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A Novel Approach to predict Blood group using fingerprint map reading

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Abstract*: Fingerprints are considered one of the most reliable methods for identifying individuals. In forensic science and legal investigations, fingerprint evidence is widely regarded as accurate and trustworthy. Two important characteristics make fingerprints effective for identification. First, the ridge patterns formed during fetal development remain stable throughout a person's life unless the skin is severely damaged or decomposed. Second, fingerprints are unique; no two individuals, not even identical twins, share the same ridge patterns or characteristics. Because of this uniqueness and permanence, fingerprints are often treated as strong evidence in courts of law.*

This study proposes a novel approach to predict blood groups using fingerprint patterns with machine learning techniques. Fingerprints, known for their distinct and permanent nature, serve as an important biometric feature. In this research, Convolutional Neural Networks (CNNs), a deep learning method, are used to analyze fingerprint images and extract complex ridge features. By learning these patterns, the model attempts to predict an individual's blood group. This approach highlights the potential of combining biometric identification with artificial intelligence for biomedical and forensic applications.

Keywords: Fingerprint, blood types ,patterns, Deep learning

I. INTRODUCTION

The early phases of extraordinary finger impression matching methods can be followed back to the sixteenth hundred years and have since state of the art through enormous obligations from striking figures like Henry Fauld, Herschel, and Sir Francis Galton. Dr. Harold Cummins drove noteworthy examination in 1926 that shed light on the aiding through significance of fingerprints, fanning out them as steadily persevering through identifiers that stay strong all through a specific's life. The boundless get-together of momentous engraving based biometric ID in India remembers its work for considering people to be well as its assessment of heading and age ID, testing standard frameworks for affirmation.

The movement of fascinating finger impression matching frameworks can be followed back to the sixteenth 100 years, advancing through gigantic obligations from Henry Fauld, Herschel, and Sir Francis Galton. Galton's done evaluations in the nineteenth century laid the foundation for mentioning fingerprints into circles, whorls, and curves. Cummins later supplemented the connection between dermal models and digit improvement, uncovering the blend of procured and typical variables during fetal new development. Human fingerprints, with their different and multifaceted nature, can be totally gathered into circles, whorls, and twists. Circles, which make up commonly 65% of fingerprints, show edge lines that stream inside, structure a rose twist, and some time later bend back. Whorls, tending to around 30% of fingerprints, consolidate models, for example, the plain whorl, focal pocket circle, twofold circle, and extemporaneous whorl. Twists, yet marvelous (containing around 5% of fingerprints), present as plain and risen twists. In spite of these models, every individual's remarkable arrangement of fingerprints changes into an unrivalled procedure for individual undeniable affirmation.

Notwithstanding the intricacy of dermatoglyphics, Karl Landsteiner uncovered the blood pack framework in 1901. This construction, twirled around the 'ABO' and 'Rhesus' parties, further depicts blood into A, B, Stomach muscle, and O packs thinking about the presence of plasma antigens. The 'Rhesus' structure consigns blood as either Rh-positive (Rh+ve) or Rhnegative (Rh - ve) reliant upon the presence of the 'D' antigen.

Past the sound interest consolidating dermatoglyphics and blood get-togethers, these ordinary markers convey huge ramifications for quantifiable science, hereditary appraisal, and modified clinical advantages. The blend of uncommon finger impression models and blood pack credits could possibly reveal further snippets of data into individualized inborn characteristics and helplessness to unequivocal difficulties.

This study leaves on an assessment of the party of various fascinating finger impression types, blood get-togethers, and bearing, plunging into the shocking cooperation that shapes our regular characters. By unwinding the mind-boggling relationship inside this plan of three, we need to add to a huger discernment of the unconventional models cut on our skin, crossing the spaces of dermatoglyphics and blood pack structures inside the colossal extent of human uniqueness.

