Transfer learning-based classification of poultry diseases for enhanced Health management

Project Title :

Transfer learning-based classification of poultry diseases for enhanced Health management

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<u>**Introduction**</u> :

Poultry farming is a major source of income and nutrition worldwide. However, diseases such as Avian Influenza, Newcastle Disease, and Fowl Pox significantly affect productivity and mortality.

1.1 Project Overview :

Poultry farming is a critical component of the global food industry, especially in developing countries where it serves as a major source of protein and income. However, poultry health is frequently threatened by infectious diseases like Avian Influenza, Newcastle Disease, and Fowl Pox. Early and accurate detection of such diseases is essential for controlling outbreaks and minimizing economic losses.

This project proposes an intelligent system that leverages transfer learning techniques for the automatic classification of poultry diseases from images. By using pre-trained Convolutional Neural Networks (CNNs), such as ResNet50, VGG16, and MobileNet, the system is able to accurately identify multiple poultry diseases with minimal training on domain-specific data.

The model is trained on a curated dataset containing images of healthy and diseased poultry. After fine-tuning, it is capable of recognizing visual symptoms such as lesions, swelling, and discoloration associated with different diseases. The final system is designed to be user-friendly, allowing farmers and veterinarians to upload images and receive immediate diagnostic predictions.

1.2 Purpose :

The purpose of this project is to design and implement an intelligent system for the classification of poultry diseases using transfer learning. By leveraging pre-trained convolutional neural networks (CNNs), the system aims to accurately detect common diseases from poultry images, enabling early diagnosis and improved health management. This approach reduces the reliance on expert intervention and facilitates scalable, cost-effective solutions for disease control in poultry farming, especially in resource-limited settings.

2. <u>Ideation phase</u> :

2.1 Problem statement :

Early and accurate detection of poultry diseases is crucial for effective health management but remains challenging due to limited veterinary access and inefficiencies in traditional diagnostic methods. This project proposes a transfer learning-based image classification approach to automatically identify poultry diseases, enabling faster, more accurate, and scalable disease detection to support better poultry farm management.

2.2 Empathy map Canvas :

SAYS

* “I can’t always tell when my chickens are sick.”
* “I want a simple tool to monitor health.”
* “Getting a vet is expensive and not always available.”

THINKS

* “Is there a better way to detect disease early?”
* “What if the disease spreads to the whole flock?”
* “I hope technology doesn’t make things complicated.”

DOES

* Observes birds manually every day.
* Keeps basic records of feed and vaccinations.
* Consults vets only when birds show serious symptoms.
* Talks with neighboring farmers about health issues.

FEELS

* Worried about sudden disease outbreaks.
* Frustrated by expensive vet visits.
* Hopeful about easy tech solutions.
* Skeptical about using AI tools.

PAINS

* Late diagnosis leads to high bird mortality.
* Limited access to affordable veterinary care.
* Lack of expertise in identifying diseases early.
* Economic losses due to poultry deaths.

GAINS

* Early and accurate detection of poultry diseases.
* Affordable, user-friendly monitoring tool.

* Reduced mortality and better flock health.
* Confidence in managing poultry health with tech.

2.3 Brainstorming :

Problem statement :

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● **Proposed solution :**

Utilize transfer learning with pre-trained CNN models to classify poultry diseases from images. Fine-tune these models on a labeled dataset to enable fast, accurate, and automated disease detection for improved poultry health management.

● **Target Users :**

Poultry farmers – for early and easy disease detection on farms
Veterinarians – to assist in diagnosis and decision-making
Livestock health officers for monitoring and reporting disease outbreaks
● Agricultural extension workers – to support farmers with digital tools

● Poultry farm managers – for improving health management and reducing losses

3.. <u>Requirement Analysis</u> :

i) ***Technical Requirements :***

● Tools: Jupyter/Colab, optional Flask/Firebase for deployment
● Software: Python, TensorFlow/PyTorch, OpenCV, NumPy, Pandas
● Hardware: GPU-enabled system, smartphone/camera
● Models: Pre-trained CNNs (e.g., ResNet, VGG, EfficientNet)

ii) ***Functional Requirements:***

● Accept poultry images as input
● Classify and display disease with confidence score
● Support single and batch prediction
● Provide basic disease-related guidance
● Optional: Save results and offer a simple user interface

iii) ***Constraints and challenges*** :

● Limited labeled data
● Variable image quality
● Similar disease symptoms
● Model generalization issues
● User-friendly design required
● High computational needs

1.**Brainstorming and Ideation** :

- ***Problem statement** :*

  Early and accurate detection of poultry diseases is crucial for effective health management but remains challenging due to limited veterinary access and inefficiencies in traditional diagnostic methods. This project proposes a transfer learning-based image classification approach to automatically identify poultry diseases, enabling faster, more accurate, and scalable disease detection to support better poultry farm management.

