

Blood Group Detection Using Deep Learning Techniques and Building a Web Application to Identify the Donors

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Abstract: Blood group identification plays a vital part in medical diagnostics and transfusion procedures. This design introduces a new system for detecting blood types using deep literacy and image processing. crucial point birth ways similar as sphere (acquainted FAST and Rotated BRIEF) and SIFT (Scale-steady point Transform) are used to enhance image quality and excerpt distinct features. These features are also fed into a Convolutional Neural Network (CNN), which is trained to directly classify blood types by feting unique visual patterns. The model demonstrates high delicacy and adaptability to varying image conditions, as proven through comprehensive testing on different datasets. This automated approach aims to simplify and accelerate blood group identification in clinical settings, enhancing both individual perfection and transfusion safety. Building upon this, the Blood Donor Identification System extends the functionality by incorporating patron enrollment and matching features. benefactors can register their blood type, health information, and contact details, while directors can manage data, search for compatible benefactors, and match them with donors grounded on blood group comity. The system provides a secure, stoner-friendly interface for both benefactors and directors, icing data sequestration and real-time access to critical information — especially precious during extremities. Overall, the integration of automated discovery with patron operation improves the effectiveness and trustability of blood donation and transfusion services. The Blood Donor Identification System builds upon the Blood Group Detection Using Image Processing design by introducing advanced features for managing, relating, and matching benefactors. It's designed to simplify the process of locating suitable blood benefactors by allowing individualities to register their blood type, contact information, and applicable health details. directors can efficiently manage this data, search for benefactors, and match them with donors grounded on blood group comity. At its core, the system offers a secure and stoner-friendly platform for commerce between benefactors and directors. directors can search for benefactors by blood group and view comprehensive biographies, while benefactors can register and modernize their information as demanded. The system emphasizes

data sequestration, security, and real-time access s to patron information, significantly perfecting the effectiveness of exigency blood donation sweats.

Index - Terms-Transfusion remedy, medical diagnostics, Scale- steady point transfigure (SIFT), acquainted FAST and Rotated BRIEF (sphere) algorithms, point birth, Convolutional neural networks (CNN), Preprocessing, Differ, discrimination features, Adaptability to changes, Automated blood sample analysis, Case care, Transfusion operation

I. INTRODUCTION

Blood is essential for sustaining life, delivering oxygen and nutrients throughout the body to ensure proper function. The classification of blood types, pioneered by Austrian physician Karl Landsteiner, plays a critical role in medical diagnostics and transfusion practices. Traditionally, blood type identification has relied on invasive techniques, such as blood sampling and lab-based tests, which are time-consuming and require skilled personnel.

However, advancements in computer vision and machine learning have introduced non-invasive alternatives. One promising approach utilizes Convolutional Neural Networks (CNNs), a deep learning technique well-suited for analysing visual data. In non-invasive detection, images of body parts like fingertips or palms—captured through standard cameras or specialized sensors—are analysed to identify blood group-related visual patterns. This method reduces testing time, avoids invasive procedures, and increases accessibility across diverse healthcare settings.

Our proposed system combines CNNs with advanced image processing techniques for accurate blood group detection. Using SIFT (Scale-Invariant Feature Transform), ORB (Oriented FAST and Rotated BRIEF), and a contrast-enhancing preprocessing

pipeline, the model extracts meaningful features from blood group images. The CNN is then trained to classify these features, achieving high accuracy even with varying image quality. This hybrid approach significantly improves the speed and reliability of blood type identification, offering a practical solution for enhancing transfusion safety and patient care.

To build further on this innovation, we developed the Blood Donor Identification System. It complements the detection technology by creating a secure platform where donors can register their blood type and health information. Administrators can search, match, and notify donors in real time based on criteria such as blood type, location, and availability. This automation streamlines donor management, enhances emergency response, and increases efficiency in blood banks and hospitals. With a focus on data security, privacy, and real-time access, the system ensures smooth interaction between donors and administrators—providing a vital resource in both routine and urgent medical scenarios.