II. LITERATURE REVIEW

Vijaykumar, Patil N et al.[1],The paper revolves around using finger impression plans as a strong and phenomenal incorporate for human unmistakable proof and explores the possibility expecting blood packs using fingerprints. The inconsequential subtleties illustration of each and every human is exceptional, with a very thin probability of likeness, even among twins. The edge configuration is in like manner novel moreover, stays unaltered from birth. The method proposed in the paper incorporates matching the specifics incorporate plan removed from fingerprints for individual distinctive verification. The novel imprint organizing is taken care of with the evaluation of edge repeat, moreover, spatial features are isolated using Gabor channel. The paper also inspects the capability of the HFDU06 finger impression scanner-based work, which integrates picture taking care of endeavors, for instance, picture to matched and reducing for helping and normalizing novel finger impression plans.

Kukadiya, Urvik et al.[2],paper proposes an original CNN-based strategy that joins surface, particulars, and recurrence range for unique finger impression include extraction. The proposed strategy acquaints a particulars consideration module with extricate viable surface highlights from neighborhood locales around the details focuses in finger impression pictures. This module centers around catching the subtleties and attributes of the edge designs close the particulars point The paper additionally presents new information increase strategies that consider the attributes of unique finger impression pictures to build the number of preparing pictures. This is significant on the grounds that the proposed strategy utilizes a public dataset with a predetermined number of unique mark classes.

Al Habsi et al.[3],A cross-sectional study conducted in Oman between January 2020 and June 2021 looked into the relationship between 200 Omani people's fingerprint patterns and ABO blood groupings. Blue ink stamp pads were used to collect fingerprint patterns, and driver's licence blood types were noted. The findings indicated a strong relationship ($p < 0.001$) between blood group and fingerprint patterns and gender. The most common patterns were loops (49.4%), followed by whorls (44.9%) and arches (5.7%). Most frequent blood category was O+ (54.0%). Understanding the forensic and diagnostic consequences of blood type and fingerprint relationships is made easier by this study.

Rastogi et al.[4],Eight hundred people participated in this study at the All India Institute of Medical Sciences (AIIMS), Patna, Bihar. Participants included medical and nursing students, staff members, and instructors. Blood group distributions and dermatoglyphics were examined in healthy adults eighteen years of age and older. Karl Landsteiner's ABO blood grouping procedure was utilised to establish blood groups, and fingerprints were captured using the ink method developed by Cummins and Mildo. Based on statistical research, fingerprints showed that 55.9% of fingerprints had prominent loop patterns, with the B+ve blood group being especially prevalent (35.8%). There were notable variations in fingerprint patterns among ABO blood types ($p=0.0003$). Knowing dermatoglyphic pattern and blood group connections in a heterogeneous population is aided by this study.

Takahashi, Ai et al.[5],examines the relationship between gender, blood type, and fingerprint patterns among students in Junagadh, Gujarat. There are 1participants in the study, with a balanced distribution of males and females and a range of ABO blood types. The most common fingerprint pattern is a loop, while an arch is the least common, according to the major findings. Compared to other Rh-ve blood groups, O+ blood groups have a higher frequency of whorls. Blood groups B and O have more loops and arches than blood group AB, which has the least amount of arches. Males tend to have more whorls and fewer loops and arches in their bodies than females do. Blood groups O+ and B+ show the same amount of whorls. Loop frequency is higher in blood group A, whereas there is a greater frequency of whorls in blood group O .By examining the connection between fingerprint patterns, blood types, and gender, the study seeks to increase the accuracy of fingerprint recognition and criminal detection. In addition to offering insights into the distinctive qualities of fingerprint patterns and their possible associations with gender and blood groups within the population under study, the references are included for additional reading and citation needs.

Smail, Harem et al.[6], The spectrophotometric detection of agglutination reactions and details the creation and verification of a portable blood typing apparatus. The machine is made to quickly and accurately perform blood type tests outside of clinical laboratories. The apparatus uses spectrophotometric analysis to find agglutination reactions, which show if a certain blood antigen is present or not. There is discussion of several blood typing techniques, such as automated and manual testing. Plate, tube, and microplate techniques are used in manual testing, whereas photometry, magnetization, or image processing are used in automatic systems. However, there are drawbacks to both approaches, including complexity, expense, and time.

