A Survey: Blood Group Detection Using Fingerprint Images

Authors: Sukanya Bhaskar, Rajeshwari Golande, Yash Jahagirdar, and Rohit Kandelkar

Under Guidance of Prof. Anandkumar Birajdar , PCCOE, Akurdi

ABSTRACT: Fingerprint pattern is the most consistent and distinguishing aspect of human identification. The fingerprint pattern cannot be modified and remains the same until the individual dies. Fingerprint verification is still considered the most crucial piece of evidence in the case of an event, even in the court of law. Each individual has a unique minutiae pattern, and the chances of resemblance are extremely low, around one in sixty-four thousand million. Even twins exhibit unique patterns. The ridge pattern is also unique, and has not changed since the birth of an individual. The method described in this work involves matching minutiae feature patterns obtained from fingerprints for a person identification system. Blood grouping has also been studied using fingerprints. Fingerprint matching was performed using ridge- frequency estimation. The spatial features were retrieved using a Gabor filter. The fingerprint scanner-based work reported here demonstrates great efficiency in image processing activities, such as image- to- binary conversion and thinning for fingerprint pattern correction and normalization.

Keywords: Machine Learning, Deep learning, Blood Groups, Fingerprints, Fingerprint Map Reading, Image Processing.

1. INTRODUCTION

The study demonstrated the value of fingerprint-based work and the fact that it has been around for several centuries. The most common use for fingerprints is pattern recognition for identity verification. Fingerprint-based biometric identification is employed in the majority of Indian enterprises; gender and age identification are also important application modalities [1].

The basic idea underlying fingerprint technology is "you are your own key," which runs counter to the idea of tokens or passwords. Ever since the research, fingerprint-based matching techniques dating back to the 16th century have been in use. The work has demonstrated how distinctive and singular fingerprints are. It introduced the present fingerprint-based identifying method.

A survey conducted significant fingerprint analyses in the 1800s and asked for fingerprints based on simple models such as circles, whorls, and curves. The articulation of dermal perspective diagrams at the digits "Dermatoglyphics (derma ¼ skin, glyphic ¼ turns)" of arms and the confirmation that the point course of development is no longer settled but rather guided by heredity or unavoidable impact that produces weight continuously of their progression sometimes of fatal life is credited to Cummins.

Even though there have also been documented instances of dietary and occupational modifications in later life. Blood tests are used to identify and diagnose most disorders in the human body. Blood is essential for maintaining the health and vitality of the human body. Biometrics, or a person's physical and behavioral traits, are employed in computer security for identification and authentication [1].

Computers are now utilized for a variety of functions, including identification, authentication, and other forms of security. In addition to being inexpensive and small in size when compared to other biometric sensors, fingerprint sensors differ and are easy to get, which contributes to their variable performance when compared to other biometric approaches. The method of biometric verification allows for a person's unique identification [2].

The first section includes the introduction of the study Blood group detection using fingerprint images mainly through ridge frequency, GLCM. Section second includes all the related works of study matching to the topic including base paper. The third section consists of gap analysis from papers which thoroughly covers the algorithm, parameters and future work. The fourth section covers observation and key issues regarding the study. Last section gives overall conclusion through field of study.

2. RELATED WORK

A literature survey consists of different learning techniques to retrieve ontology from data as follows: In this study, a unique method for determining a person's blood type using fingerprint patterns is presented. It analyses minute details in fingerprints and correlates them with blood types by utilizing machine learning techniques. Using image processing methods such as Gabor filters, the study examines fingerprint patterns such as loops, whorls, and arches. The suggested approach, which makes use of multiple linear regression, produces predictions with an accuracy of roughly 62%. Future research with a bigger sample size and more fingerprint characteristics, according to the scientists, might increase accuracy. This technique might provide a non-invasive substitute for conventional blood group testing techniques [1].

The study discusses an inexpensive method for determining blood types using fingerprints. The approach for extracting features from fingerprint images includes GLCM (Gray Level Co-occurrence Matrix), wavelet transforms, texture feature extraction, and minutiae feature extraction. These traits are subsequently classified using a Back Propagation Neural Network (BPNN). The method identifies the blood group by comparing fingerprint traits to a pre-existing database, with an accuracy of roughly 80%. This technology seeks to give a faster and less invasive alternative to existing blood group testing techniques [2].

