Real-Time Blood Group Detection by Fingerprints Using CNN

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Introduction:

Blood group detection is crucial in emergency medical treatments and transfusions. Traditionally, this process requires invasive blood sampling, laboratory tests, and time-consuming procedures. To address these limitations, our project explores a novel, non-invasive approach to detect blood groups using fingerprint images and deep learning techniques. The unique patterns in fingerprints carry subtle biometric information that can be mapped to blood groups through trained models. Leveraging Convolutional Neural Networks (CNNs), the system can learn discriminative features and make accurate predictions. The main objective is to develop a secure, scalable, and real-time web-based system that supports medical professionals in rapid diagnosis. With the integration of image processing and machine learning, this innovation holds significant promise in transforming traditional healthcare practices and supporting critical decision-making.

Objectives:

1. Develop a machine learning-based system for blood group detection using fingerprint images.
2. Utilize CNN to achieve high accuracy in classification.

3. Minimize manual intervention in blood testing procedures.

4. Offer a fast, scalable, and real-time solution suitable for clinical and emergency settings.

5. Ensure the model is optimized for practical deployment with a user-friendly interface.

Methodology:

1. Data Collection:

Acquired fingerprint images labeled with corresponding blood groups (A, B, AB, O - Positive/Negative).

2. Preprocessing:

Images were resized, normalized, and augmented (rotation, flipping, noise addition) to improve model generalization and reduce overfitting.

3. Model Architecture:

A Convolutional Neural Network (CNN) was designed specifically for the classification of fingerprint images, consisting of convolutional layers, pooling layers, and dense layers with ReLU activation and softmax output.

4. Training and Evaluation:

The model was trained on a labeled dataset using a train-validation-test split. Evaluation metrics included accuracy, precision, recall, F1-score, and confusion matrix. Cross-validation techniques ensured the model's robustness.

5. System Integration:

A web interface was developed to allow users to upload fingerprint images and receive real-time blood group predictions.

6. Testing:

The system underwent performance testing under various conditions, including low-resolution images and partial fingerprints, to validate stability and accuracy

The CNN-based system achieved high prediction accuracy in detecting blood groups from fingerprint images. The results showed consistency across different datasets and testing conditions, demonstrating robustness and generalization. The final model integrated with a web application enabled real-time predictions within seconds. The user interface was intuitive and responsive, making it suitable for hospital and emergency setups. Our project conclusively proves the viability of using deep learning

for medical diagnostics, opening doors for further innovations in non-invasive techniques.

Project Outcome & Industry Relevance

This project provides a cost-effective, non-invasive, and quick method for blood group detection. It reduces dependence on lab-based diagnostics and enhances efficiency in critical environments like emergency rooms and rural health camps. The system's integration capability with hospital databases makes it relevant for both medical and forensic applications. Moreover, its scalability ensures potential adoption in mobile diagnostics and remote health monitoring.

Working Model vs. Simulation/Study

The project includes a fully working model, not just a simulation. A real-time web-based system has been developed and tested successfully. The next step involves integrating hardware (sensor input) for seamless real-world deployment.

Project Outcomes and Learnings

- Mastered deep learning model development and tuning for image classification tasks.
- Gained hands-on experience in preprocessing, model evaluation, and deployment.
- Developed a real-time web interface, enhancing understanding of end-to-end system design.
- Learned to address challenges in data quality, real-time predictions, and UI responsiveness.
- Improved teamwork, documentation, and project management skills.

Future Scope

In the future, the system can be expanded to use multi-biometric input such as iris, retina, or palm prints to improve accuracy and security. Clinical trials can be conducted for real-world validation, followed by deployment in rural and emergency healthcare centers. Collaborations with medical device companies can enable integration into handheld diagnostic tools. The system can also be extended to predict other health parameters such as blood sugar levels or genetic markers using AI. Intellectual property rights (IPR) will be pursued to patent the CNN architecture and preprocessing

innovations. Additionally, deep learning optimization techniques like quantization and pruning will be applied for edge deployment and mobile compatibility.