SICKLE CELL ANEMIA CLASSIFICATION USING DEEP LEARNING

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING
SRKR ENGINEERING COLLEGE, BHIMAVARAM

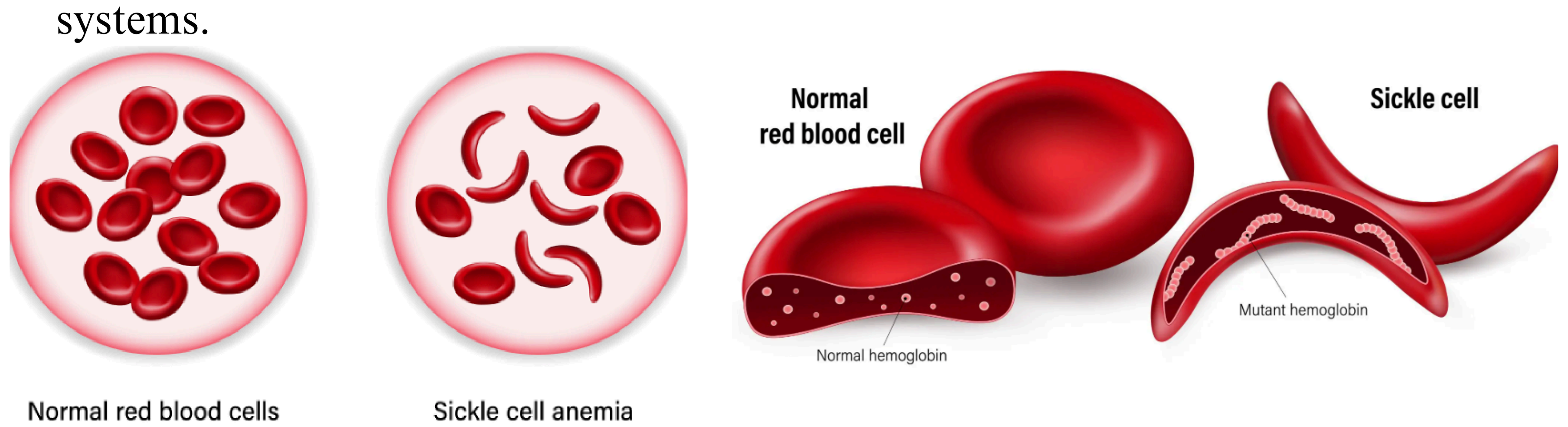
PROJECT GUIDE:
Dr.R.Shiva Shankar
SUBMITED BY:
Goriparthi Jahnavi
21B91A05A3,I-1(C)

ABSTRACT

- An AI-driven method is proposed for detecting Sickle Cell Anemia using microscopic blood smear images.
- Multiple deep learning models were evaluated, including InceptionV3, VGG16, ResNet, and MobileNet.
- Transformer-based models such as MaxViT, CoAtNet, DeiT-3, and Mobile SAM were also tested.A hybrid model combining InceptionV3 and Mobile SAM was developed.
- This hybrid model achieved an accuracy of 92.5%.
- The approach provides a scalable and noninvasive solution for early SA detection.
- It is especially suitable for implementation in resource-limited settings.

INTRODUCTION

- Sickle Cell Anemia (SCA) is a hereditary disorder caused by a mutation in the β-globin gene.This mutation results in the formation of sickle-shaped red blood cells.
- Sickle-shaped cells block blood flow, leading to pain, anemia, and potential organ damage.
- AI-based systems aid in diagnosing SCA by automating blood smear analysis.
- These systems enhance diagnostic accuracy, especially useful in low-resource settings.
- SCA has the highest prevalence in Sub-Saharan Africa, India, and the Democratic Republic of Congo.
- In these regions, the prevalence is ≥ 15–20 cases per 1000 births.
- Sickle cells have a significantly reduced lifespan only 10–20 days compared to the normal 120 days.
- The highest hospital readmission rates are seen in young adults aged 18–30 years.
- This age group is vulnerable due to the transition from pediatric to adult healthcare systems.

