Fish Disease Detection System

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ABSTRACT

Aquaculture is an important process in the world food security, but fish health management is a major challenge as bacterial diseases, viral diseases, fungal diseases, and parasitism are widespread. The conventional methods of diagnostics depend rather on the manual checking of the specialists, which leads to subjective diagnostics, slowness of the intervention, and inability to make the interventions in large or distant farms. To resolve these issues, an AI-based Fish Disease Detection System was built based on a database of fish images taken in aquaculture farms and open repositories in 2020-2024 and comprised more than 45 disease types of both freshwater and marine organisms. The preprocessing image pipeline is using the OpenCV-based resizing, normalization, bilateral filters, and contrast enhancement to standardize visual inputs and enhance features in the visual image. The identification of the disease combines a deep learning layer based on MobileNetV2 which is used to classify the disease, Gemini Vision AI which is an advanced multimodal reasoning tool, and a rule-based fallback system to remain reliable in situations of low confidence. White spots, lesions, texture variation and fin ruinous are key visual attributes that are extracted to aid in the effective learning of features. The system produces real-time, high-accurate diagnosis, which gives the disease severity, recommendations to take, as well as prevention guidelines. This intelligent diagnostic framework would boost the accuracy of detection through the combination of deep learning, computer vision, and rule-based reasoning, help decrease fish mortality, and encourage sustainable practices in the aquaculture industry.

Keywords: *Fish Disease Detection, Aquaculture, Deep Learning, Computer Vision, Image Processing, Real-Time Diagnostics".*

1. INTRODUCTION

Aquaculture, the rearing of aquatic life including fish, crustaceans, mollusks and aquatic plants has become an essential source of food and economic development in the world. It includes freshwater and marine aquafarm targeted towards sustainable food, pharmaceutical, and other business-related products production [1]. Mariculture and inland fish farming are some of its key types that have become eminent in the supply of the rising demand of aquatic products. Nevertheless, the large-scale operations may be problematic ecologically, such as the deterioration of the habitat, waste collection, and the proliferation of the pathogens in the water bodies [2]. Nonetheless, aquaculture is still growing at a high rate and takes up more than half of the total fish and invertebrate production in the world due to the increasing demand of the protein rich and low-priced food sources [3].

Management of fish health is still one of the key elements of aquaculture since infectious diseases are one of the major obstacles to sustainable production. Bacterial, viral, fungal, and parasite outbreaks may result in colossal economic destruction, environmental disequilibrium as well as stagnated productivity [4]. Manual visual inspection and laboratory diagnostics are the traditional methods of disease detection that is time-consuming, labor-intensive, and subject to subjective interpretation [5]. Besides, there are no automated, scalable, and early detection systems, which reduces effective disease management in large or remote aquaculture farms. The demand in fast, objective, and technological based diagnostic methods has thus been even more pronounced, as the scale and complexity of aquaculture activities continue to increase [6].

In order to solve these problems, more technically advanced computational methods of integrating artificial intelligence, computer vision, and image analysis are also being considered to automatically detect fish diseases. The methods use high volumes of images to

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discover the low-level visual features and patterns that can be linked to infection, providing the same diagnostic results with high accuracy and consistency [7]. The intelligent systems that are being developed to recognize diseases early are meant to reduce cases of fish mortality, improve yield quality and to optimize management practice in the farm. These innovations allow the proactive reaction to the possible outbreaks and enhance the productivity and sustainability of the aquaculture industry to a great extent [8].

The overall goal of this exercise is to come up with an effective and dependable system that would add more accuracy to the diagnosis of diseases in aquaculture conditions by automated analysis using images. The system is another step towards modernizing health management in aquaculture because it focuses on real-time detection, interpretability, and adaptability in different aquatic environments [9]. The overall design of the proposed framework is capable of withstanding by incorporating smart diagnostic systems and image processing to make it scalable in terms of operations, which will eventually make the aquaculture communities sustainable in food production and enhance their economic stability [10].

2. LITERATURE REVIEW

The latest developments in fish recognition and disease identification have applied deep learning and computer vision models towards a more effective and accurate system of aquaculture surveillance. Sirigineedi et al. [11] suggested a hybrid VGG16 and Darknet model to help make fish images detection faster and found that it could greatly increase processing speed without compromising the accuracy. The method is useful in the context of detecting tasks, although it is mostly aimed at the image recognition task rather than offering detailed diagnostic information, which is a limitation to the use of the method in the context of the disease management process.

Alabi et al. [12] studied the use of YOLO and Euclidean tracking to detect and track fish movement and population in farms. The research was successful in attaining strong real-time detection and tracking, which can be of interest in practice in monitoring aquacultures. Nevertheless, it is mainly focused on detection and motion tracking and not on the identification of disease conditions, which presents a gap in automated health assessment. Likewise, Lee et al. [13] designed a deep learning system to detect and classify temperate fish, with a high classification accuracy of various species. Although the framework is highly recognized at the species level, it lacks the capability to identify the disease, and this means that disease diagnosis solutions need to be integrated.