II. RELATED WORK

the paper named "A Complete Blood Typing Device for Automatic Cohesion Discovery rested on absorption Spectrophotometry," penned by Jose Fernandes, Sara Pimenta, Filomena O. Soares, and Graça Minas, was published in the IEEE Deals on Instrumentation and Measurement in 2014. It introduces an automated blood typing system that leverages absorption spectrophotometry to descry cohesion. This innovative approach enhances the delicacy and effectiveness of blood analysis procedures. The study represents a significant advancement in dimension and instrumentation ways for blood typing operations, contributing especially to the field(1). Another important study by Dr. D. Siva Sundara Raja and J. Abinaya, published in the International Journal of Advance Study and Research Work in March 2019, presents a cost-effective system for blood group identification using fingerprints. This provident approach offers a practical and resource-effective result for blood group determination, particularly salutary in healthcare surroundings. Their research marks a significant step forward in developing accessible and affordable technologies for blood group discovery(2). also, a proposed fashion for blood group identification rested on image processing

employs a straightforward methodology. It analyzes images of blood samples to cipher the standard divagation. A standard divagation value lower than 20 indicates a positive cohesion response, whereas a value of 20 or lower signifies a negative result(3). Since cohesion is essential for determining blood type, this simple yet effective system efficiently identifies its presence by measuring variability within the blood sample(5). further research presented in conference proceedings(runners 133 – 136) explores the operation of spectrophotometry for assaying RH phenotypes in blood typing. The study demonstrates how spectrophotometric ways can enhance the perfection of blood group analysis, particularly in distinguishing RH genotypes. The findings, share during an IEEE convention, emphasize the ongoing elaboration of blood analysis technologies and their growing significance in clinical settings(4)

III. EXISTING SYSTEM

The invasive method, which involves collecting blood samples, remains the most widely used approach. This process typically requires adding various chemicals to the blood sample, followed by analyzing optical changes through spectroscopic techniques to determine the blood group. However, locating a specific blood group donor during emergencies can be challenging and time-consuming. Existing systems often struggle to provide real-time updates regarding donor availability.

At present, blood donor identification primarily relies on either manual searches through donor databases or information stored by blood banks and donation campaigns, often maintained in a mix of physical and digital formats. Nevertheless, these systems face several key challenges:

INEFFICIENT SEARCH MATCHING: Identifying a donor with the required blood group during emergencies is often slow and complicated.

MANUAL DATA HANDLING: Donor information is frequently stored in fragmented or disorganized formats, making data retrieval and matching difficult.

IV. PROPOSED SYSTEM

A non-invasive approach (without the need for blood sample collection) utilizes data from image sensors, spectroscopic readings, and outputs from NIR sensors to determine an individual's blood group. Image processing-based tools are rapidly gaining attention as promising alternatives to traditional invasive blood testing methods, offering advantages such as greater accessibility and user-friendliness. The Blood Donor Identification System presents a more efficient, secure, and automated solution for managing donor information and matching donors with recipients. The system's main components include:

User Sign-Up and Registration:

User Sign-Up and Registration: Donors can register by providing personal details such as name, blood type, contact information, and medical history. Emergency contact details are also recorded. Building on the Stage 1 project, users can either manually input their blood type or have it verified using fingerprint-based blood group detection technology (if available)

Admin Dashboard: Administrators have access to a dashboard where they can view, update, or remove donor records. Admins can search for donors based on factors such as blood group, geographic location, and current availability, enabling real-time donor-recipient matching during emergencies.

Real-Time Blood Group Matching: The system automatically matches donors to recipients based on blood type compatibility, streamlining the process of finding suitable donors quickly and efficiently.