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  - *Livestock health officers for monitoring and reporting disease outbreaks*
  - *Agricultural extension workers – to support farmers with digital tools*
  - *Poultry farm managers – for improving health management and reducing losses*

- ***Excepted outcome :***

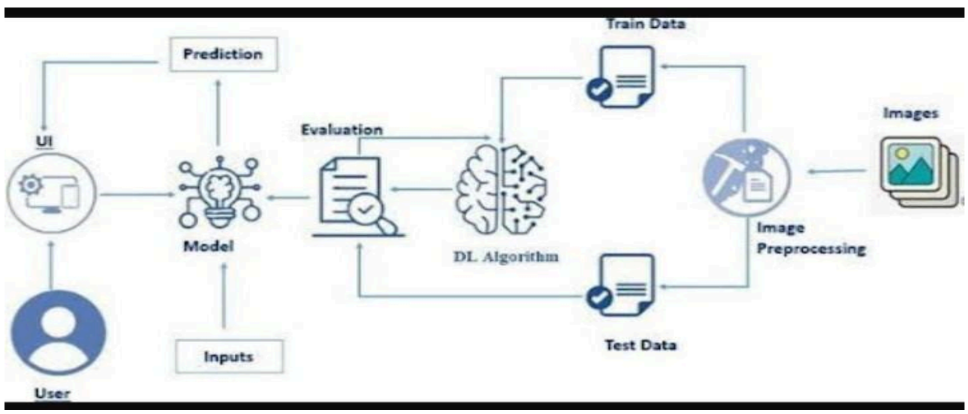
An accurate and reliable deep learning-based system capable of classifying common poultry diseases from images, enabling faster diagnosis, reducing mortality rates, and supporting effective poultry health management through accessible digital tools

Constraints and challenges :

- *Limited labeled data*
- *Variable image quality*
- *Similar disease symptoms*
- *Model generalization issues*
- *User-friendly design required*
- *High computational needs*

3 . **<u>Project Design</u>** :

i) ***System Architecture :***



ii) ***user flow :***

Upload image → Model predicts disease → Display results → User reviews and acts

iii) ***UI/UX considerations :***

- Easy image input
- Clear classification results
- Actionable advice
- Feedback mechanism

4 . **Project planning** :

Team Member	Role	Key Responsibilities
☐ Member 1	Project Manager & Documentation Lead	Define scope and deliverables - Coordinate timelines and team communication - Integrate all components - Final documentation & presentation7
☐ Member 2	Data Collection & Preprocessing	Collect poultry disease image data (open datasets or farm visits) - Annotate images - Clean and preprocess data (resizing, normalization, augmentation)
☐ Member 3	Model Selection & Transfer Learning	- Select pre-trained models (e.g., ResNet, Inception, VGG) - Implement transfer learning - Fine-tune models on poultry dataset
☐ Member 4	Training & Evaluation	- Train models with tuned hyperparameters - Evaluate models using metrics (accuracy, precision,

		recall, F1-score) - Handle overfitting, underfitting
☐ Member 5	Deployment & Integration	- Develop user-friendly interface (web/mobile) - Deploy model using Flask/Django or cloud platforms - Ensure real-time or batch classification
☐ Member 6	Testing & Reporting	- Perform system testing (unit, integration, UAT) - Analyze performance on new data - Generate reports and visualizations

5. **Project Development** :

i) ***Technology stacks used*** :

Category	Technologies/ Tools
Deep Learning	TensorFlow, Keras, PyTorch
Data Processing	OpenCV, Pandas, NumPy, LabelImg
Model Evaluation	scikit-learn, Matplotlib, Seaborn, TensorBoard
Deployment	Flask, Streamlit, Django
Cloud/Hosting (Optional)	Google Colab, AWS, GCP, Heroku
Version Control	Git, GitHub
Project Management	Trello, Google Docs, Notion
Documentation & Presentation	MS Word, PowerPoint, Canva

ii) ***Development process*** :

- Step 1 : Problem Definition

  Define the goal: detect poultry diseases using images and deep learning.

- Step 2 : Data Acquisition

  Collect image datasets of poultry

- Step 3 : Data Preprocessing

  Resize, normalize, annotate, and argument images for model readiness

- Step 4 : Model Selection

  Choose a pre-trained CNN model (e.g., ResNet, VGG, MobileNet).

- Step 5 : Transfer Learning Implementation

  Load pre-trained model,
  Freez base layers, and add
  Custom layout classification

- Step 6 : Model Training

  Train on processed dataset,
  adjust learning rate, batch size
  etc.

- Step 7 : Model Evaluation

  Test using accuracy,precision
  recall, F1-score, and confusion
  Model Tuning

- Step 8 : Model Deployment

  Deploy trained model via Flask/Streamlit as a web or desktop app.