Galbally, Javier et al.[7]Traditional identifying techniques can be replaced with biometric authentication techniques, such as fingerprint recognition. But it's important to know how time modifies biometric properties and how that affects recognition systems. This work examines how time affects fingerprint identification, taking into account two important variables: the chronological impact and the ageing impact. The ageing effect looks at changes in accuracy brought on by the time variation among reference and probing samples, whereas the age effect looks at variations in accuracy within age groups. A thorough study is carried out utilising a sizable dataset of over 400,000 fingerprints, spanning ages from 0 to 98 years old with time intervals of up to 7 years between samples, in order to address these problems. The outcomes of experiments shed light on how older people and those between the ages of 13 and 25 have more consistent performance throughout time. These findings deepen our understanding of the dependability of systems that recognise fingerprints and can guide the creation of guidelines for system optimisation and template updates.

Naeem, Awad Bin et al.[8]The link between blood groups and fingerprint patterns as distinctive identifiers for individual identification is investigated in this study. Fingerprint patterns—which are categorised into whorls, loops (left and right), tented arches, and arches—have been used for almost a century because of their durability and individuality. Similar to this, blood types like Rh and ABO don't alter during the course of a person's life. Potential predictive usefulness is suggested by statistical research that shows relationships between particular blood types and fingerprint patterns. By utilising machine learning methods, specifically Convolutional Neural Networks (CNNs), we suggest a CNN model that has been optimised to forecast blood types using fingerprint photos gathered from 392 participants. The CNN model achieves high precision in blood group prediction, outperforming previous CNN designs and traditional approaches. Our results highlight CNN models' potential . Our results highlight CNN models' potential in biometric identification tasks and its implications for forensic science and medical research .According to reports, the suggested CNN model predicts blood types 91.53% of the time using fingerprint pictures. This high degree of accuracy shows how well the model works to detect blood types from fingerprint patterns.

Kc, Sudikshya, Niroj Maharjan et al.[9],In this study, dentistry students between the ages of 18 and 25 have their fingerprint patterns, gender, and ABO blood groups analysed. The friction points on the palms and soles of the feet generate fingerprint patterns, which are distinct and last a lifetime. The examination of fingerprint patterns, or dermatoglyphics, provides information about the effects of heredity and environment on ridge patterns. Fingerprint patterns were gathered using ink and paper impressions, and they were categorised into major patterns (loops, whorls, arches).The findings showed that fingerprint patterns varied according to gender and blood group, with blood group B being the most common. The most common fingerprint pattern was loops, which was followed by whorls and arches. The frequency of specific fingerprint patterns showed gender differences, with loops being more prevalent in females and whorls being more common in males. The prevalence of particular fingerprint patterns differed among Rh factors and blood groupings as well. All things considered, this work advances our knowledge of the interactions among blood types, gender, and fingerprint patterns, which has ramifications for forensic and medical research.

Ravindran et al.[10],The suggested solution reduces human error in blood group detection by using image processing techniques. Blood samples are examined for agglutination patterns using morphological procedures, thresholding, and preprocessing. To divide images and identify blood groups, the system uses a variety of thresholding techniques, includes global, local, and adaptive approaches. Through automation of the detection process, the technology improves medical diagnostic efficiency and accuracy and provides a quick fix for blood type detection in clinical settings.

Joshi, S et al.[11],This study looked into the connections between medical students' blood types and fingerprint patterns. The fingerprints of 178 participants in all were classified as composites, whorls, loops, and arches. It was also noted how the participants' blood types were distributed. The most common blood group, according to the results, was O, which was followed by A, B, and AB. The most prevalent fingerprint patterns were loops, followed in decreasing

order of frequency by whorls, arches, and composites. The study also discovered that a greater percentage of the subjects belonged to Rhpositive blood groups. These results shed light on the possible relationship between blood types and fingerprint patterns, which may have forensic and medical applications for dermatoglyphics.

