Fish Disease Detection and Classification using Computer Vision and Machine Learning Methods in Aquaculture

S. A. Sandas Gimhana and B. Mayurathan
Department of Computer Science, Faculty of Science, University of Jaffna
2019csc014@univ.jfn.ac.lk, barathym@univ.jfn.ac.lk

Abstract

Aquaculture is vital for global food security, but fish diseases pose a significant challenge, leading to considerable economic losses. Early detection and classification of these diseases are critical for maintaining healthy fish populations. In this research, we propose a computer vision and machine learning approach using convolutional neural networks (CNN) to automatically detect and classify fish diseases. While reviewing the literature, we found numerous studies on fish disease detection, but little research focused on disease classification.

We applied various deep learning models, including ResNet152, ResNet50, VGG19, MobileNetV3Large, and MobileNetV3Small, to a dataset of infected fish images from Kaggle. Preprocessing techniques like image resizing, augmentation, and normalization were used to enhance model performance. Among the models, ResNet152 achieved the highest accuracy of 88%, effectively classifying diseases such as Parasitic disease, Bacterial Red disease, and Bacterial Gill disease.

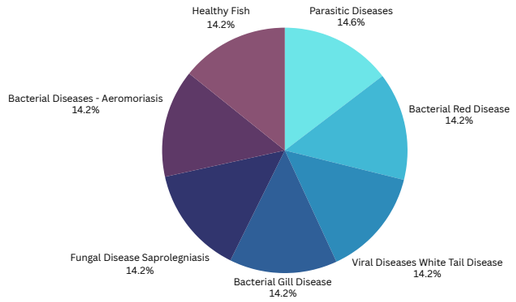
These findings suggest that integrating machine learning into aquaculture can significantly improve disease management, providing farmers with accurate and timely tools for monitoring fish health.

Introduction

- Fish diseases pose a major threat to aquaculture, leading to significant economic losses.
- Early detection and accurate classification of fish diseases are crucial for maintaining healthy fish populations.
- Traditionally, disease detection in fish relies on manual inspection by experts, which can be time-consuming and prone to human error.
- This research leverages computer vision techniques combined with machine learning algorithms to automate fish disease detection and classification.
- By employing advanced models such as Convolutional Neural Networks (CNN), we aim to enhance the accuracy and speed of disease identification compared to traditional methods.
- The system considers various visual features of fish, such as color, texture, and lesions, and classifies different disease types.
- This approach not only supports aquaculture farmers in making timely interventions but also improves the efficiency and scalability of fish health monitoring.

Dataset

- Fish Disease Dataset From Kaggle
- 7 Classes and 1750 Images
  - Parasitic Diseases - 250 Images
  - Bacterial Red Disease - 250 Images
  - Viral Diseases White Tail Disease - 250 Images
  - Bacterial Gill Disease - 250 Images
  - Fungal Disease Saprolegniasis - 250 Images
  - Bacterial Diseases - Aeromoriasis - 250 Images
  - Healthy Fish - 250 Images



Methodology

Data Collection and Preprocessing

- Image Resizing: Uniform size 224x224 pixels.
- Dataset split: 80% training, 20% testing.
- Image Augmentation: Applied techniques like rotation, flipping, and zooming to improve model generalization on training dataset.
- Normalization: Scaled pixel values to the range [0,1] to standardize input data.

Model Selection

- Used CNN architectures: VGG19, ResNet50, ResNet152, and MobileNetV3Small for disease classification.
- Dropout values: 0.3 - 0.5.
- Activation Functions: ReLU and SoftMax.

Training Configuration

- Optimizer: Adam optimizer, learning rate: 0.001.
- Loss Function: Categorical Cross-entropy.
- Epochs: 20.
- Batch Size: 32.

Training and Evaluation

- Used cross-validation to ensure robustness and avoid overfitting.
- Evaluated performance on accuracy, precision, recall, and F1-score.

Model Comparison

- ResNet152 achieved highest accuracy (88%), followed by VGG19 and ResNet50.

Results

Existing Research Results for Disease Detection

Research	Result
Fish Disease Detection System: A Case Study of Freshwater Fishes of Bangladesh [4]	K-means - 96.48% C-means - 97.90%
Fish Disease Detection Using Image Based Machine Learning Technique in Aquaculture [3]	Accuracy - 91.42%
Feasibility Study of Fish Disease Detection using Computer Vision and Deep Convolutional Neural Network (DCNN) Algorithm [2]	mAP - 0.237 AR - 0.187

Proposed Research Results for Disease Classification

Model	Accuracy	Precision	Recall	F1-score
MoblieNetV3Small	0.76	0.78	0.75	0.75
MoblieNetV3Large	0.81	0.82	0.81	0.81
VGG19	0.83	0.85	0.82	0.82
ResNet50	0.88	0.88	0.89	0.88
ResNet152	0.88	0.88	0.88	0.88

Existing research focuses on fish disease detection, achieving high accuracy (K-means: 96.48%, C-means: 97.90%) with smaller datasets. However, no studies have addressed disease classification. Our proposed research tackles both detection and classification using a larger dataset and advanced CNN models. ResNet152 and ResNet50 achieved the highest accuracy of 88%, followed by VGG19 with 83%. While MobileNetV3Large and Small had lower performance, the proposed models significantly outperform existing work in classification. This comprehensive approach provides a more robust solution for managing fish health in aquaculture.

Discussion & Conclusion

- ResNet50 and ResNet152 delivered the highest accuracy (0.88) with strong precision and recall (0.88 and 0.89), making them the most effective models for fish disease detection.
- VGG19 performed well with 0.83 accuracy, 0.85 precision, and 0.82 recall, making it a reliable alternative, though slightly behind ResNet models.
- MobileNetV3Large (accuracy 0.81, precision 0.82, recall 0.81) offers a good balance between accuracy and computational efficiency, making it suitable for real-time applications.

In conclusion, ResNet50, ResNet152, and MobileNetV3Large are the top-performing models for fish disease detection, with ResNet models being the most accurate. These models can significantly improve disease management in aquaculture by offering fast, accurate classification.

Reference

[1] N. Darapaneni, S. Sreekanth, A. R. Paduri, A. S. Roche, V. Murugappan, K. K. Singha, and A. V. Shenwai, "AI Based Farm Fish Disease Detection System to Help Micro and Small Fish Farmers," in 2022 Interdisciplinary Research in Technology and Management (IRTM), 2022.

[2] M. L. Yasruddin, M. A. H. Ismail, Z. Husin, and W. K. Tan, "Feasibility Study of Fish Disease Detection using Computer Vision and Deep Convolutional Neural Network (DCNN) Algorithm," in 2022 IEEE 18th International Colloquium on Signal Processing & Applications (CSPA), 2022.

[3] Ahmed, Md Shoaib, Tanjim Taharat Aurpa, and Md Abul Kalam Azad. "Fish disease detection using image based machine learning technique in aquaculture." Journal of King Saud University-Computer and Information Sciences 34.8 (2022): 5170-5182.

[4] M. S. Ahmed, T. T. Aurpa, and M. A. K. Azad, "Fish disease detection using image based machine learning technique in aquaculture," Journal of King Saud University-Computer and Information Sciences, 2022, Elsevier.