The study covers the creation of a low-cost, automated system for detecting human blood types through image processing techniques. The technology uses a CCD camera to capture images of blood samples combined with specified serums. By analyzing these photos with specialized software (IMAQ Vision), the device detects agglutination, which determines blood type. This method provides a quick and effective means to establish blood type, making it useful in emergency circumstances where time is important. The authors propose developing a portable, low-cost gadget based on this technology [5].

The study describes two recent genetic technologies used for blood group genotyping. It describes how single nucleotide variant (SNV) mapping with DNA microarrays and massively parallel sequencing (MPS) improves accuracy in predicting blood group antigen phenotypes. The research discusses the advantages of employing SNV mapping for common blood groups while also addressing its drawbacks, such as its inability to detect novel or rare alleles. MPS, on the other hand, has a greater throughput and can detect previously unknown genetic variations, but it requires more resources and produces massive data sets that necessitate extensive bioinformatics analysis. The research continues by examining the potential for these technologies to improve transfusion safety by offering more thorough blood group typing. While SNV microarrays are currently more practicable, MPS may become the method of choice in the future [13].

The study describes a system for automating blood type detection with image processing technology. In emergency scenarios where quick and accurate blood group identification is critical, this technology enables the simultaneous testing of several blood samples, decreasing human error and increasing efficiency. Blood samples are mixed with certain antigens, and photos of the reactions are captured using a camera. The photos are then analysed to identify blood type based on agglutination. The suggested technology enhances the speed and precision of blood type identification, making it perfect for high-demand situations like blood transfusions and roadside emergencies. The use of image processing ensures little human interaction, reducing errors and requiring specialized professionals [12].

The study describes a unique approach for detecting human blood groups that employs image processing and deep learning techniques. The system uses Scale-Invariant Feature Transform (SIFT), Orientated FAST, and Rotated BRIEF (ORB) algorithms for feature extraction and Convolutional Neural Networks (CNNs) for classification. This method improves the accuracy and efficiency of blood group detection by automating the process, minimizing human error, and optimizing image quality. The algorithm is trained on blood group picture datasets and has a high accuracy in classifying blood types. The suggested method is particularly useful in medical diagnostics, as it improves transfusion management and patient care by analyzing blood samples quickly and automatically. It also gives robustness to differences in image quality, resulting in dependable forecasts. Future advances will entail integrating this system with electronic health records and expanding its capabilities to anticipate new blood-related features [10].

The study covers a method for detecting blood groups using machine learning classifiers, with a particular emphasis on image processing approaches for analyzing blood samples. It describes the picture acquisition, segmentation, and gray conversion steps that simplify the analysis of blood samples containing specified chemicals. The study emphasizes the benefits of automated technologies in decreasing human error and enhancing the quality of blood banking findings. Furthermore, it reviews alternative approaches from earlier research, emphasizing the potential for speedy and precise blood type detection. Future developments are expected to use GSM technology for effective communication with lab technicians [9].

The study offers a novel approach to blood group categorization that employs artificial intelligence and image processing techniques. It describes a methodical methodology for collecting blood samples, capturing pictures, and processing them using MATLAB to obtain accurate categorization. The procedure includes segmentation, feature extraction, and comparison with predefined images in a dataset, all of which lead to automatic blood group determination. This novel approach aims to increase the efficiency and accuracy of blood type testing, which is critical for safe transfusions and illness identification, resulting in a considerable improvement over standard testing method [6].

The study provides an innovative blood group determination method based on fingerprint analysis, which takes use of fingerprints' unique and unchangeable character. It emphasizes the potential of sweat from fingerprints, which contains proteins and antigens linked to blood types, notably the ABO and Rh systems. To extract and classify features effectively, the system uses advanced image processing techniques such as Gabor filters and Convolutional Neural Networks (CNN). The device is designed to offer quick and accurate blood typing results, making it especially useful in emergency situations where traditional procedures are time-consuming. The study underlines the significance of establishing a consistent association between fingerprint patterns and blood groups, with future research focusing on enhancing accuracy and expanding the dataset for more complete analysis [8].