Ali, Mouad MH et al.[12],The distinctiveness and dependability of biometric templates for personal identification, especially fingerprints. The abstract covers the many stages of fingerprint recognition, such as matching, minutiae extraction, post-processing, and picture preparation. It highlights how important it is to extract minute details for precise identification, particularly in low-quality fingerprint photos. The abstract also discusses fingerprint scanning technologies and enhancing methods like Fourier transform and histogram equalisation. The methodical approach taken to fingerprint recognition and its use in personal identity.

Susmiarsihet al.[13],A total of 302 medical students participated in the study, which was carried out within the Department of Biology, YARSI University, Indonesia (115 males, 187 females). Using the ink technique outlined by Cummins and Midlo, dermatologoglyphic prints were produced. Following a qualitative study, the prints from both hands were categorised as arches, loops, and whorls. Ridge counts and indexes such the Cummins Midlo, Dankmeijer, Furuhata, and Poll were included in the quantitative study. Using the Chi-square test, statistical analysis evaluated the relationship between fingerprint patterns and ABO blood types. The distribution of patterns of fingerprints and their correlation with blood group ABO were shown by the results.

Fernandes, Jose et al.[14],In Nepalese people, the relationship between Rh blood types, ABO blood groups, and fingerprint patterns is investigated. Three hundred individuals in all were enlisted, and their blood types and fingerprint patterns were examined. The alternative hypothesis proposes a considerable difference between blood groups and fingerprints, while the null hypothesis predicts no difference at all. Our knowledge of the connection between blood types and dermatoglyphic patterns in the Nepalese population will improve as a result of these discoveries.

Kaur, Amandeep et al.[15],The approach and procedure of fingerprint recognition, a popular biometric method for personal identification, are examined in this article. Fingerprint recognition is preferred because it is simple to obtain, unique, and long-lasting. The study describes the stages of testing and training that go into fingerprint recognition, with an emphasis on enrollment and verification procedures. One important technique for feature extraction is highlighted: the minutiae extraction algorithm. It is capable of identifying bifurcations and ridge termination. The fingerprint picture preprocessing, feature extraction, and match phases make up the three main sections of the suggested system, with additional divisions for the identification and verification procedures. Although the pre processing stage improves the visibility of ridge patterns, the acquisition stage entails acquiring fingerprint pictures using a variety of techniques. Methods like histogram equalisation, orientation determination, and ridge segmentation are used to enhance the quality of the images, equalisation is applied. In general, the research offers valuable perspectives on the all encompassing procedure of fingerprint identification and its importance in biometric authentication systems..

Ekanem, A. U et al.[16],The evaluation the connections between adult gender, blood group, and fingerprint patterns in Maiduguri, Nigeria. Four hundred volunteers, split equally between men and women, signed up for the research. Blood groups were ascertained using Anti-serum A, B, and D, and fingerprint patterns were categorised as loops, whorls, and arches. With varied frequencies of different blood groups, the bulk of participants were from blood group O +ve. Among fingerprint patterns, loops were the most prevalent, followed by whorls and arches. Blood group AB displayed the lowest frequency across all fingerprint patterns, while blood group O displayed the greatest amount of loops. While females displayed a higher frequency of arches, men were more likely to have loops and whorls. These results advance our comprehension of the distribution of blood types and fingerprint patterns within the population under study is better understood thanks to these studies.

Umraniyaet al.[17],In order to better understand blood group distributions and dermatoglyphic patterns, 304 MBBS students from B. J. Medical College in Ahmedabad, India, participated in the study. Using the ink procedure as outlined by Cummins & Midlow, dermatoglyphic analysis recorded basic information and blood types. The findings revealed a 2.45:1 male to female ratio with a preponderance of men. Blood group O was the most common (38.49%), followed by B, A, and AB. 96.38% of cases were Rh-positive according to the Rh blood group system, with blood group O being the most prevalent, followed by B and A. 7.89% of Rh-positive cases belonged to the AB-positive blood group. Less frequently occurring instances (1.97%) were Rh-negative, with blood group O predominating.

