Technology Stack Documentation

Project: PoultryDetect - AI-Powered Poultry Disease Detection System
Location: Ongole, Andhra Pradesh
Date: June 2025
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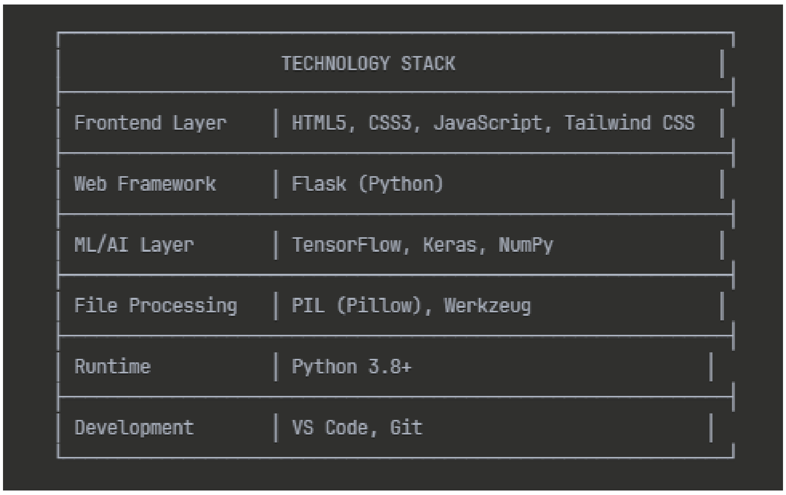
1. Technology Stack Overview

1.1 Architecture Pattern

Pattern: Model-View-Controller (MVC) with AI/ML Integration **Deployment:** Single-tier web application with integrated ML model



```
┌─────────────────────────────────────────────────────────┐
│                    TECHNOLOGY STACK                     │
├─────────────────────────────────────────────────────────┤
│ Frontend Layer    │ HTML5, CSS3, JavaScript, Tailwind CSS │
├─────────────────────────────────────────────────────────┤
│ Web Framework     │ Flask (Python)                      │
├─────────────────────────────────────────────────────────┤
│ ML/AI Layer       │ TensorFlow, Keras, NumPy            │
├─────────────────────────────────────────────────────────┤
│ File Processing   │ PIL (Pillow), Werkzeug              │
├─────────────────────────────────────────────────────────┤
│ Runtime           │ Python 3.8+                        │
├─────────────────────────────────────────────────────────┤
│ Development       │ VS Code, Git                       │
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```

2. Backend Technologies

2.1 Core Framework

Flask Web Framework

- **Version:** 2.3.0+
- **Purpose:** Web application framework and routing
- **Key Features:**
  - Lightweight and flexible
  - Jinja2 templating engine
  - Built-in development server
  - RESTful request dispatching

Implementation Details:

```
from flask import Flask, render_template, request


app = Flask(__name__)
```

```
@app.route('/')
def index():
    return render_template('index.html')


@app.route('/predict', methods=['POST'])
def upload():
    # File processing and prediction logic
    pass
```

Advantages:

- Minimal setup and configuration
- Excellent for prototyping and small applications
- Strong community support
- Easy integration with Python ML libraries

2.2 Machine Learning Stack

TensorFlow/Keras

- **Version:** TensorFlow 2.12.0, Keras 2.12.0
- **Purpose:** Deep learning model inference
- **Model Type:** Convolutional Neural Network (CNN)
- **Model File:** healthy_vs_rotten.h5 (pre-trained)

Key Capabilities:

```
from keras.models import load_model
from keras.preprocessing import image
import numpy as np


# Model loading
model = load_model("healthy_vs_rotten.h5")


# Image preprocessing
img = image.load_img(img_path, target_size=(224, 224))
arr = image.img_to_array(img) / 255.0
arr = np.expand_dims(arr, axis=0)


# Prediction
pred = model.predict(arr)[0]
```

NumPy

- **Version:** 1.24.0+
- **Purpose:** Numerical computations and array operations
- **Use Cases:**
    - Image array manipulation
    - Model prediction processing
    - Mathematical operations

2.3 File Processing

Werkzeug

- **Version:** 2.3.0+
- **Purpose:** WSGI utility library and file handling
- **Key Features:**
    - Secure filename sanitization
    - File upload handling
    - HTTP utilities

PIL (Pillow)

- **Version:** 9.5.0+
- **Purpose:** Image processing and manipulation
- **Features:**
    - Image format conversion
    - Resizing and cropping
    - Format validation

Implementation:

```
from werkzeug.utils import secure_filename
from PIL import Image


# Secure file handling
```

```
filename = secure_filename(file.filename)


# Image processing
img = Image.open(img_path)
img = img.resize((224, 224))
```

3. Frontend Technologies

3.1 Core Web Technologies

HTML5

- **Purpose:** Semantic markup and structure
- **Key Features:**
  - File input for image uploads
  - Semantic elements for accessibility
  - Canvas support for image display
  - Form validation

CSS3

- **Purpose:** Styling and visual presentation
- **Advanced Features:**
  - Flexbox and Grid layouts
  - CSS animations and transitions
  - Backdrop filters for glass effects
  - Responsive design media queries

JavaScript (Vanilla)

- **Purpose:** Client-side interactivity
- **Features:**
  - Form submission handling
  - File validation
  - Dynamic content updates
  - Animation controls

3.2 CSS Framework

Tailwind CSS

- **Version:** 3.3.0 (CDN)

- **Purpose:** Utility-first CSS framework
- **CDN Integration:**

```
<script src="https://cdn.tailwindcss.com"></script>
```

Key Benefits:

- Rapid UI development
- Consistent design system
- Mobile-first responsive design
- Minimal custom CSS required

Usage Example:

```
<div class="bg-white/70 backdrop-blur-md rounded-2xl p-8 shadow-lg">
  <h1 class="text-4xl font-bold text-green-700 mb-4">PoultryDetect</h1>
</div>
```

3.3 UI Enhancement Libraries

Lottie Animations

- **Source:** @lottiefiles/lottie-player
- **Purpose:** Vector animations
- **CDN:** unpkg.com/@lottiefiles/lottie-player@latest
- **Implementation:**

```
<lottie-player src="animation.json"
            background="transparent"
            speed="1" loop autoplay>
</lottie-player>
```

Custom CSS Animations

- **Purpose:** Interactive elements and visual feedback
- **Examples:**
    - Walking hen animation
    - Hover effects
    - Loading indicators

4. Development Tools

4.1 Code Editor

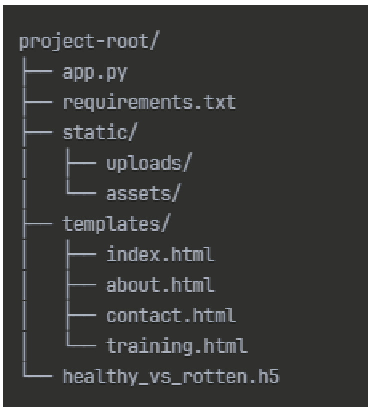
Visual Studio Code

- **Extensions:**
  - Python extension pack
  - HTML/CSS/JS language support
  - Git integration
  - Live Server for development

4.2 Version Control

Git

- **Purpose:** Source code management
- **Repository Structure:**