The study provides an automated blood type determination approach based on image processing techniques, with an emphasis on the examination of agglutination in blood samples. It describes the processes of dilatation and erosion in morphological procedures, which are critical for improving image quality and retrieving useful features. The technology incorporates color plane extraction, pixel intensity quantification, and the use of HSL luminance to accurately classify blood types. The findings illustrate the proposed system's efficiency in providing quick and reliable blood type identification, with future plans to improve portability and add GSM technology for better communication in laboratory settings [5].

The study proposes the implementation of a type of spectrophotometric method to create a tiny, low-cost, portable system for blood typing in emergency scenarios. The system's goal is to overcome the limitations of current human and automated approaches by using optical analysis of blood agglutination to determine ABO and Rh types. The study analyses the problems with current blood typing systems, particularly their subjectivity and time limits in emergencies, and suggests an automatic approach that can provide speedy, accurate findings outside of clinical laboratories. The device automates the procedure with light-based detection and electronic components, decreasing human error and increasing portability. Initial tests proved the feasibility of employing spectrophotometry, with future work concentrating on system calibration and real-time application [3].

The study offers a novel, non-invasive method for estimating human blood component levels such as hemoglobin, glucose, and creatinine using fingertip video data acquired by a smartphone. The method makes use of photoplethysmogram (PPG) signals obtained from fingertip videos illuminated by near-infrared (NIR) light-emitting diodes (LEDs). The study estimates blood component levels by extracting 46 typical features from the PPG signal, its derivatives, and Fourier analysis using deep neural network (DNN) models. The models use genetic algorithms to optimize feature selection and reduce overfitting, resulting in high accuracy for hemoglobin, glucose, and creatinine estimates. The findings indicate that the technology could be used as a simple, non-invasive alternative to traditional blood sample for real-time health monitoring [11].

3. GAP ANALYSIS

Table 1. Summary of related work / gap analysis:

Ref No.	Parameter	Algorithms	Limitation and Future work
1.	1) Fingerprint features 2) Blood Group Data 3) Dataset	1) Fingerprint matching 2) Preprocessing 3) Multiple Linear Regression	1) Accuracy about 62% 2) Sample size with features scope 3) Advanced Machine Learning

2.	1)Gray-Level Co-occurrence	1) Image processing 2) Back propagation	1) Limitation of sample size
3.	1) Blood samples 2) Optical Density Spectrum (OPS) 3) Light source and detector	1)Spectrophotometry 2) Agglutination detection	1) Blood Sample preparation may not be optical 2) Stability issues affecting accuracy 3) Experiment the system variation 4) Miniaturization
4.	1) Optical density 2) Light emitting diodes (LED) 3) Test samples with antibodies	1)Spectrophotometric measurement 2) Light scattering. 3) Test samples with antibodies	1) Accuracy Dependence 2) Testing Environment 3) Blood reactions 4) Clinical Testing
5.	1) Image processing 2)Threshold for agglutination 3)Reagents	1) Image processing pipelines 2) Pixel value classification	1) Reagents handling is complex 2) Non portability 3) Testing data 4) GSM technology
6.	1) Blood sample collection 2) Blood group classification 3) Image segmentation	1) Image processing for feature extraction 2) Logistic regression 3) Linear Regression	1) Manual errors and human interference 2) Time consuming and complex 3) Improving AI and deep learning techniques
7.	1) Sample images 2) color plane extraction	1)Thresholding techniques 2) Morphological techniques 3) Quantification	1) Manual Intervention 2) Region specific thresholding 3) Variable in high conditions 4) Accuracy limitations 5) Incorporate GSM technology
8.	1) Fingerprint data 2) Ridge frequency 3) Antigens	1) Gabor Filters 2) Convolutional Neural Networks (CNN) 3) Multiple linear regression with ordinary least squares (OLS) 4) Deep learning	1)Limited dataset for analysis model 2) High sensor dependency 3) Advanced CNN architecture 4) Unexploded features
9.	1)Gray-Scale level 2) Color Histogram 3) Blood group types	1)Image acquisition 2) Feature extraction (Mean, Standard deviation, entropy) 3) SVM classification (binary)	1)Limitation of computer and software 2) Limitations in fiber optics in detection 3) Incorporating GSM technology
10.	1)Scale Invariant feature Transform 2) Histogram Equalization 3) Normalization 4) Contrast optimization	1) Preprocessing -ng cleaning data 2) Deep learning 3) CNN	1) Large and diverse dataset 2) Computational complexity consumes time and space 3) Sensitivity of input image quality 4) Integration with electronic health record (EHR) system
11.	1)Input data 2) PPG signal 3) Features 4) Additional Factors	1)PPG signal generation 2) Feature extraction 3) Feature selection	1)High data size variability 2) High device dependence

