HematoVision: Advanced Blood Cell Classification Using Transfer Learning

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1. Project Overview

HematoVision is an advanced blood cell classification system that leverages transfer learning techniques on deep convolutional neural networks to classify different types of blood cells accurately. This project aims to support medical diagnostics by automating the process of blood cell identification through image classification.

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2. Architecture

The system uses a pretrained convolutional neural network (CNN) such as ResNet50 or InceptionV3 as the backbone for feature extraction. The model is fine-tuned on a dataset of blood cell images to classify multiple blood cell types. The architecture includes:

- **Input Layer:** Preprocessed blood cell images
- **Feature Extractor:** Pretrained CNN layers (frozen or fine-tuned)
- **Classifier Head:** Fully connected layers with dropout and softmax output
- **Output:** Blood cell classification labels

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3. Prerequisites

- Python 3.11

- Libraries: TensorFlow/Keras, NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn
- GPU-enabled environment (Google colab)

4. Prior Knowledge

- Fundamentals of deep learning and CNNs
- Basics of transfer learning
- Image preprocessing and augmentation techniques
- Model evaluation metrics for classification

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5. Objectives

- Build an accurate blood cell classification model using transfer learning
- Apply data augmentation to improve generalization
- Visualize dataset distribution and model performance
- Deploy the model for prediction on new blood cell images

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6. Project Flow

1. Data collection and preprocessing
2. Exploratory data analysis and visualization
3. Data augmentation
4. Train-validation-test data split
5. Model building using transfer learning
6. Training and hyperparameter tuning
7. Model evaluation and testing
8. Prediction on new images

7. Project Structure

```
bash
CopyEdit
HematoVision/
│
├── data/
│   ├── raw/                    # Original
images
│   ├── processed/              # Resized and
augmented images
│
├── notebooks/
│   ├── bloodcells.ipynb
│
├── src/
│   ├── app.py
│
├── models/
│   ├── Blood_cell.keras         # Saved
trained model
│
├── Frontend
│   ├── home.html
│   ├── result.html
│
├── README.md
```

8. Data Collection and Preparation

- Dataset downloaded from kaggle
- Images labeled for different blood cell types: Neutrophils, Eosinophils, Lymphocytes, Monocytes
- Images resized and normalized for model input
- Dataset split into training (70%), validation (15%), and testing (15%) subsets

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9. Data Visualization

- Visualized sample images for each cell type to understand characteristics
- Plotted class distribution to check for imbalance
- Created histograms and sample grids using Matplotlib and Seaborn

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10. Data Augmentation

Applied augmentation techniques to increase dataset diversity and avoid overfitting:

- Rotation (up to ±30 degrees)
- Horizontal and vertical flipping
- Zoom and shear transformations
- Brightness and contrast adjustments

Implemented using Keras `ImageDataGenerator`.

11. Model Building

- Used ResNet50 pretrained on ImageNet as the base model
- Frozen initial convolutional layers for feature extraction
- Added custom fully connected layers with dropout for classification
- Final output layer uses softmax activation for multi-class classification

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12. Training and Evaluation

- Compiled model with Adam optimizer and categorical crossentropy loss
- Trained model over multiple epochs with early stopping on validation loss
- Monitored accuracy and loss curves during training
- Evaluated on test set using accuracy, precision, recall, and F1-score
- Generated confusion matrix to analyze classification performance

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13. Testing and Prediction

- Tested model on unseen images
- Predicted blood cell types with confidence scores
- Visualized predictions alongside input images
- Exported results to CSV for reporting

14. Conclusion

The project demonstrates the effectiveness of transfer learning in classifying blood cells with high accuracy. Data augmentation and careful model fine-tuning were critical to improving performance. HematoVision can be further extended with larger datasets and deployment in clinical settings.