```
project-root/
├── app.py
├── requirements.txt
├── static/
│   ├── uploads/
│   └── assets/
├── templates/
│   ├── index.html
│   ├── about.html
│   ├── contact.html
│   └── training.html
└── healthy_vs_rotten.h5
```

4.3 Package Management

pip (Python Package Installer)

- **Requirements File:** requirements.txt
- **Key Dependencies:**

Flask==2.3.2

tensorflow==2.12.0

keras==2.12.0

numpy==1.24.3

Pillow==9.5.0

Werkzeug==2.3.6

5. External Services & CDNs

5.1 Content Delivery Networks

Tailwind CSS CDN

- **URL:** https://cdn.tailwindcss.com
- **Purpose:** CSS framework delivery

- **Fallback:** Local Tailwind build if CDN fails

Lottie Files CDN

- **URL:** https://unpkg.com/@lottiefiles/lottie-player@latest
- **Purpose:** Animation player library
- **Alternative:** Local animation files

5.2 External APIs

Google Scholar Integration

- **Purpose:** Research paper access
- **Implementation:** Direct URL construction

research_url = f"https://scholar.google.com/scholar?q={disease_name}+in+Poultry"

6. System Requirements

6.1 Development Environment

Hardware Requirements:

- RAM: 8GB minimum, 16GB recommended
- Storage: 10GB available space
- Processor: Multi-core CPU (Intel i5/AMD Ryzen 5 or better)
- Network: Stable internet connection for CDN resources

Software Requirements:

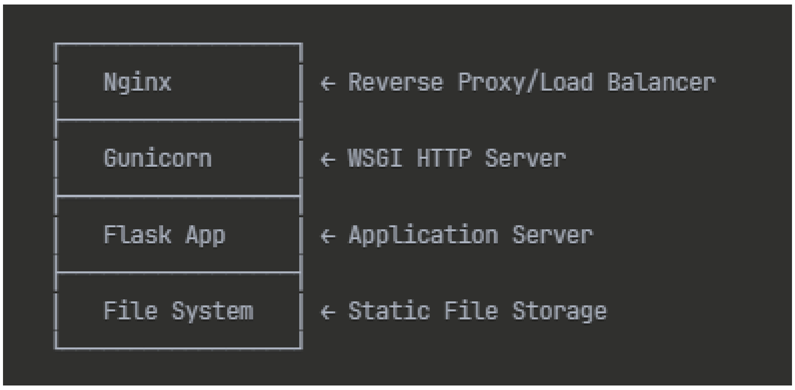
- Operating System: Windows 10/11, macOS 10.15+, or Linux Ubuntu 18.04+
- Python: 3.8 or higher
- Web Browser: Chrome, Firefox, Safari, or Edge (latest versions)

6.2 Production Environment

Server Specifications:

- RAM: 4GB minimum
- Storage: 20GB available space
- CPU: 2 cores minimum
- Network: Reliable internet connection

Deployment Stack:



```
┌─────────────────┐
│   Nginx         │ ← Reverse Proxy/Load Balancer
├─────────────────┤
│   Gunicorn      │ ← WSGI HTTP Server
├─────────────────┤
│   Flask App     │ ← Application Server
├─────────────────┤
│   File System   │ ← Static File Storage
└─────────────────┘
```

7. Performance Optimizations

7.1 Frontend Optimizations

CSS Optimization:

- Tailwind CSS purging for production
- Critical CSS inlining
- Image optimization and compression
- Lazy loading for non-critical assets

JavaScript Optimization:

- Minification for production
- Asynchronous loading
- Event delegation
- Debounced input handling

7.2 Backend Optimizations

Flask Optimizations:

- Template caching
- Static file serving optimization
- Gzip compression
- Request routing optimization

ML Model Optimizations:

- Model preloading on application start
- Image preprocessing optimization
- Batch prediction capability
- Memory management for large images

7.3 Caching Strategy

Browser Caching:

- Static asset caching headers
- CDN resource caching
- Application cache for offline capability

Server-Side Caching:

- Template fragment caching
- Model prediction result caching
- Static file caching

8. Security Considerations

8.1 Input Validation

File Upload Security:

```
ALLOWED_EXTENSIONS = {'png', 'jpg', 'jpeg'}
MAX_FILE_SIZE = 10 * 1024 * 1024  # 10MB


def allowed_file(filename):
    return '.' in filename and \
           filename.rsplit('.', 1)[1].lower() in ALLOWED_EXTENSIONS
```

8.2 Security Headers

HTTP Security Headers:

- Content Security Policy (CSP)
- X-Frame-Options
- X-Content-Type-Options
- Secure file upload handling

8.3 Data Privacy

Privacy Measures:

- No persistent user data storage
- Automatic file cleanup
- Minimal logging
- No tracking or analytics

9. Testing Framework

9.1 Testing Strategy

Manual Testing:

- Cross-browser compatibility testing
- Responsive design testing
- File upload functionality testing
- ML model prediction accuracy testing

Automated Testing (Future):

- Unit tests for Flask routes
- Integration tests for ML pipeline
- Performance testing for file uploads
- Security testing for file handling

9.2 Quality Assurance

Code Quality:

- Python PEP 8 style compliance
- HTML/CSS validation
- JavaScript linting
- Documentation coverage

Performance Monitoring:

- Response time measurement
- Memory usage tracking
- File storage monitoring
- Error rate tracking