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Blood Group Detection Using Fingerprint

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ABSTRACT
Blood group information is a critical requirement during medical emergencies such as accidents, trauma care, surgeries, and blood transfusions. Conventional blood group determination relies on serological testing methods that require blood samples, laboratory infrastructure, chemical reagents, and trained personnel. Although accurate, these methods are time-consuming and may not be immediately available during emergencies. Several studies have explored fingerprint-based blood group prediction using statistical analysis, image processing, and machine learning techniques. However, these approaches lack sufficient medical validation and reliability.
This paper presents a fingerprint-based blood group identification system in which fingerprint biometrics are used strictly as a secure authentication mechanism rather than a biological prediction feature. During the registration phase, fingerprint data and medically verified blood group information are stored in a centralized database. In emergency situations, a fingerprint sensor interfaced with a NodeMCU ESP8266 microcontroller authenticates the individual and retrieves the corresponding blood group information through IoT-based communication. The proposed system acts as a decision-support tool that provides fast, non-invasive, and reliable access to verified blood group data while complementing conventional medical practices.
Index Terms *- Fingerprint Authentication, Blood Group Identification, IoT, NodeMCU ESP8266, Emergency Healthcare Systems.*

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I.INTRODUCTION

Blood group identification plays a vital role in healthcare systems, particularly during blood transfusions, surgical procedures, and emergency medical treatment. Incorrect or delayed identification of blood group can lead to severe transfusion reactions and life-threatening complications. The ABO and Rh blood group systems are among the most critical parameters that must be accurately determined before blood transfusion [1].

Traditionally, blood group determination is performed using serological methods such as agglutination tests. These methods require blood samples, laboratory equipment, reagents, and trained medical personnel. While highly accurate, they are time-consuming and may not be suitable for emergency situations where immediate medical intervention is required [2]. In scenarios such as road accidents, natural disasters, or unconscious patient admissions, patients may be unable to communicate their medical history, and laboratory facilities may not be instantly accessible.

With advancements in biometric technologies and Internet of Things (IoT)–based healthcare systems, secure storage and retrieval of medical data have become feasible. Fingerprint recognition is widely adopted due to its uniqueness, permanence, ease of acquisition, and cost-effectiveness. Motivated by these advantages, several researchers have attempted to explore the relationship between fingerprint patterns and blood groups using dermatoglyphics, image processing, and intelligent algorithms [3]–[6]. However, these studies report weak correlations and emphasize that fingerprint-based prediction cannot replace medical blood tests.

II.LITERATURE REVIEW

Dermatoglyphics and Their Relationship With Blood Group - 2019 [1] presented a dermatoglyphic study analyzing the relationship between fingerprint patterns and ABO/Rh blood groups using statistical methods. The study categorized fingerprints into loops, whorls, and arches and examined their distribution across different blood groups. The main advantage of this work is that it provides a foundational statistical perspective on fingerprint–blood group association; however, the observed correlations were weak and inconsistent, making the approach unsuitable for medical decision-making. The authors explicitly stated that fingerprint patterns cannot replace conventional blood tests, and no system implementation or accuracy percentage was reported.

Blood Group Determination Using Fingerprint - 2024 [2] proposed a fingerprint-based blood group determination approach using digital image processing and feature comparison techniques. The paper demonstrated the feasibility of extracting fingerprint features and mapping them to blood group labels, which is an advantage from an algorithmic exploration perspective. However, the system was largely conceptual, lacked clinical validation, and relied on limited datasets, reducing reliability. The authors did not report a standardized accuracy percentage, highlighting the experimental nature of the study.

Study of Fingerprint Patterns in Relation to Different Blood Groups – 2024 [3] focused on analysing fingerprint pattern distributions across ABO blood groups. The authors found that loop patterns were dominant across all blood groups, with only minor variations observed among groups. The advantage of this work lies in its empirical validation of fingerprint pattern prevalence; however, the minimal variation observed limits its predictive usefulness. No classification model or accuracy metrics were provided, reinforcing that the study is observational rather than application-oriented.

A Study of Relationship between Blood Type and Fingerprint Designs - 2024 [4], the authors conducted a statistical investigation to identify correlations between fingerprint designs and blood types. The study's strength lies in its systematic statistical analysis and reinforcement of dermatoglyphic research findings. However, it concluded that strong prediction is not feasible due to weak correlations and demographic variability. The paper did not report any prediction accuracy, emphasizing its limitation as a non-implementable medical solution.

