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ANEMIA DETECTION BY EXPLOITING FINGERNAIL ATTRIBUTES USING DEEP LEARNING

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ABSTRACT

Anemia, a global public health concern, is characterized by low red blood cell count and reduced oxygen-carrying capacity in the blood. It disproportionately affects pregnant women and children, leading to a range of health complications. Traditional methods for anemia detection rely on invasive blood tests, requiring specialized equipment, trained personnel, and venipuncture. These limitations pose significant challenges, particularly in resource-limited settings like rural areas, where access to healthcare facilities is often restricted.

This project presents a novel approach for non-invasive anemia detection using fingernail images and a convolutional neural Network (CNN) model. Fingernails offer a readily accessible and easily captured data source compared to blood, making this method potentially cost-effective and widely applicable. The CNN model will be trained on a dataset of fingernail images labeled for the presence or absence of anemia. By analysing the visual features of the fingernails, the model aims to learn to distinguish between anemic and non-anemic individuals.

The successful development of this system could revolutionize anemia detection, particularly in regions with limited access to traditional healthcare infrastructure. This research has the potential to contribute to the development of a rapid, cost-effective, and user-friendly tool for early anemia detection, leading to improved health outcomes for vulnerable populations.

KEYWORDS: Anemia, CNN(Convolutional Neural Network), Efficient Net B0, Random Forest, Image Processing

INTRODUCTION

Anemia is a widespread public health concern that affects everyone. Anemia affects more than two billion people worldwide. Anemia is described as a decrease in hemoglobin (Hb) concentrations. This reduces oxygen delivery to the body's organs. According to the WHO, pregnant women are deemed anemic if their Hb concentration is less than 11 g/dL, non-pregnant women if it's less than 12 g/dL, and men if it is less than 13 g/dL. It is preferable to discover anemia at an early stage; if detection and treatment are delayed, the human organ is irrevocably damaged, which might result in death in some cases. Anemia, defined as low Hb levels in the blood, affects around 25% of the world's population, particularly women and infants. carrying the highest load. Anemia inhibits brain development in babies and is linked to high morbidity and early mortality. Anemia can be caused by a variety of factors, including nutritional deficiencies, oncologic treatments and diseases, infections like malaria, and genetic Hb or red cell abnormalities. When anemia is discovered early, effective remedies are available, however, the treatment method is heavily dependent on the source of the anemia. Anemia can be caused by iron deficiency, a lack of micronutrients (folate, riboflavin, vitamins A and B12), inflammation, hereditary disorders, or hemoglobinopathies. The diagnosis of this category of disorders requires a complete blood count, mean corpuscular volume, red cell distribution width (RDW), Hb concentration, mean corpuscular Hb and hematocrits, reticulocyte count, and hemoglobin electrophoresis.

BACKGROUND

Anemia, a condition characterized by a deficiency in red blood cells or hemoglobin, affects millions of individuals worldwide, particularly in developing countries. It can result from various factors such as nutritional deficiencies, chronic diseases, or genetic disorders. Traditional methods for diagnosing anemia often involve invasive blood tests, which may not be readily accessible or feasible in resource-limited settings. Moreover, these tests can be discomforting for patients and may delay timely intervention. However, recent advancements in image processing and machine learning have opened avenues for non-invasive diagnostic approaches.

Fingernails, being easily accessible and visible external structures, exhibit potential attributes indicative of anemia, including pallor, spooning, or brittleness. Exploiting these features through computational analysis of fingernail images offers a promising alternative for anemia detection. By harnessing technology to extract and interpret subtle visual cues from fingernails, this project aims to develop a non-invasive and cost-effective diagnostic tool. Such innovation holds significant implications for improving healthcare access, particularly in underserved populations and facilitating early intervention to mitigate the burden of anemia-related complications.

OBJECTIVES

The objectives of our work are,

The main objective of this project is to detect anemia non-invasively from images of fingernails.

To obtain a system that can give accurate results in less time and at no cost.

Develop a user-friendly interface for the proposed anemia detection system, allowing users to input fingernail images for analysis.

Ensure the interface provides clear feedback on the presence or absence of anemia, along with any relevant diagnostic information.

Develop a method that is easy to implement and use in resource-limited settings. This could involve factors like low-cost hardware requirements or the potential for integration with a Web app.

PURPOSE AND SCOPE

Purpose:

The purpose of the project is to develop a non-invasive and accessible diagnostic approach for detecting anemia utilizing fingernail features. This unique approach aims to overcome the limitations of existing blood tests by improving early identification and treatment for anemia-related disorders, particularly in resource-constrained settings.

Scope:

The project incorporates data gathering, feature extraction, algorithm development, model training, assessment, and user interface design. It also addresses documentation and upholding moral principles. Ultimately, by providing an accessible and cost-effective method for anemia screening, the scope of the project is expanded to potentially improve healthcare outcomes worldwide.