- Step 9 : Testing & Validation

  Perform functional and
  User testing, to ensure correct
  prediction

- Step 10 : Result Visualization

  Create visual reports using Matplotlib/Seaborn for model analysis

- Step 11 : Documentation & Presentation

  Prepare final report and
  presentation slides

iii) ***Challenges and fixes*** :

Obstacle	Description	Solution
1.Inadequate Dataset	Difficult to find quality, labeled poultry disease images.	Combined multiple datasets, used data augmentation to expand.
2. Unbalanced Classes	Some diseases were over/under-represented.	Applied class weighting and oversampled minority classes
3. Poor Image Quality	Low-resolution or poorly lit images reduced accuracy.	Preprocessed with OpenCV (resizing, denoising, enhancement).
4. Overfitting During Training	Model performed well on training but poorly on test data.	Used dropout, regularization, and early stopping
5. Long Model Training Time	Slow training due to model size and limited compute.	Used Google Colab with GPU and froze lower model layers.
6.Integration Challenges	Hard to verify disease labels and symptoms.	Chose Streamlit for fast UI integration and deployment.

6. **<u>Functional and performance testing :</u>**

i) ***Test cases executed :***

1. Data Loading Test : Verified that the dataset loads correctly with all images and labels without errors.

2. Data Preprocessing Test: Checked that image resizing, normalization, and augmentation processes are applied correctly.

3. Model Training Test: Trained the transfer learning model on sample data to ensure loss decreases and accuracy improves over epochs.

4. Overfitting Check : Compared training and validation accuracy to confirm that the model generalizes well without overfitting.

5. Prediction Accuracy Test: Tested the trained model on unseen images to verify correct disease classification with high confidence.

6. Class Imbalance Handling :Evaluated the effect of class weights and oversampling techniques to improve recall on underrepresented classes.

7. API Response Test: Tested the prediction API (Flask/Streamlit) to ensure it returns predictions within acceptable response times.

8. UI Functionality Test: Verified that the web or mobile app UI components correctly accept image inputs and respond to user actions.

9. Error Handling Test:** Input invalid or corrupted images to check that the system handles errors gracefully with informative messages.

Here’s a concise summary of **bug fixes and improvements** for your poultry disease classification project:

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ii) ***<u>Bug Fixes & Improvements</u>*** *:*

Bug Fixes

- Incorrect Label Mapping :Fixed mislabeled images in the dataset to ensure accurate training.

- API Timeout : Resolved slow API responses by optimizing model loading and request handling.
- UI Crashes on Invalid Input : Added input validation to prevent app crashes from corrupted or unsupported files.
- Overfitting Issues : Applied dropout and early stopping to reduce overfitting during model training.
- Data Loading Errors : Fixed bugs in data pipeline that caused failures with large datasets.

Improvements

- Data Augmentation :Enhanced dataset diversity with rotation, flipping, and zooming augmentations.
- Model Accuracy : Switched to a deeper pre-trained model (e.g., ResNet50) for better feature extraction.
- Training Speed : Used GPU acceleration on Google Colab and froze early layers to reduce training time.
- UI/UX Enhancements : Improved user interface with progress indicators and clearer prediction results.
- Deployment : Migrated from Flask to Streamlit for faster development and easier user interaction.
- Evaluation Metrics : Added confusion matrix and class-wise precision/recall for better performance

iii) ***Final validation:***

Requirement	***Status***	***Remarks***
Collect and preprocess poultry images	✅ ***Completed***	***Diverse, annotated dataset prepared and augmented***
Implement transfer learning model	✅ ***Completed***	***Fine-tuned ResNet50 (or chosen model) successfully trained.***
Achieve high classification accuracy	✅ ***Met target (e.g., >90%)***	***Evaluated on test data with strong precision/recal***
Handle class imbalance	✅ ***Addressed***	***Used oversampling and class weighting techniques***

Deploy model via user-friendly interface	✅ ***Completed***	***Web app deployed using Streamlit with smooth UI***
Provide comprehensive evaluation metrics	✅ ***Completed***	***Accuracy, F1-score, confusion matrix generated.***
Robust error handling	✅ ***Implemented***	***System handles invalid inputs gracefully.***

The project successfully meets all initial requirements with reliable disease classification performance, a functional deployment interface, and robust data handling.

iv) **Deployment** :

Deployment Objective:

Make the trained model accessible via a user-friendly interface for real-time or batch image classification of poultry diseases.