Ferraz et al[18],Using image processing techniques, a novel approach to automating blood type determination was devised. Using a CCD camera, real-size pictures image processing software was used for analysis. Higher standard deviation values, according to the results, suggested that agglutination had occurred, allowing for a safe and quick twominute blood type identification. This method enhances the value of commercial products and has the potential to be used in emergency scenarios. Building on this methodology, further research attempts to create a portable, low-cost blood type determination device.

Vasavi et al.[19],Blood tests play a vital role in evaluating an individual's health, primarily through the analysis and identification of blood cell composition. Manual blood cell counting procedures have historically involved time-consuming procedures and dangers of infection transmission. They also call for specialised equipment and trained workers. An image processing method is used in this suggested system to type blood according to the ABO blood group classification. Without the need for human error, the device swiftly and accurately types blood by automatically recognising and extracting the blood group antigens in a picture of the blood sample.With an accuracy of 80%, the system uses Convolutional Neural Networks (CNNs) for image classification. This non-invasive technique is appropriate for usage at home and in emergency scenarios because it does not require intrusive procedures like the use of needles. This project uses technology to automate blood type procedures, which will increase healthcare availability and standard of life in the long run.

SAHITO et al[20],Over 200 medical and dental students participated in this study, which was carried out at the Department of Anatomy, MES Medical College, Perinthalmanna. There were 146 female students and 54 male students. Using the ink approach, dermatologoglyphics were obtained, and blood kinds were noted. Evidence of fingertip illness or injury was omitted, but clearprints with written permission were included. According to the results, O blood groups predominated (46.5%), and 91.5% of the individuals were Rh-positive. The most common patterns were loops (54.5%), then whorls and arches. Blood group O Rh-positive individuals were more likely to have loops. This study advances our knowledge of blood group correlations with dermatoglyphic patterns in dental and medical students.

III. LITERATURE FINDINGS

Sl No.	Citation	Year	Methodology/ Algorithms used	Observation
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), pp. 1-7. IEEE, 2021.	2021	The ridge frequency is estimated for fingerprint matching. Gabor filter is used to extract spatial features for blood group prediction. The HFDU06 fingerprint scanner shows significant efficiency in image processing tasks	predict blood group using different machine learning methods. Proposed system predicts blood group using Multiple Linear Regression with Ordinary Least Squares (OLS) with 62% accuracy.
2	Kukadiya, Urvik, Pratik Trivedi, Ashish Rathva, and Chintan Lakhani. "Study of fingerprint patterns in relationship with blood group and gender in saurashtraregion." International Journal of Anatomy and Research 8, no. 2.3 (2020): 7564-7567..	2020	Fingerprint matching methods typically use minutiae points and texture as features. This paper proposes a CNN-based method that combines texture, minutiae, and frequency spectrum.	Loops were the most common fingerprint pattern found. Whorls were less common compared to loops. Arches were the least common fingerprint pattern. Total number of loops found in all digits was 844.