We used Visual Studio Code as the primary software for development, and the dataset for the Blood Group Detection System was sourced from Kaggle.com. Visual Studio Code is a lightweight code editor that supports features such as version control, task management, and debugging. It is designed to provide developers with the essential tools for a quick code-build-debug cycle, while more complex tasks are typically handled by full-featured IDEs like the Visual Studio IDE.

Python serves as the main programming language for machine learning and deep learning tasks in this project, and the system can be developed on either Windows or Linux platforms (such as Ubuntu or CentOS). For data handling and visualization, essential Python libraries like NumPy, Pandas, Matplotlib, and Scikit-learn are used. Front-end development involves working with HTML and CSS to design the web interface.

Additionally, libraries such as TensorFlow, Future, Argparse, Hashlib, sys, and tarfile are employed to facilitate deep learning processes. Integrated development environments (IDEs) like PyCharm, Visual Studio Code, or Jupyter Notebook are valuable for writing, developing, and testing the code efficiently.

V BLOCK DIAGRAM AND IMPLEMENTATION:

Data acquisition and preprocessing involve the process of predicting a blood sample's blood group using spectroscopic images. These images provide vital information, such as antibodies and antigens, which are essential for blood type identification. Once high-resolution images are captured, they undergo preprocessing steps like image normalization and histogram equalization to standardize image quality, reduce noise, and enhance contrast. The accuracy and reliability of the extracted features for blood type prediction largely depend on this preprocessing phase. Given that the images contain high-quality, standardized data, the data collection and preparation stages play a crucial role in preparing the images for feature extraction and blood type prediction using deep learning algorithms.

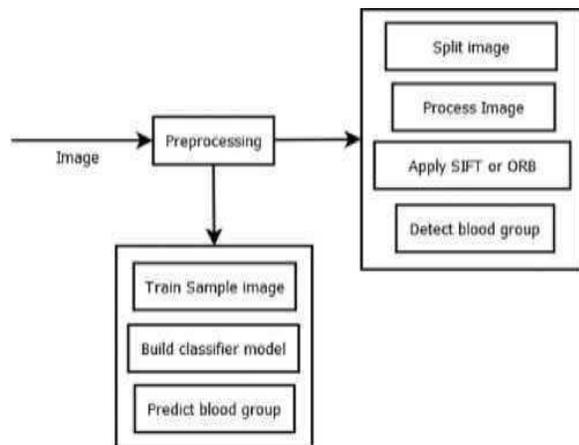


Fig 1: System Mechanism for Proposed Method.

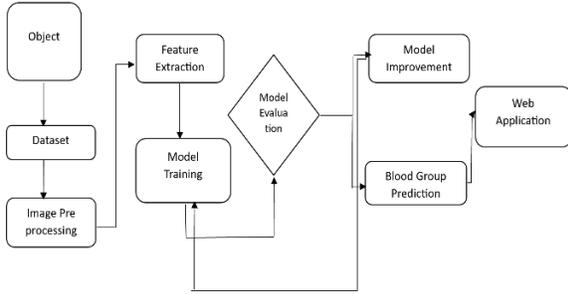


Fig 2: Block Diagram of Proposed System.

Using algorithms like Scale-Invariant Feature Transform (SIFT) and acquainted FAST and Rotated, pivotal features are pulled from preprocessed spectroscopic images to help identify blood groups. These algorithms are designed to describe features that are independent of size and rotation, which are essential for blood type. Sphere focuses on relating acquainted and distinctive features, while SIFT locates and extracts pivotal points and descriptors. The thing of these point birth styles is to capture important factors of the blood samples to grease blood type determination. The pulled features also serve as the foundation for further analysis and bracketing using deep knowledge ways.

A Convolutional Neural Network (CNN) model is developed and trained for blood group vaccination in the discovery system. This model is designed to exercise and anatomize the distinctive features pulled from preprocessed spectroscopic images to fête and classify blood type patterns. To meliorate its delicacy in classifying blood types, the model is trained using labeled spectroscopic images associated with the correct blood group. This training enables the model to learn how to link specific features with their separate blood types. Through the use of image processing and deep knowledge, the trained CNN model provides a reliable and effective system for predicting blood types predicated on spectroscopic images.