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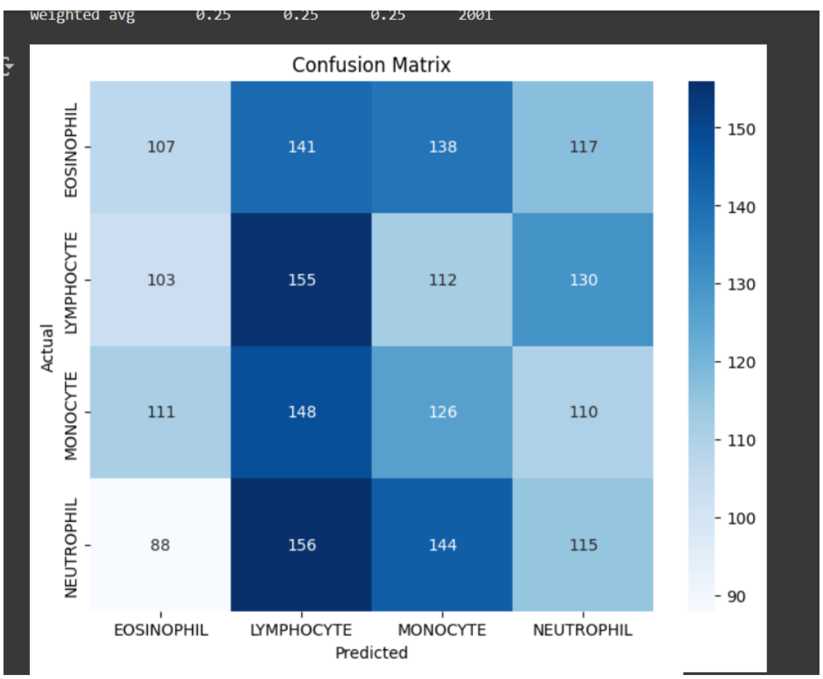