3	Al Habsi, Tariq, Hussein Al Khabori, Sara Al Qasmi, Tasnim Al Habsi, Mohamed Al Mushaiqri, Srijit Das, and Srinivasa Rao Sirasanagandla" The association between fingerprint patterns and blood groups in the Omani population." Arab Gulf Journal of Scientific Research (2023).	2023	Loops are the most common fingerprint pattern, arches are the rarest. Whorls dominate in O -ve blood group. Loops and arches more common in females, whorls more common in males.	Loop fingerprint pattern was the most common among Omani subjects. Whorl pattern most common in males, loop pattern most common in females. Whorl pattern most common in ABþ and OÀ blood groups.
4	Rastogi, Ashok, MD Abu Bashar, Nishat Ahmed Sheikh, and MD ABU BASHAR. "Relation of Primary FingerprintPatterns With Gender and Blood Group: A Dermatoglyphic Study From a Tertiary Care Institute in Eastern India." Cureus 15, no. 5 (2023).	2023	Conducted on 800 healthcare students and workers. Results may aid in creating local biometrics banks in the future.	Majority of study participants were males (66.0%) Most common blood group was Bve (35.8%) Loop fingerprint pattern was most common (55.9%)
5	Takahashi, Ai, Yoshinori Koda, Koichi Ito, and Takafumi Aoki. "Fingerprint feature extraction by combiningtexture, minutiae, and frequency spectrum using multi-task CNN." In 2020 IEEE International Joint Conference on. Biometrics (IJCB), pp. 1-8. IEEE, 2020	2020	Fingerprint matching methods typically use minutiae points and texture as features. This paper proposes a CNN-based method that combines texture, minutiae, and frequency spectrum.	The proposed method exhibits efficient performance on fingerprint verification.
6	Smail, Harem Othman, Dlnya Ahmed Wahab, and Zhino Yahia Abdullah. "Relationship between pattern of fingerprints and blood groups." J Adv Lab Res Biol 10, no. 3 (2019): 84-90.	2019	study investigates relationship between fingerprint patterns and ABO blood groups. People with ABO and Rh blood types have specific fingerprint patterns.	Link found between fingerprint pattern distribution and blood group People with ABO and Rh blood types have specific fingerprint patterns O blood group is significantly attached to loops, B to arches, AB to whorls
7	Galbally, Javier, Rudolf Haraksim, and Laurent Beslay. "A study of age and ageing in fingerprint biometrics." IEEE Transactions on Information Forensics and Security 14, no. 5 (2018): 1351-1365.	2018	The paper explores the impact of age on biometric system performance. The age effect is studied in terms of fingerprint image quality and system accuracy.	Finding 1: Elderly have significantly lower fingerprint quality than children. Finding 2: Adults have the highest fingerprint quality.
8	Kc, Sudikshya, Niroj Maharjan, Nischita Adhikari, and Pragya Shrestha. "Qualitative Analysis of Primary Fingerprint Pattern in Different Blood Group and Gender in Nepalese." Anatomy research international (2018).	2018	The study analyzed fingerprints in Nepalese individuals of different blood groups and genders. The incidence of loops was highest in ABO blood group and Rh +ve blood types.	Proposed CNN model achieved 95.27% accuracy in predicting blood groups. Lenet-5 had 43.65% accuracy, AlexNet had 85.12% accuracy. Proposed model took 62 minutes to

			Whorls were highest in Rh - ve blood types.	execute
9	Ravindran, G., T. Joby, M. Pravin, and P. Pandiyan. "Determination and classification of blood types using image processing techniques." International Journal of Computer Applications 157, no. 1 (2017): 12-16	2017	Blood type determination is important in emergency situations before transfusion. Manual tests can lead to human errors, so automated image processing is developed. Image processing techniques like thresholding and morphological operations are used. The developed method evaluates agglutination and determines blood type accurately.	Developed automated method for determining blood types using image processing techniques. Used thresholding and morphological operations to process images of slide tests. Evaluated occurrence of agglutination in processed images. Useful in emergency situations to determine blood group without human error.
10	Susmiarsih, Tri Panjiasih, M. Samsul Mustofa, and MirfatMirfat. "A Dermatoglyphic Study: Association of Fingerprint Patterns Among ABO Blood Groups." Biosaintifika: Journal of Biology & Biology Education 8, no. 3 (2016): 294-300.	2016	Study investigates correlation between fingerprint patterns and ABO blood groups. Ulnar loops most common	. Study investigates correlation between fingerprint patterns and ABO blood groups.
11	Joshi, S., D. Garg, P. Bajaj, and V. Jindal. "Efficacy of fingerprint to determine gender and blood group." J Dent Oral Care Med 2, no. 1 (2016): 103.	2016	Fingerprint evidence is reliable and acceptable in the court of law. Males had a higher incidence of whorls, while females had a higher incidence of loops.	Fingerprint evidence is reliable and acceptable in the court of law. Males had a higher incidence of whorls, while females had a higher incidence of loops. Frequency of loops was highest in both Rh-positive and Rh-negative subjects
12	Ali, Mouad MH, Vivek H. Mahale, Pravin Yannawar, and A. T. Gaikwad. "Fingerprint recognition for person identification and verification based on minutiae matching." In 2016 IEEE 6th international conference on advanced computing (IACC), pp. 332-339. IEEE, 2016	2016	Fingerprint recognition system divided into four stages: acquisition, preprocessing, feature extraction, and matching Locally adaptive binarization method used for pre-processing. Minutiae detection	Fingerprint recognition system divided into four stages: acquisition, pre-processing, feature extraction, and matching. Locally adaptive binarization method used for pre-processing. Minutiae detection
13	Fernandes, Jose, Sara Pimenta, Filomena O. Soares, and Graca Minas. "A complete blood typing device for automatic agglutination detection based on absorption spectrophotometry." IEEE Transactions on Instrumentation	2014	Uses spectrophotometric approach for agglutination detection with fast response time ABO, Rh phenotype, reverse, and Crossmatching tests can be performed	Uses spectrophotometric approach for agglutination detection with fast response time ABO, Rh phenotype, reverse, and Crossmatching tests can be performed