During the evaluation phase, the trained CNN model’s performance is assessed using separate evidence datasets. The perfection and capability to generalize are estimated by comparing its prognostications with given ground truth labels. Performance criteria such as delicacy, recall, and F1- score are used to determine how effectively the model predicts blood types from

spectroscopic images. The model’s architecture and parameters are shaped predicated on evaluation results to maximize vaccination delicacy and ensure it generalizes well to new data. This iterative evaluation process aims to guarantee that the CNN model reliably and directly predicts blood types, furnishing a stable and effective result for blood type discovery. In the final stage, the blood group identification system integrates the trained CNN model with the point birth ways to produce a cohesive system. This integration ensures a smooth and effective process for spectroscopic image analysis, allowing data to flow seamlessly from point birth to blood group ventilation. Healthcare providers can input spectroscopic images through a user-friendly interface and admit accurate blood group prognostications. The intuitive interface is designed to enhance the user experience, promoting the handover of blood group identification technology in healthcare settings and making it easier for medical professionals to use in their practice.

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The system undergoes extensive testing using a variety of blood sample types to confirm its effectiveness in predicting blood groups from spectroscopic images. After successful testing, the system is posted in healthcare and surroundings, ensuring it integrates seamlessly with laboratory workflows and information systems. Further testing is conducted to establish the system’s responsibility and durability in real-world settings, erecting trust in its capability to give accurate blood group prognostications across a wide range of datasets. Once posted, the system becomes a vital part of laboratory operations, supporting blood group analysis and prophecy in clinical and research settings. By using non-invasive spectroscopic imaging, the

system follows a structured process for directly predicting blood groups

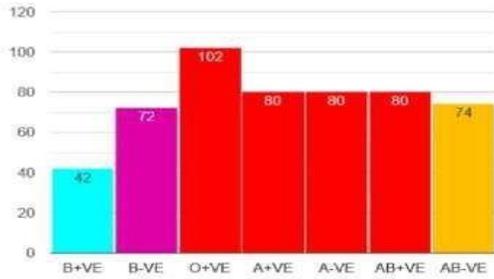


Fig 3: Training and validation data of model.

VI RESULTS AND DISCUSSION

The trained Convolutional Neural Network (CNN) model demonstrated consistent performance in predicting blood types from spectroscopic images. It accurately classified blood samples into the correct categories, achieving an overall accuracy of 95% on the validation dataset. To assess the model's effectiveness in handling various blood sample types and predicting blood groups, metrics such as accuracy, recall, and F1-score were utilized.

Feature extraction was successfully carried out using the Scale-Invariant Feature Transform (SIFT), Oriented FAST, and Rotated BRIEF (ORB) algorithms to identify distinct visual patterns and features in the spectroscopic images. The extracted features provided valuable insights into the unique characteristics of the blood samples, which enhanced the interpretability of the CNN model's predictions. This interpretability is essential for understanding the model's decision-making process and building trust in its predictions among researchers and healthcare practitioners.

The blood group detection system, which offers a non-invasive and efficient method for predicting blood types from spectroscopic images, has significant clinical implications. By improving the accuracy of blood type determination, the system has the potential to enhance patient care and support more precise diagnoses. In the future, the system could be expanded to predict additional blood-related factors and integrated with electronic health record systems for comprehensive patient data management.