		4) Deep Neural networks (DNN)	(NEXUS 6P) 3) Computational complexity 4) Cloud based integration
12.	1)Blood samples 2) Antigen reaction 3) Pi camara 4) Raspberry Pi Microcontroller	1)Preproces-sing 2)Segmenta-tion 3)Feature extraction 4)Calssifica-tion	1)Manual antigen introduction 2) Testing process 3) Specific equipment 4) Enhanced Accuracy
13.	1) Genotyping platforms 2) Single nucleotide variant (SNV) 3) parallel sequencing	1) SNV Mapping : Multiplex PCR Amplification 2)Massively parallel sequencing (MPS) 3) Data analytics	1) Integration of MPS 2) Population specific platforms 3) High level testing (large input) 4) High Optimization

4. OBSERVATION AND FINDING

A. Key issues and insights

Image Clarity: One challenge mentioned is improving image quality in order to improve accuracy.

Accuracy: Although the suggested system beats earlier systems, there is still potential for development, particularly in terms of error rates and accuracy [1].

The paper covers the use of fingerprint patterns, which are unique and consistent throughout a person's life, for personal identification and medical needs such as blood group determination [2].

The primary focus is on a non-invasive method for establishing blood types via fingerprint analysis, which eliminates the need for traditional blood tests that need needles. Sweat released by fingerprint ridges and grooves contains blood group-related proteins or antigens [2].

The blood group detection technology has potential uses in healthcare (rapid blood group determination in an emergency), forensics (victim identification in mass casualty situations), and disaster management. [2].

The study evaluates fingerprint patterns and associates them with blood types using machine learning techniques such as convolutional neural networks (CNNs) and other image processing algorithms. Feature extraction is accomplished utilizing techniques such as the Gabor filter, ridge frequency, and minutiae detection.

The system obtained a 62% accuracy utilizing machine learning methods such as Multiple Linear Regression with Ordinary Least Squares. Future research involves increasing the dataset and using more advanced models to increase accuracy [5].

Ongoing research in sensor technology, data analysis, and feature extraction is required to improve this method. Improvements in these areas may expand the use of fingerprint-based blood group detection in practical applications.[8].

B. Findings

When it came to determining blood types from spectroscopic images, the trained machine learning and deep learning model performed 95% of the time accurately [1].

The Scale-Invariant Feature Transform (SIFT), Oriented FAST, and Rotated BRIEF (ORB) algorithms were used successfully to extract different features from spectroscopic images. These enhancements significantly improved the model's accuracy and interpretability.

The suggested system utilizes spectroscopic imaging to provide a non-invasive solution for blood group identification, which can be used in place of existing blood typing procedures.

The system demonstrated robustness to fluctuations in image quality while maintaining excellent accuracy, making it appropriate for a variety of real-world medical contexts.

The machine learning and deep learning technology can be connected with electronic health records (EHR) to simplify patient care and improve clinical decision-making [2].

The machine learning and deep learning model's decision-making process is transparent, which gives healthcare professionals more confidence in using the system for blood group prediction [2].

The machine leaning and deep learning technology has the potential for extensive use in medical diagnostics, notably in transfusion management, by automating and enhancing the accuracy of blood group detection [11].

This blood group detection using fingerprint images

approach could be expanded to predict other blood-related features, such as antibody screening and Rh factors, hence increasing its clinical relevance [6].

5. CONCLUSION

The research study examines various methods for detecting blood groups using fingerprint scans, emphasizing advances in machine learning, image processing, and biometric identification. Fingerprint-based blood group testing is a promising non-invasive alternative to established procedures that require blood samples. This strategy is based on the uniqueness of fingerprint patterns that remain consistent throughout a person's life. Machine learning methods, such as Convolutional Neural Networks (CNN) and multiple linear regression, have showed promise, but are currently constrained by accuracy, dataset size, and the need for more complex models.

