Enchanted Wings: Marvels of Butterfly Species

1. INTRODUCTION

1.1 Project Overview

I developed a deep learning-based butterfly species classification system titled "Enchanted Wings: Marvels of Butterfly Species". The goal was to automate the identification of butterfly species using computer vision techniques. I used transfer learning with a pre-trained CNN (VGG16) to build a robust classification model. The dataset comprised 6,499 images from 75 butterfly species, divided into training, validation, and test sets.

1.2 Purpose

- Build a scalable model for butterfly classification
- Assist conservationists in biodiversity monitoring
- Engage the public in educational and citizen science
- Reduce manual identification effort while maintaining high accuracy

2. IDEATION PHASE

2.1 Problem Statement

Manual butterfly identification is difficult and time-consuming. This project aims to automate the process with a reliable deep learning model.

2.2 Empathy Map Canvas

Says: "I can't identify this butterfly" | Thinks: "I wish there was a tool for this"

Does: Takes photos, posts online | Feels: Curious, frustrated

2.3 Brainstorming

- Use VGG16 or ResNet50
- Add data augmentation
- Build simple web interface
- Offer real-time predictions and educational info

3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

Awareness -> Engagement -> Learning -> Sharing -> Feedback

3.2 Solution Requirement

- Input: butterfly image
- Output: species prediction with confidence
- Accuracy > 85%, intuitive frontend, educational output

3.3 Data Flow Diagram

[Upload] -> [Flask Backend] -> [Preprocessing] -> [VGG16 Model] -> [Output]

3.4 Technology Stack

- Frontend: HTML, CSS, JS
- Backend: Flask, Python
- ML: TensorFlow, Keras, VGG16
- Visualization: Matplotlib, Seaborn

4. PROJECT DESIGN

4.1 Problem Solution Fit

Transfer learning was an ideal solution to balance accuracy, training time, and scalability.

4.2 Proposed Solution

Frontend + Flask backend + VGG16 model pipeline

4.3 Solution Architecture

Frontend <-> Flask <-> Preprocessing <-> VGG16 <-> Prediction <-> Output Display

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Week 1: Dataset prep | Week 2: Model training | Week 3: UI development

Week 4: Integration | Week 5: Testing | Week 6: Documentation

6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

Accuracy: 88.7%, F1: 0.885

Fast predictions, stable training, good generalization

7. RESULTS

7.1 Output Screenshots

- index.html: welcome screen
- input.html: upload and predict
- output.html: species name, confidence, reference image

Example: Monarch Butterfly - 94.2% confidence

8. ADVANTAGES & DISADVANTAGES

Advantages:

- Accurate, fast, scalable
- Public-friendly UI
- Educational output

Disadvantages:

- Image quality dependent
- Needs labeled data
- Not deployed live yet

9. CONCLUSION

Transfer learning-based species classification has real-world ecological and educational applications.

This project is scalable and encourages public engagement in conservation.

10. FUTURE SCOPE

- Mobile app integration
- Real-time detection via webcam
- GPS tagging
- Multilingual interface
- Visual explainability (XAI)

11. APPENDIX

GitHub: https://github.com/Painameghana/enchanted-wings-marvels-of-butterfly-species

Dataset: Kaggle Butterfly Classification

Structure:

- app.py
- model/
- static/
- templates/
- README.md