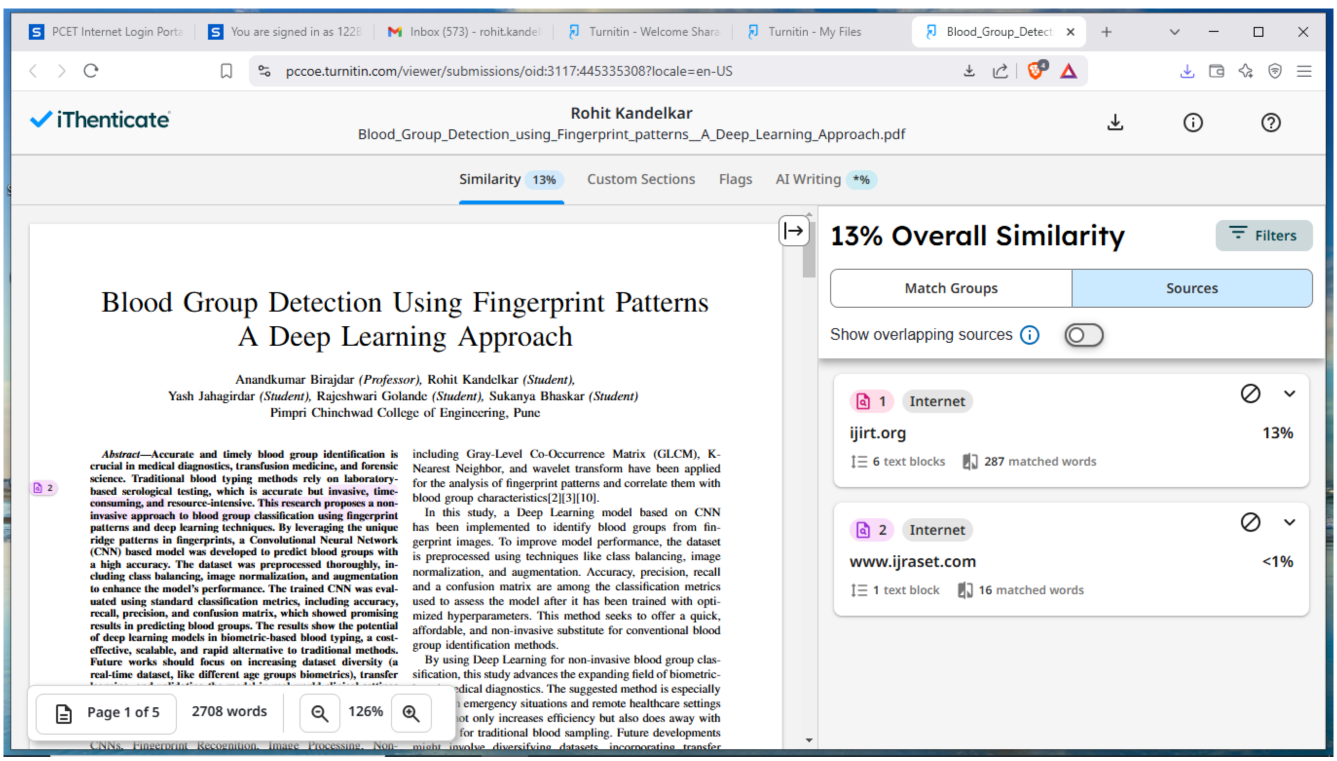

Figure 9.1: Plagiarism Check Using iThenticate Software

Chapter 10

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