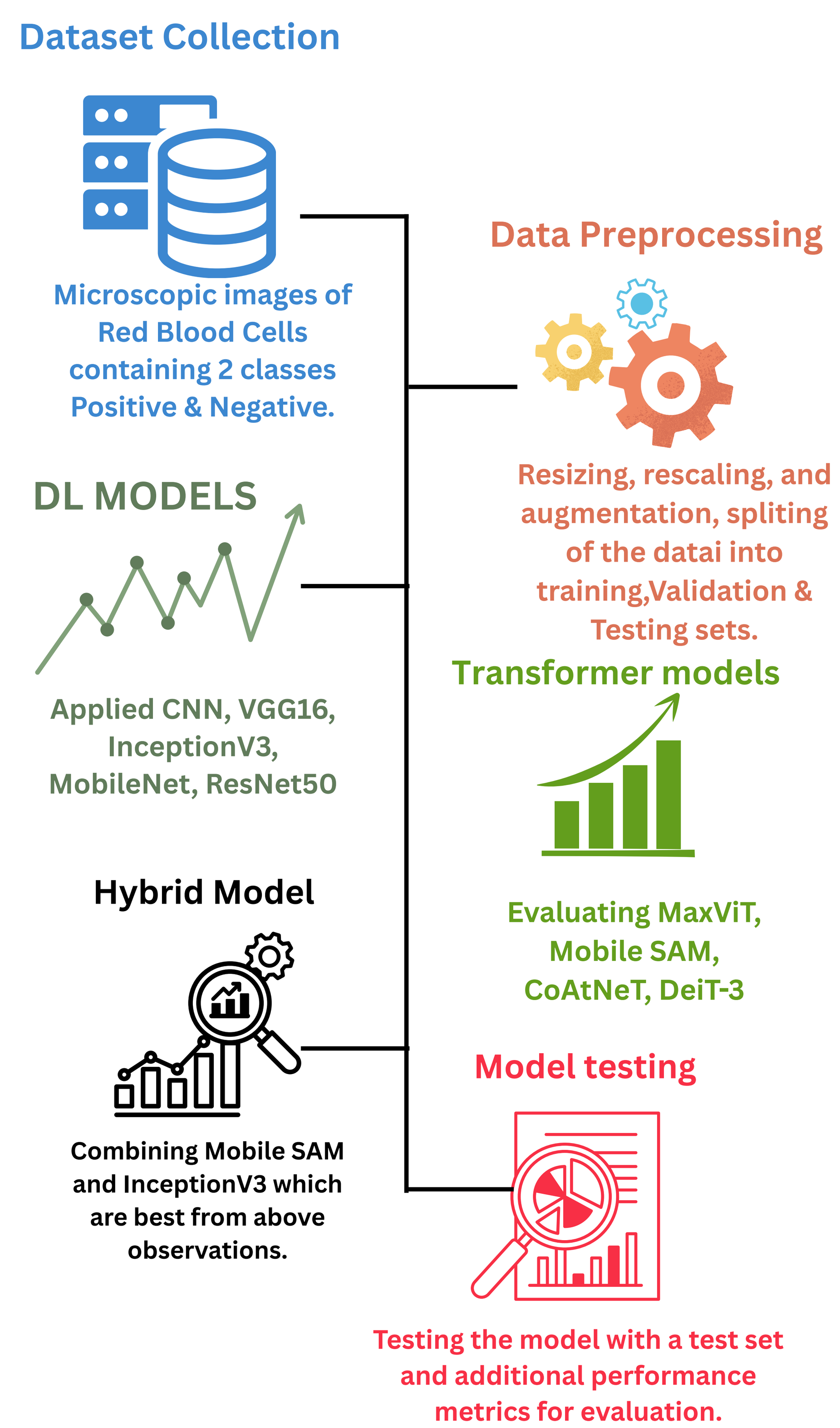


OBJECTIVES

Outlined below are the major aims of the present work: using deep learning techniques to classify Sickle Cell Anemia and detect it better.

- Develop an advanced deep learning model for accurate Sickle Cell Anemia detection from biomedical data, focusing on minimizing classification loss and improving diagnostic accuracy.
- Explore hybrid learning strategies that integrate feature extraction and classification for enhanced SCA detection.
- Investigate transformer-based architectures for automated detection, evaluating performance and classification effectiveness.