	and Measurement 64, no. 1 (2014): 112-119			
14	Kaur, Amandeep, and Babita Ameeta. "Minutiae extraction and variation of fast Fourier transform on fingerprint recognition." International Journal of Engineering Research and General Science 2, no. 6 (2014).	2014	Paper proposes a novel FKP verification method based on vector consistency among CIPs Experimental results show effectiveness of the proposed approach in FKP verification FFT is used to enhance specific blocks by their dominant frequencies	Paper proposes a novel FKP verification method based on vector consistency among CIPs Experimental results show effectiveness of the proposed approach in FKP verification FFT is used to enhance specific blocks by their dominant frequencies
15	Ekanem, A. U., H. Abubakar, and N. I. Dibal. "A study of fingerprints in relation to gender and blood group among residents of Maiduguri, Nigeria." Arches 200, no. 5.00 (2014): 328.	2014	Study correlates palmar dermatoglyphics patterns with ABO and Rh blood groups.	Fingerprints classified based on ridge patterns, remain unchanged throughout life.
16	Umraniya, Y. N., H. H. Modi, and H. K. Prajapati. "Study of Correlation of Finger Print Patterns in Different ABO, Rh Blood Groups." International Journal Research Publications 2, no. 9 ((2013): 337-339.	2013	Blood group detection using deep learning for faster and accurate results. Manual counting of RBCs in images is timeconsuming and inefficient.	Study correlates palmar dermatoglyphics patterns with ABO and Rh blood groups. Majority of students in the study had blood group O.

IV. DISTRUBUTION OF CASES BASED ON BLOOD GROUPS

Fingerprint Pattern Observed	Blood Group Distribution	RH factor	Blood Type	Blood group
Loop	37	Positive	Positive	B
Loop	35	Positive	Positive	O
Loop	21	Positive	Positive	A
Whorl	37	Negative	Positive	B
Whorl	35	Negative	Positive	O
Whorl	21	Negative	Positive	A
Whorl	7	Negative	Positive	AB
Loop	21	Negative	Negative	A
Loop	37	Negative	Negative	B
Loop	35	Negative	Negative	O
Loop	7	Negative	Negative	AB
Whorls	35	Negative	Negative	O

V. CONCLUSION

The conclusion drawn from this research emphasizes the stability and potential of biometric identification using fingerprint methods across various applications. The study introduces an efficient technique for blood group identification by leveraging the unique minutiae features present in fingerprints. These minutiae features serve as distinctive markers that can be utilized to predict an individual's blood group using different machine learning methods. Specifically, the proposed system employs Multiple Linear Regression with Ordinary Least Squares (OLS) to predict blood groups, achieving an accuracy rate of 62%. While this accuracy level represents a significant step forward in

blood group identification through fingerprint analysis, the conclusion highlights avenues for future research and improvement.

Firstly, the suggestion to increase the sample size in future studies is crucial. By expanding the dataset with more fingerprint samples and corresponding blood group data, researchers can enhance the reliability and generalizability of the predictive model. A larger sample size allows for better representation of the population diversity, reducing the risk of bias and improving the accuracy of predictions. Secondly, the conclusion proposes considering additional fingerprint features that have not yet been incorporated into the analysis.

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