**1. INTRODUCTION**

**1.1 Project Overview**

This project aims to classify various species of butterflies using deep learning, specifically Convolutional Neural Networks (CNN). The application of artificial intelligence in biodiversity research helps automate species recognition and contributes to conservation efforts.

**1.2 Purpose**

To develop an intelligent system that can recognize butterfly species from images with high accuracy, reducing manual identification work and promoting ecological awareness.

**2. IDEATION PHASE**

**2.1 Problem Statement**

Manual classification of butterfly species requires biological expertise and is time-consuming. An AI-based image classifier can automate this process and provide accurate results quickly.

**2.2 Empathy Map Canvas**

* **Users:** Researchers, Students, Wildlife Enthusiasts
* **Needs:** Easy-to-use, fast identification tool
* **Pains:** Misidentification, manual effort
* **Gains:** Speed, accuracy, awareness, conservation support

**2.3 Brainstorming**

Ideas included:

* Training a CNN on butterfly image datasets
* Mobile app deployment for on-field classification
* Extending the system to other insect species

**3. REQUIREMENT ANALYSIS**

**3.1 Customer Journey Map**

1. User uploads butterfly image
2. Model processes the image
3. Prediction of butterfly species
4. Display of results to user

**3.2 Solution Requirement**

* Butterfly image dataset
* Image preprocessing tools
* Deep learning model (CNN)
* Hosting environment (e.g., Google Colab)

**3.3 Data Flow Diagram**

Image Input → Preprocessing → CNN Model → Classification Output

**3.4 Technology Stack**

* **Language:** Python
* **Libraries:** TensorFlow, Keras, OpenCV, NumPy, Pandas
* **Tools:** Google Colab, Jupyter Notebook
* **Other:** Matplotlib (for visualization)

**4. PROJECT DESIGN**

**4.1 Problem Solution Fit**

Deep learning is a suitable approach due to its strong performance in image classification tasks, especially when labeled data is available.

**4.2 Proposed Solution**

We propose a CNN-based classifier trained on labeled images of butterfly species. It uses multiple convolutional and pooling layers to extract image features and classify them.

**4.3 Solution Architecture**

Input Image

→ Convolutional Layers

→ Pooling Layers

→ Flatten Layer

→ Dense Layers

→ Softmax Output (Species Label)

| **5. PROJECT PLANNING & SCHEDULING**  **5.1 Project Planning**  **week task** |  | |
| --- | --- | --- |
| **1** | **Research & Requirements** | |
| **2** | **Dataset Collection & Cleaning** | |
| **3** | **Model Building** | |
| **4** | **Testing & Evaluation** | |
| **5** | **Documentation & Submission** | |
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**6. FUNCTIONAL AND PERFORMANCE TESTING**

**6.1 Performance Testing**

The CNN was trained on 80% of the dataset and validated on 20%.

* **Accuracy Achieved:** ~85%
* **Evaluation Tools:** Accuracy graph, loss graph, confusion matrix
* **Testing Platform:** Google Colab

**7. RESULTS**

**7.1 Output Screenshots**

* **Screenshot 1:** Training vs Validation Accuracy & Loss
* **Screenshot 2:** Sample butterfly image with predicted species label  
  (Note: These screenshots are available in your GitHub repo.)

**8. ADVANTAGES & DISADVANTAGES**

**Advantages:**

* Automates butterfly classification
* Supports researchers and conservationists
* Saves time and effort
* Educational tool for biodiversity awareness

**Disadvantages:**

* Performance depends on image quality
* Needs a large and diverse dataset
* May misclassify under poor lighting or damaged images

**9. CONCLUSION**

This project demonstrates the effective use of deep learning for butterfly species classification. It has applications in ecology, education, and biodiversity monitoring. The model shows promising accuracy and can be deployed in real-time applications.

**10. FUTURE SCOPE**

* Integration into mobile applications
* Use of advanced CNN models like ResNet, EfficientNet
* Collection of larger and diverse global datasets
* Real-time butterfly recognition for field researchers
* Cloud-based model API for remote access

**11. APPENDIX**

* **Source Code:** Available in the GitHub repository
* **Dataset Link:** https://www.kaggle.com/datasets/phucthaiv02/butterfly-image-classification
* **GitHub & Demo Link:** <https://github.com/ARJUN-VAKA/enchanted-wings-marvels-of-butterfly-species>
* https://drive.google.com/file/d/1\_jgQuG7QjAYPg1okmiSAiILq2IsBjL9F/view?usp=drive\_link