WORK FLOW DIAGRAM

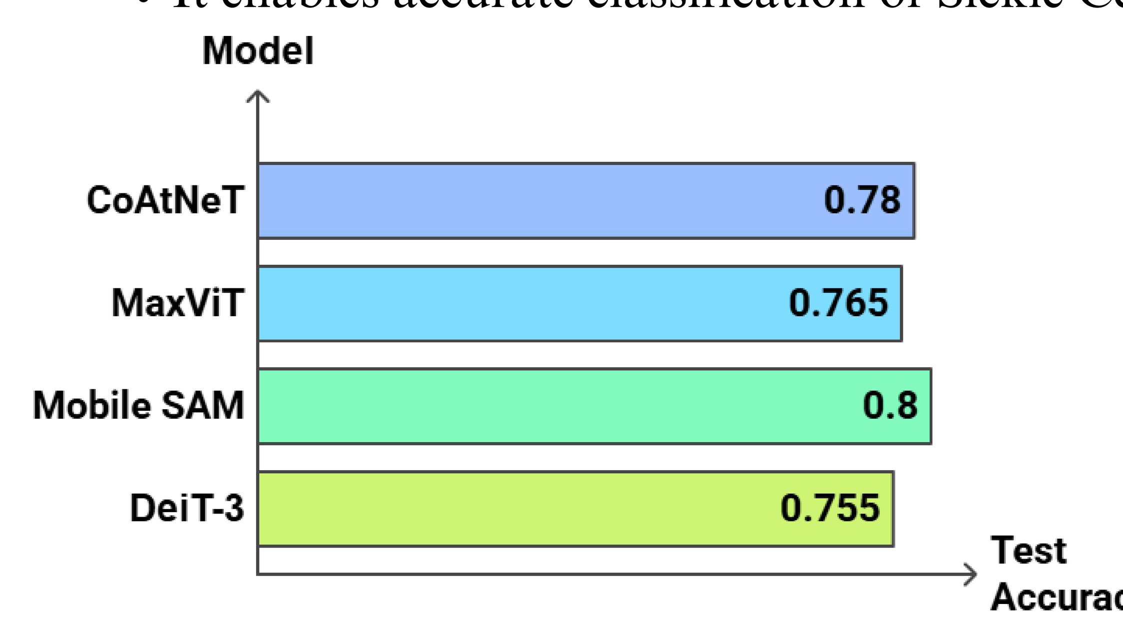


PROPOSED MODEL ALGORITHM

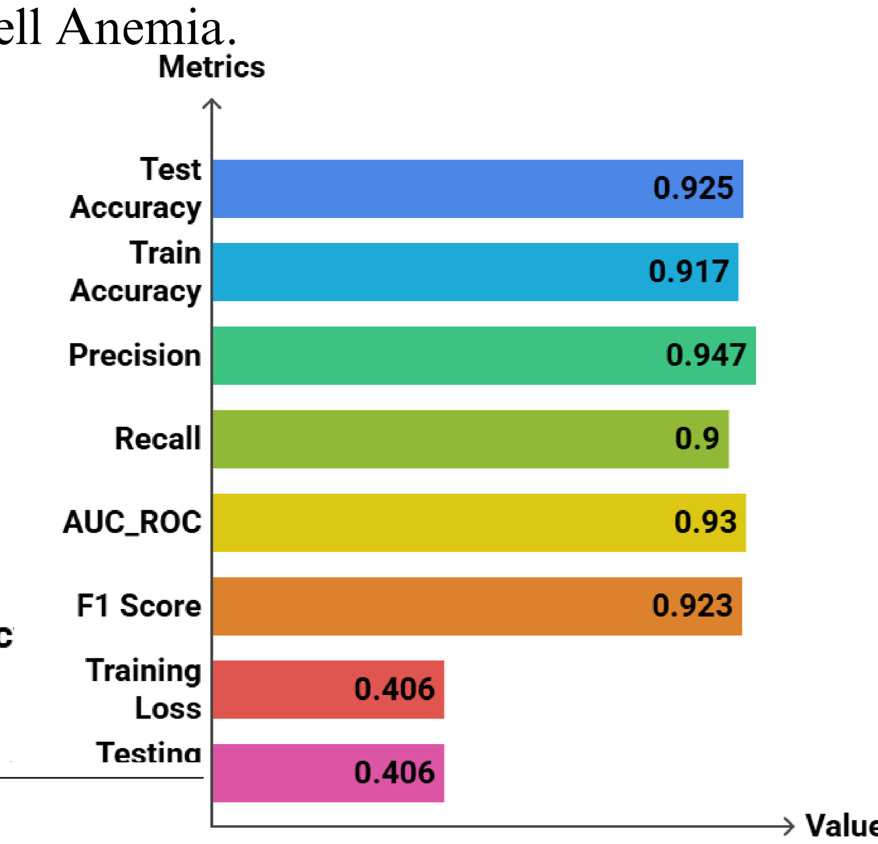
- **Step 1:** Initialize MobileSAM (224×224, patch 16, dim 256, depth 8, heads 8); freeze base layers.
- **Step 2:** Extract Inception-style multi-scale features (scales: 1.0, 0.75, 0.5, 0.25).
- **Step 3:** Compute 24-bin color histograms and LBP-based texture descriptors.
- **Step 4:** Fuse MobileSAM, Inception, and histogram features (SAM weight = 1.2); apply TruncatedSVD to 350 dims.
- **Step 5:** Build stacking ensemble—base (MLP, RF, GBoost, SVC), meta-learner (MLP).
- **Step 6:** Train using stratified k-fold (k = 5, 10, 15, 20) with class-balanced sampling.
- **Step 7:** Optimize classification threshold per fold (maximize F1 + balanced accuracy).
- **Step 8:** Post-process masks (threshold adjustment + object filtering) and evaluate on test set.