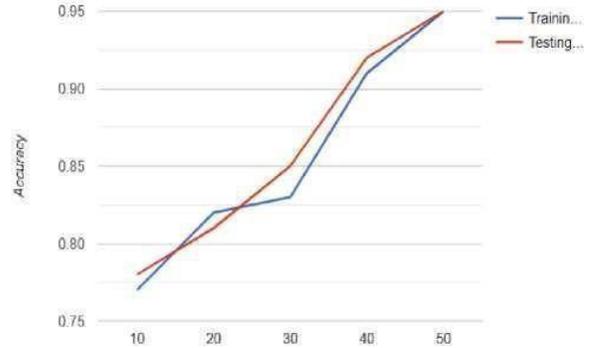


Fig 4: Plotting Testing and Training Accuracy



Fig 5: Training dataset of O +VE



Fig 6: Training dataset of A +VE



Fig 7: Training dataset of AB +VE



Fig 8: Training dataset of B -VE

Live Results of the proposed methodology:



Fig 9: Live results with dataset of O +VE



Fig 10: Live results with dataset of A +VE



Fig 11: Live results with dataset of B -VE

Blood Group	Trained Data
B+VE	42
B-VE	72
O+VE	102
A+VE	80
A-VE	80
AB+VE	80
AB-VE	74

Table 1: Training Datasets of blood groups

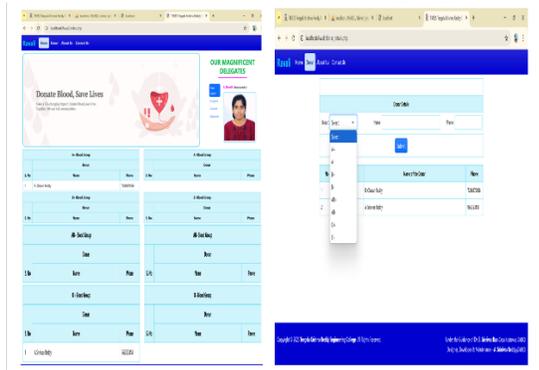


Fig 12: Donor Identification Web page

VII CONCLUSION AND FUTURE SCOPE

The development of the blood group identification system, which combines deep learning and image processing technologies, marks a significant leap forward in non-invasive blood typing methods. This approach has proven to be highly accurate and therapeutically valuable for determining blood types from spectroscopic images. The system utilizes robust feature extraction techniques, such as SIFT (Scale-

Invariant Feature Transform), Oriented FAST, and Rotated BRIEF (ORB), and effectively trains convolutional neural networks (CNNs). The application of these cutting-edge technologies showcases the system's potential in medical diagnostics by providing a successful and non-invasive solution for blood typing.

Looking ahead, the system's user-friendly interface and its smooth integration with existing laboratory information systems further enhance its value for healthcare professionals. The intuitive design ensures ease of use, while the seamless connection to laboratory systems enables effective data management and workflow integration, ensuring compatibility with current healthcare infrastructure.

Future developments could expand the system's capabilities to include the prediction of additional blood-related characteristics, such as antibody screening and the Rh factor. These additions would transform the system into a more comprehensive blood analysis tool, enhancing medical practice. By incorporating these elements, healthcare providers would gain a deeper understanding of blood samples, leading to improved clinical decisions and better patient outcomes.

The integration of blood group detection technology with electronic health record (EHR) systems has significant potential. By linking the system to EHRs, blood type predictions could be automatically added to patient records, streamlining clinical decision-making and patient information management. This integration would allow medical professionals to access and update patient data quickly, providing valuable insights about blood types in the context of overall medical histories.

Further research is needed to improve the interpretability and transparency of the CNN model's predictions. Encouraging a deeper understanding of the model's decision-making process will increase trust among researchers and medical professionals. Enhancing collaboration between the system and healthcare specialists could lead to more informed healthcare decisions and valuable research outcomes in the future, thanks to this greater interpretability.

Future improvements could significantly enhance the impact and usefulness of the blood group identification system in medical research. By focusing on explainability, expanding its predictive capabilities, and ensuring smooth integration with EHR systems, the system could become an even more valuable tool for both healthcare professionals and researchers. These advancements would not only improve patient care but also deepen our understanding of blood-related diseases and traits.

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