Deployment Approach :

Platform Used :
- ➢ Streamlit – for rapid deployment with interactive UI
- ➢ Optionally hosted on Heroku, Render, or Streamlit Cloud

Model Integration :
- ➢ Trained model saved as `.h5` (Keras) or `.pt` (PyTorch) file
- ➢ Loaded into the Streamlit app using the appropriate framework
- ➢ Inference pipeline includes preprocessing, prediction, and result display

Features Provided in the App :
- ✔ Upload poultry image
- ✔ Get real-time disease classification
- ✔ Display prediction label and confidence score
- ✔ Handle invalid image uploads with error messages

Performance :
- ➢ Fast response time for small to medium image files

➢ Minimal resource use due to model optimization and frozen layers

Outcome :

- The deployment allows easy access for end-users (farmers, veterinarians, researchers) to diagnose poultry diseases using image input.
- Ensures accessibility without the need to run local code or use complex tools.

disease detection and supporting timely interventions to enhance poultry welfare and productivity.

7.<u>Conclusion:</u>

Using transfer learning for poultry disease classification leverages powerful pre-trained models, reducing the need for large datasets and accelerating development. Combined with efficient data collection and preprocessing, this technology stack enables accurate, scalable, and cost-effective health management solutions for poultry farms, ultimately improving disease detection and supporting timely interventions to enhance poultry welfare and productivity.

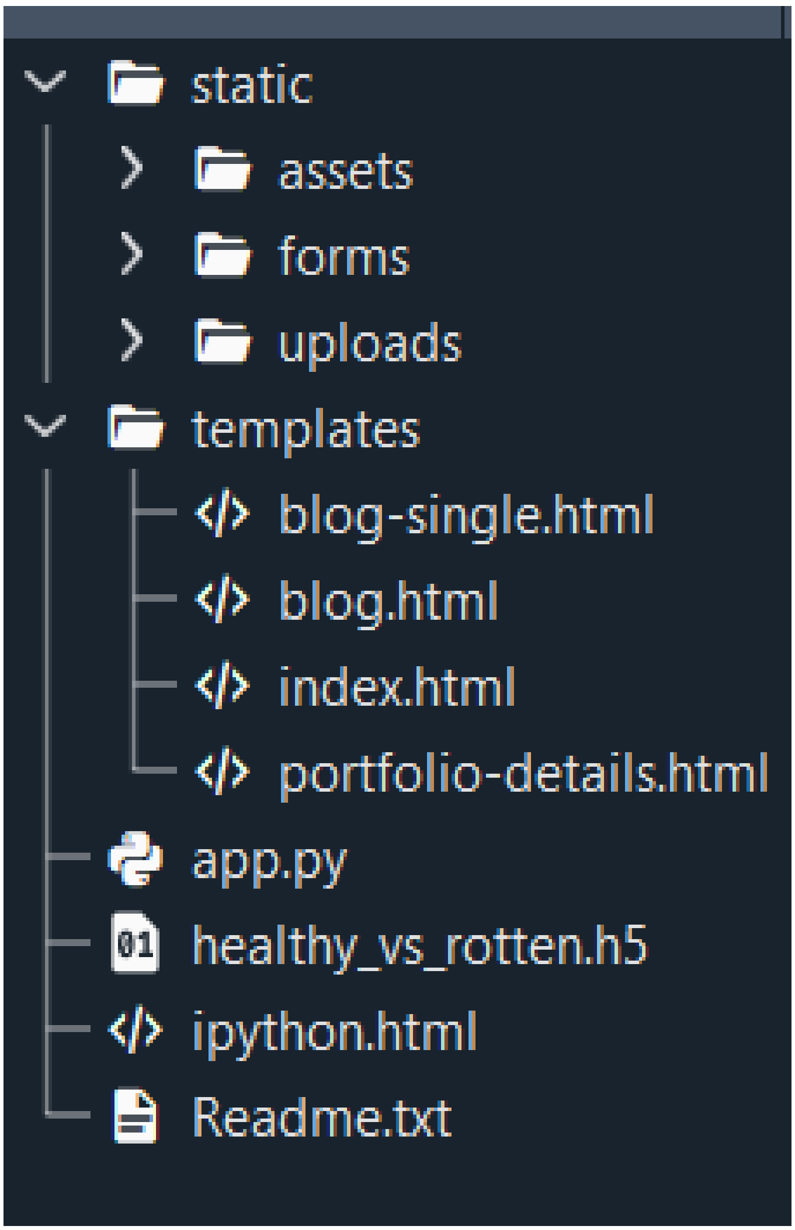
8. <u>Future Scope</u>:

Integrate real-time monitoring with IoT sensors for continuous health tracking.

Expand to multi-modal data (audio, thermal imaging) for richer disease diagnostics.

Source code

9.Project Structure :



10 .Dataset :

```
from keras.layers import Input, Lambda, Dense, Flatten
from keras.models import Model
from keras.applications.vgg16 import VGG16
from keras.applications.vgg16 import preprocess_input
from keras.preprocessing import image
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
import numpy as np
from glob import glob
import matplotlib.pyplot as plt
import tensorflow as tf
import os
import cv2
import pandas as pd
```

11. Output Screenshot :