Blood Group Detection Using Fingerprints and Image Processing - 2025 [5] introduced an image-processing-based framework combined with machine learning and CNN models to classify blood groups from fingerprint images. The key advantage of this study is the application of advanced algorithms that reportedly improve experimental classification performance. However, the system depends on private datasets, lacks large-scale clinical validation, and raises concerns about overfitting. While the authors claim improved accuracy, an exact standardized accuracy percentage was not clearly specified in the provided information.

Blood Group Detection with Fingerprint Using Deep Learning – 2025 [6] explored deep learning techniques, particularly Convolutional Neural Networks, for predicting blood groups from fingerprint images. The advantage of this work is the use of automated feature learning, which reduces dependence on handcrafted features and improves experimental performance. However, the study suffers from limitations such as limited dataset size, lack of cross-population validation, and absence of medical certification. Although improved prediction accuracy is claimed, a universally acceptable accuracy percentage for clinical use is not established.

IoT Based Blood Group Prediction Using Fingerprints - 2025 [7] proposed an IoT-enabled architecture where fingerprint data is captured through sensors and processed using machine learning models on a cloud platform. The strength of this study lies in its scalable IoT architecture suitable for emergency healthcare environments. However, it combines IoT with biologically unverified prediction models, which reduces medical reliability. While performance improvements were discussed, exact accuracy values were not clearly specified.

Automated Blood Group Detection Using Fingerprint Biometrics and Deep Learning - 2025 [8], the authors presented an automated framework combining fingerprint scanning and deep learning classification. The key advantage is system automation and real-time usability in controlled environments. However, the work remains a proof-of-concept, relies on experimental datasets, and lacks clinical validation. Although improved accuracy is claimed, no universally accepted accuracy percentage is reported.

Blood Group Prediction Using Fingerprint – 2024 [9] employed CNN-based fingerprint image analysis to classify blood groups. The advantage of this work is its detailed preprocessing and model training methodology. However, it shares common limitations with similar studies, including dataset dependency, lack of medical approval, and limited generalization. The reported results are experimental, and a clinically reliable accuracy percentage is not established.

IoT Enabled Fingerprint Based Healthcare Database Management System - 2024 [10] proposed an IoT-enabled fingerprint-based healthcare database management system using NodeMCU for secure medical data access. Unlike prediction-based studies, this work focuses on biometric authentication and secure retrieval of healthcare records, which is a major advantage and closely aligns with real-world deployment. The limitation is that it does not directly address blood group detection; however, it provides a robust architectural foundation. Accuracy metrics are not applicable, as the system focuses on authentication rather than classification.

III.RESEARCH GAP AND PROPOSED DIRECTION

Existing studies attempting to determine blood group from fingerprints largely rely on dermatoglyphic correlations, image processing, or machine learning models. However, these approaches suffer from weak biological justification, limited datasets, lack of clinical validation, and inconsistent accuracy across populations. As a result, fingerprint-based prediction cannot be considered medically reliable for transfusion decisions.

Another critical limitation is that most systems focus on predicting blood group rather than securely retrieving medically verified information. In emergency healthcare scenarios, reliability and speed are more important than speculative prediction.

Therefore, a safer and more practical approach is to use fingerprint biometrics strictly as an authentication mechanism linked to a verified healthcare database. Instead of predicting blood group, the system retrieves pre-validated medical records associated with the individual. This direction aligns better with real-world deployment requirements, improves reliability, and complements existing medical practices.

IV.CONCLUSION

This paper reviewed existing research on fingerprint-based blood group identification and IoT-enabled healthcare systems. Dermatoglyphic and statistical studies indicate that correlations between fingerprint patterns and blood groups are generally weak and unsuitable for clinical decision-making. Recent approaches using image processing, machine learning, and deep learning report improved experimental performance; however, these methods lack standardized datasets, cross-population validation, and medical certification.

The analysis highlights that prediction-based systems introduce reliability concerns in critical medical situations. In contrast, IoT-enabled biometric authentication systems offer a safer alternative by securely storing and retrieving verified medical data rather than attempting biological prediction.

Future research should focus on developing robust healthcare database systems integrated with biometric authentication, secure cloud infrastructure, and interoperability with hospital information systems. Such solutions can enable rapid, reliable access to patient blood group information during emergencies while maintaining privacy, accuracy, and clinical compliance.

Overall, fingerprint-based authentication combined with verified medical databases represents a promising direction for practical deployment in emergency healthcare environments.

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