RESULTS

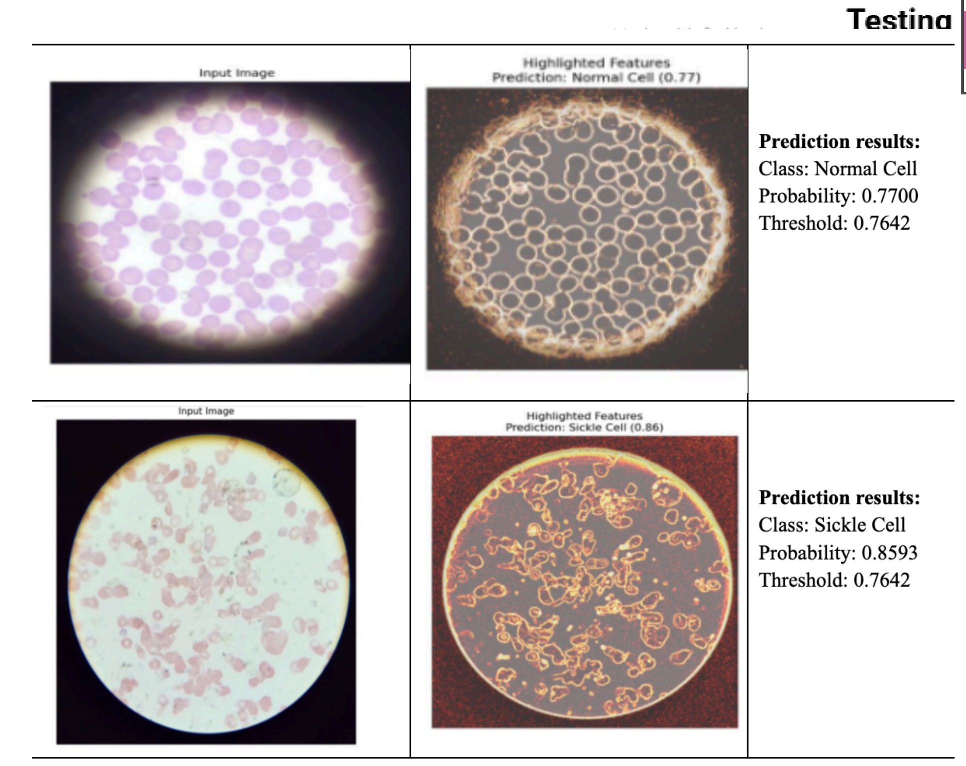
- Deep learning (DL) models were applied for Sickle Cell Anemia (SCA) detection.
- Among DL models, InceptionV3 achieved the highest accuracy of 79%.
- Transformer-based models were also evaluated, with Mobile SAM achieving the best accuracy of 80%.
- A hybrid model was developed combining InceptionV3 feature extraction and Mobile SAM segmentation.
- The model was trained using early stopping, 50 epochs, and cross-validation.
- The final hybrid model achieved: Test accuracy: 92.5%, Precision: 94.7%, Recall: 90%, AUC-ROC: 0.93.
- The model demonstrated superior performance, robustness, and reliability across validation folds.
- It enables accurate classification of Sickle Cell Anemia.



Model Test Accuracies Comparison



MOBILE SAM WITH INCEPTION



CONCLUSION

- The proposed AI-driven approach shows promising results in Sickle Cell Anemia (SCA) detection.
- It highlights the effectiveness of hybrid deep learning models.
- These models offer accurate and efficient diagnostic capabilities.
- The approach is scalable for broader implementation.
- It is particularly beneficial in low-resource healthcare environments.