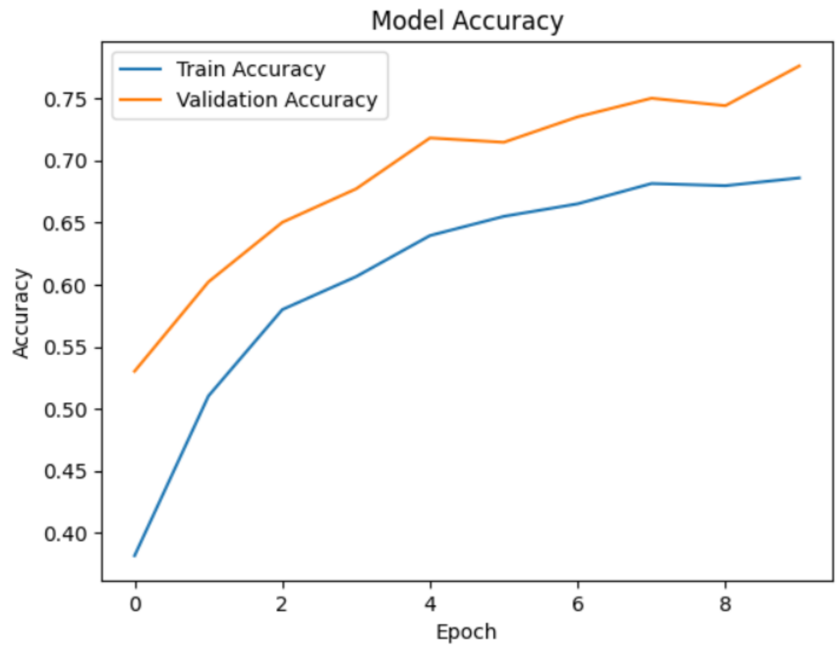
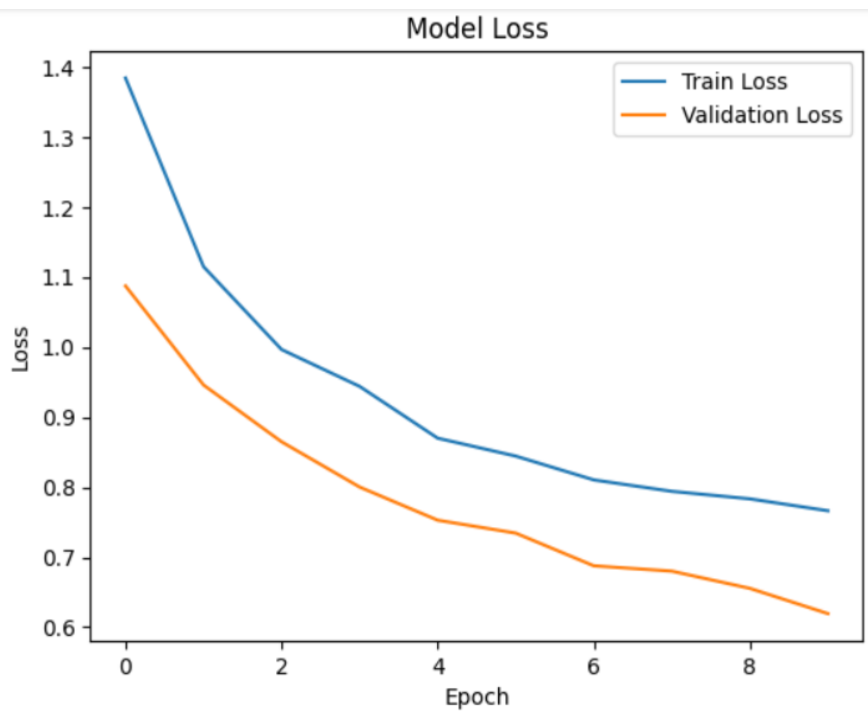
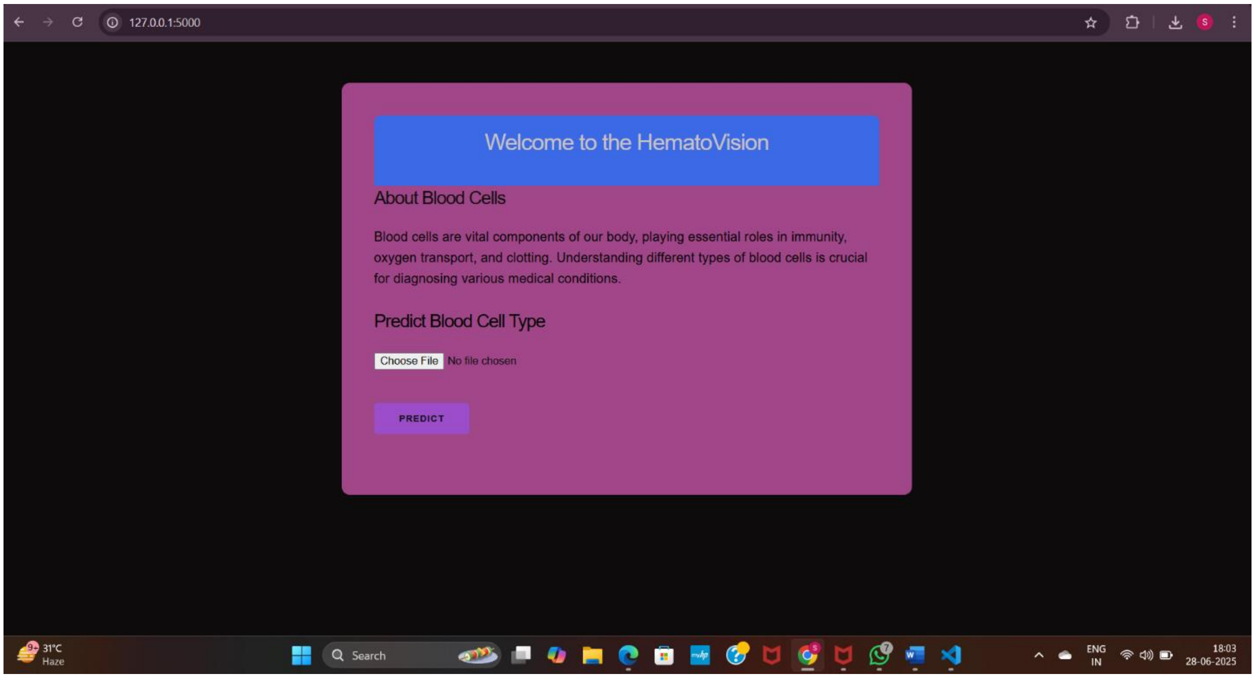
15. Result