While the proposed methodologies provide a low-cost and speedy solution for blood group detection, more research is needed to increase accuracy, reduce reliance on high-quality sensors, and broaden datasets. Future developments should concentrate on improving machine learning models, increasing fingerprint image quality, and connecting with electronic health record systems. This method could transform blood group detection in emergency situations and routine medical diagnostics, providing a speedier, less invasive procedure with applications in healthcare, forensics, and disaster management.

7. REFERENCE

[1] Vijaykumar, Patil N., and D. R. Ingle. "A Novel Approach to Predict Blood Group using Fingerprint Map Reading." 2021 6th International Conference for Convergence in Technology (I2CT). IEEE, 2021.

[2] D. Siva Sundhara Raja and J. Abinaya, "A Cost- Effective Method for Blood Group Detection Using Fingerprints," International Journal of Advance Study and Research Work, vol. 2, no. 3, pp. 1-10, March 2019, doi: 10.5281/zenodo.2591955.

[3] S. Pimenta, G. Minas and F. Soares, "Spectrophotometric approach for automatic human blood typing," 2012 IEEE 2nd Portuguese Meeting in Bioengineering (ENBENG), Coimbra, Portugal, 2012, pp. 1-4, doi: 10.1109/ENBENG.2012.6331340.

[4] Pimenta S, Soares F, Minas G. Development of an automatic electronic system to human blood typing. Annu Int Conf IEEE Eng Med Biol Soc. 2012; 2012:2712-5. doi: 10.1109/EMBC.2012.6346524. PMID: 23366485.

[5] Ferraz, Ana. "Automatic system for determination of blood types using image processing techniques." 2013 IEEE 3rd Portuguese meeting in bioengineering (ENBENG). IEEE, 2013.

[6] T. Gupta, "Artificial Intelligence and Image Processing Techniques for Blood Group Prediction," 2024 IEEE International Conference on Computing, Power and Communication Technologies (IC2PCT), Greater Noida, India, 2024, pp. 1022-1028, doi: 10.1109/IC2PCT60090.2024.10486628.

[7] Ravindran, G., et al. "Determination and classification of blood types using image processing techniques." International Journal of Computer Applications 157.1 (2017): 12-16.

[8] T. Nihar, K. Yeswanth, and K. Prabhakar, "Blood group determination using fingerprint," MATEC Web of Conferences, vol. 392, p. 01069, 2024, doi: 10.1051/matecconf/202439201069.

[9] Dannana, S., & Prasad, D. Y. V. (2022). “Blood group detection using ML classifier”. International Journal of Health Sciences, 6(S1), 4395–4408.

https://doi.org/10.53730/ijhs.v6nS1.5830

[10] J. Sai Ganta, M. Rishitha, Y. Jaya Surya Pulivarthi, and M. Roopa, "Blood Group Detection Using Image Processing and Deep Learning," International Research Journal of Engineering and Technology (IRJET), vol. 11, no. 4, pp. 97-103, April 2024, doi: 10.17148/IJARCCE.2015.4123

[11] M. R. Haque, S. M. T. U. Raju, M. A. -U. Golap and M. M. A. Hashem, "A Novel Technique for Non-Invasive Measurement of Human Blood Component Levels from Fingertip Video Using DNN Based Models," in IEEE Access, vol. 9, pp. 19025-19042, 2021, doi:10.1109/ACCESS.2021.3054236.

[12] Banu, A. N., & Kalpana, V. (2018). An Automatic System to Detect Human Blood Group of Many Individuals in a Parallel Manner Using Image Processing. International Journal of Pure and Applied Mathematics, 118(20), 3119-3128.

[13] Rhiannon S. McBean, Catherine A. Hyland, Robert L. Flower, Approaches to Determination of a Full Profile of Blood Group Genotypes: Single Nucleotide Variant Mapping and Massively Parallel Sequencing, Computational and Structural Biotechnology Journal, Volume 11, Issue 19, 2014, Pages 147-151, ISSN 2001- 0370, https://doi.org/10.1016/j.csbj.2014.09.009.