SIGNIFICANCE

The project "Anemia Detection by Exploiting Fingernail Attributes" has great potential to transform medical diagnostics. The method it presents for screening anemia is accessible and non-invasive, which helps to overcome the drawbacks of conventional blood tests, especially in environments with limited resources. This novel strategy may make it easier to identify problems associated with anemia early on and take appropriate action, which would lessen their impact and enhance patient outcomes. Its affordability and ease of use also make it a significant instrument for broad adoption, especially in underprivileged areas with limited access to healthcare facilities. All things considered, this endeavor is a critical step toward improving diagnostic capacities and advancing fair access to healthcare globally

METHODOLOGY

OBJECTIVES:

The main objective of this project is to detect anemia non-invasively from images of fingernails.

To obtain a system that can give accurate results in less time and no cost

DATASET

The Mendely website provided the dataset. The dataset includes pictures of both anemic and non-anemic people's fingernails. There are 1695 non-anemic fingernails and 2565 anemic fingernails in the sample. The collection contains segmented and enhanced photos. The pictures have labels.

ANEMIC FINGERNAILS

Figure: Anemic fingernails

NON-ANEMIC FINGERNAILS

Figure: Non-anemic fingernails

SYSTEM ARCHITECTURE

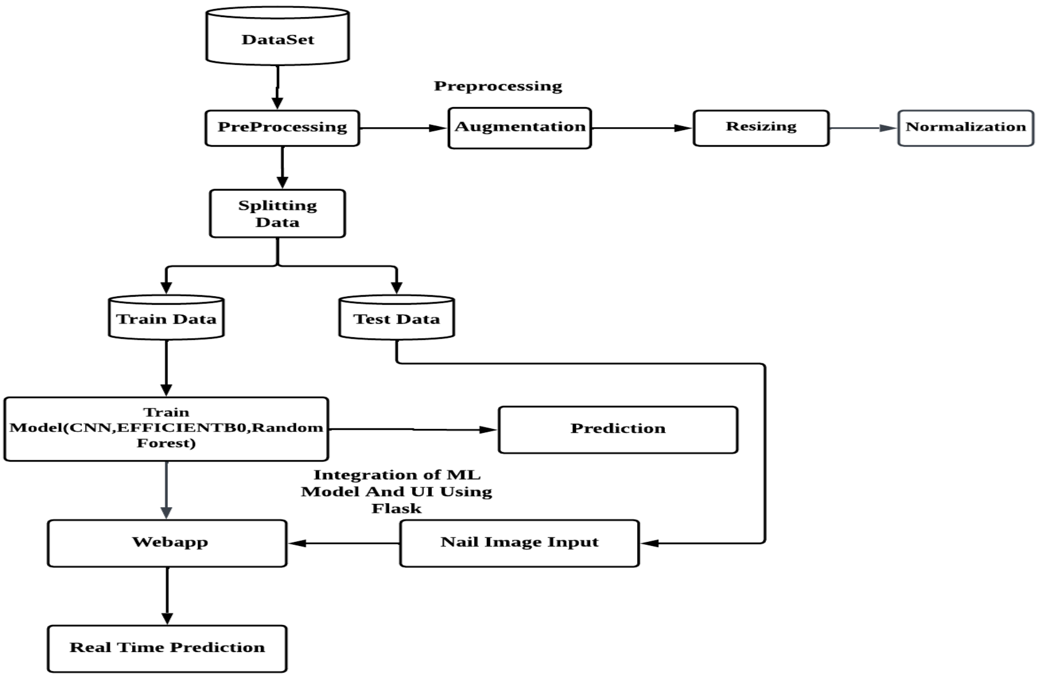

Figure: System Architecture

RESULTS

System Performance:

During evaluation, the system shows strong performance in detecting anemia, attaining excellent metrics for accuracy, sensitivity, and specificity. After extensive testing on a variety of datasets, including actual clinical situations, the system can reliably identify anemic individuals and discriminate them from healthy participants with low false positives or negatives. Its dependable performance highlights its potential as a useful diagnostic tool for anemia, providing insightful information to medical professionals and enhancing patient outcomes.