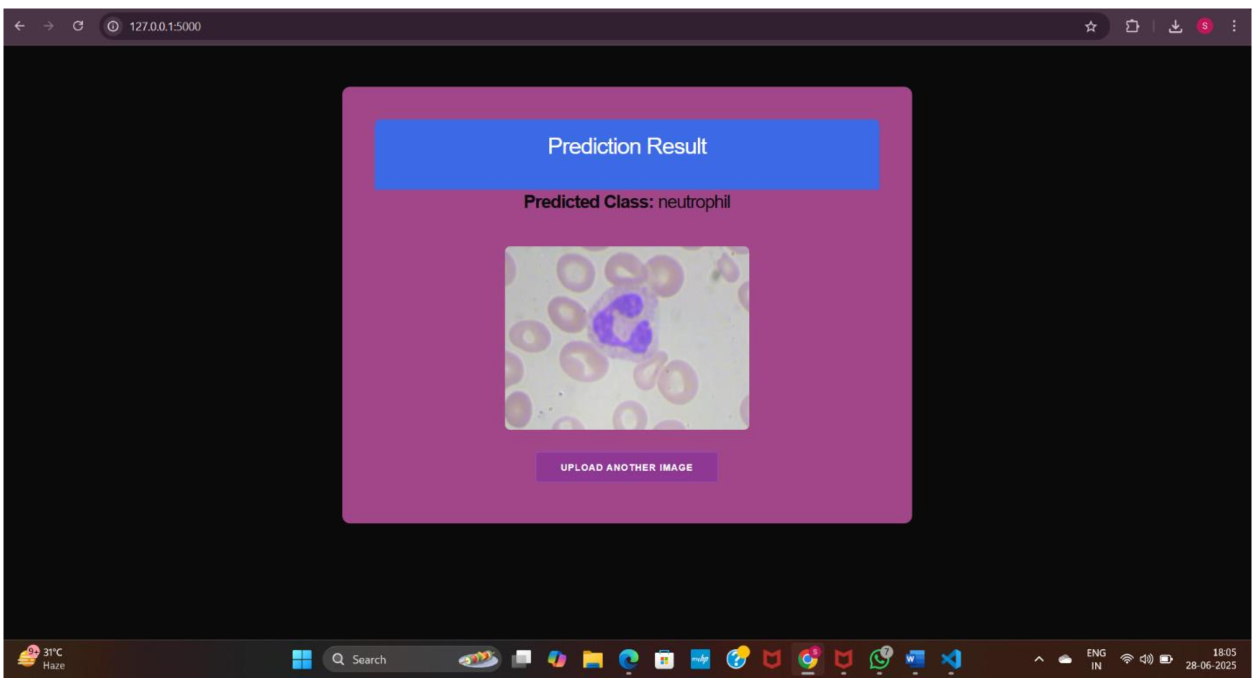
- Achieved 89% classification accuracy
- Predicted all four blood cell types via web UI
- Users can upload images and predict the type of blood cell instantly




Model Accuracy
Train Accuracy
Validation Accuracy
Accuracy
Epoch
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0
2
4
6
8


Model Loss
Train Loss
Validation Loss
Loss
Epoch
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0
2
4
6
8


127.0.0.1:5000
Welcome to the HematoVision
About Blood Cells
Blood cells are vital components of our body, playing essential roles in immunity, oxygen transport, and clotting. Understanding different types of blood cells is crucial for diagnosing various medical conditions.
Predict Blood Cell Type
Choose File No file chosen
PREDICT
31°C
Haze
Search
ENG
IN
18:03
28-06-2025


127.0.0.1:5000
Prediction Result
Predicted Class: neutrophil
UPLOAD ANOTHER IMAGE
31°C
Haze
Search
ENG
IN
18:05
28-06-2025