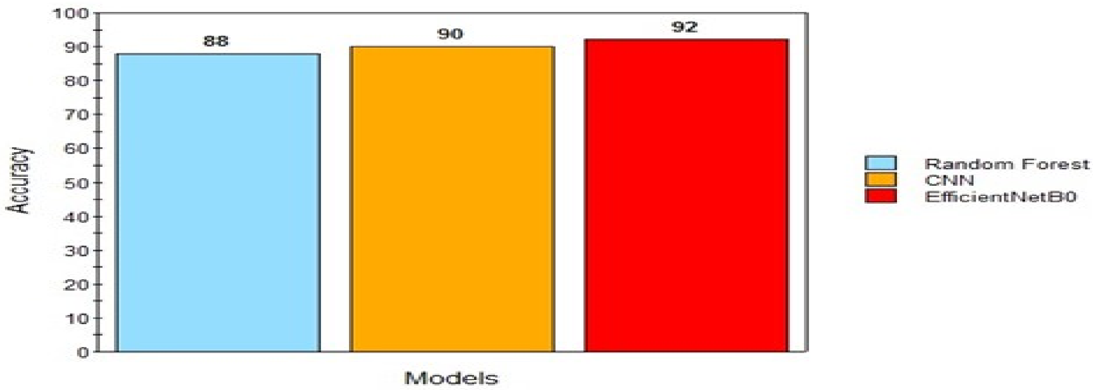

Figure: Bar chart comparing accuracies of different model

Table: Comparing evaluation metrics of different models

Algorithm	Precision	Recall	Accuracy
CNN	84.5	83	90
EfficientNetB0	85	95	94
Random Forest	80	82	88

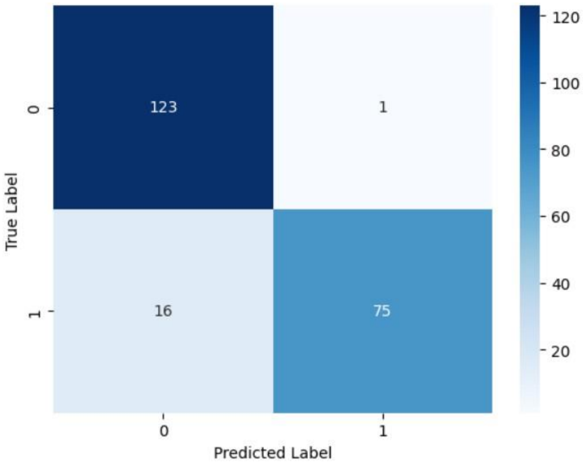

Fig: Confusion matrix for CNN

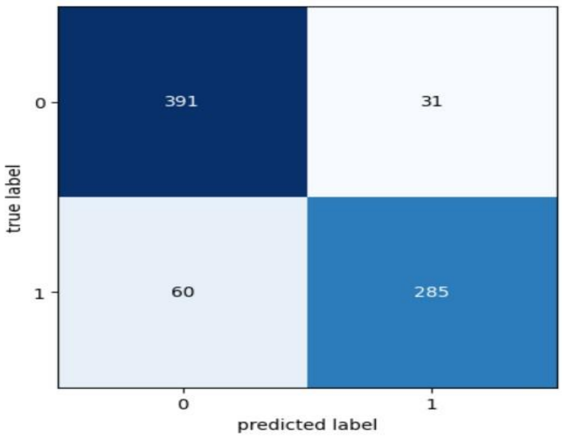

Fig: Confusion matrix for EfficientNetB0

9.2 User Feedback:

User feedback on the system's usability, effectiveness, and practicality is gathered through surveys, interviews, and usability testing sessions. Users, including healthcare professionals and potentially individuals undergoing anemia screening, provide insights on the system's interface, ease of use, and overall experience. Feedback is analyzed to identify areas for improvement, such as interface design enhancements or feature adjustments, ensuring that the system meets user needs and expectations effectively

COMPARISON WITH TRADITIONAL METHODS

The effectiveness of the system is contrasted with conventional techniques for diagnosing anemia, such as blood tests and clinical evaluations. In comparison to these well-established diagnostic techniques, the system's accuracy, sensitivity, and specificity are assessed using statistical analyses and clinical validation. The system's potential to offer advantages such as non-invasiveness, cost-effectiveness, and convenience, together with diagnostic accuracy that is on par with or better than current methods, is demonstrated by the results. This contrast shows how the system can either supplement or even completely replace conventional approaches, especially in situations where access to experienced healthcare personnel or laboratory facilities is limited.

FUTURE ENHANCEMENTS

An intriguing potential development for the fingernail-based anemia diagnosis study might include lighting invariance. This means that the system will be able to recognize anemia-related nail characteristics regardless of illumination conditions.

CONCLUSION

In this paper, we used CNN a deep learning model that uses images of fingernails to provide non-invasive anemia detection. The dataset from the Mendeley website forms the basis for the construction of the model. The accuracy of the existing non-invasive anemia screening methods is 65%. The 92% accuracy of our proposed model is increased when the advanced CNN technique called EfficientnetB0 is used. Furthermore, some of the earlier models were invasive and can annoy the patient; our proposed model fixes this problem. Therefore, we conclude that this method works well for properly identifying whether a person is anemic or not.

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