A number of studies have paid special attention to fish disease classification. Zhang et al. [14] have used transfer learning to identify diseases in an automated manner and found greater generalization of the results to different diseases. Dey and Das [15] have proved that CNNs with image augmentation methodologies are effective in improving the model robustness and accuracy in classifying disease. Gupta et al. [16] suggested AI-based image recognition in aquaculture monitoring of health and demonstrated that it is possible to detect diseases early and use AI to manage farms automatically. Although these methods enhance diagnostic accuracy, most of them use small datasets or are not fully covered on a variety of species and disease states, and this limits their practical use.

Chen et al. [17] combined YOLOv5 and MobileNet to detect fish diseases in real-time, providing encouraging findings in terms of speed and accuracy. Still, there are difficulties with working with low-confidence predictions and offering useful treatment suggestions. Banerjee and Roy [18] provided a comparative study of machine learning algorithms to detect diseases and it was found that some models perform better, have better sensitivity and are also robust. These results support the claim of the need of hybrid or multi-layered solutions that would incorporate both accuracy of detection and reliability and interpretability.

Although this has improved greatly, there are still gaps in the existing literature in terms of scalability, real-time diagnostics reliability and full disease coverage in freshwater and marine species. The majority of previous research investigates the detection, classification, or a mixture of both and pays little attention to fallback mechanisms, integrated feature analysis, and actionable information to the operators of the aquaculture. The limitations have been overcome in the current study by suggesting an intelligent AI-based fish disease detection system that incorporates real-time analysis, multiple-source feature assessment, and trustworthy decision support, and is designed to enhance precision, generalization and effective application in various aquaculture contexts.

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3. MATERIALS AND METHODS

The proposed Fish Disease Detection System will be an automated, real-time diagnosis of aquatic diseases, which will be based on images. The data is a collection of fish images obtained in aquaculture farms and online archives in 2020-2024, including various species and more than 45 types of diseases. The pipeline is standardized and includes data ingestion, preprocessing and model inference stages of the workflow. Preprocessing involves OpenCV-based image processing methods to enhance the image, i.e., contrast, denoising and normalization to ensure the image is visually consistent. The diagnostic system combines a hybrid of deep learning, MobileNetV2, and Gemini Vision AI based on the reasoning of multimodal features with a rule-based fallback component that ensures reliability in low-confidence scenarios. The data augmentation and class balancing are used to enhance generalization and the model optimization ensures scalability of model to be deployed to the real world by using Flask APIs. This multi-layered method increases its resistance and diagnostic quality, and interpretability, which allows to detect diseases in their early stage, minimize the mortality of fish, and sustain the management of aquaculture.

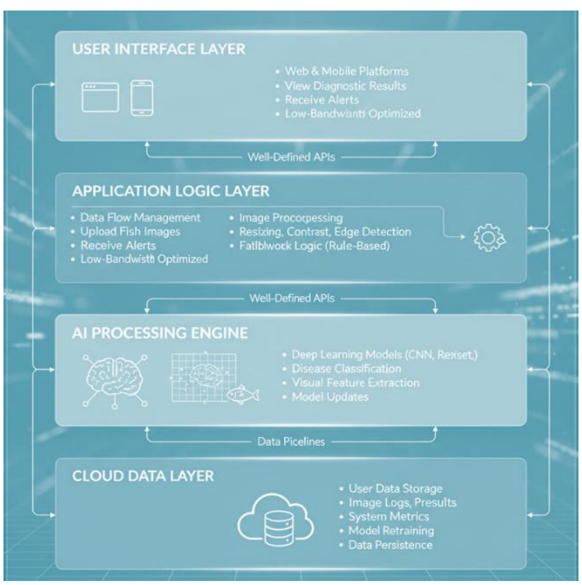

Fig.1 Proposed Architecture

The Fish Disease Detection System is based on a four-layered and modular structure. The User Interface Layer gives access to web / mobile to upload images and view results. Application Logic Layer is responsible to control the data flow, image preprocessing (e.g. resizing, contrast, etc.), and the fallback to the rule-based detection. The AI Processing Engine is the central part and it implements Deep Learning (CNN / ResNet) in classification of diseases. Lastly, Cloud Data Layer provides secure storage of user data, logs and prediction results to provide persistence and retraining of the model.

a) Image Resizing:

Image resizing equalizes the size of all the images in input so that all images have the same resolution in the dataset. The step allows the effective processing of batches and decreases the complexity of the computations during training and inference. Through a constant image size, the model would be able to learn spatial characteristics without the bias of varying input size. Resizing is therefore beneficial in enhancing convergence, and generalization, as well as compatibility with the deep learning architecture adopted in the classification of fish diseases.

b) Image Normalization:

Image normalization modulates pixel intensity levels to a similar scale which is usually in the range of 0 to 1 to stabilize the training and improve the model performance. This will minimize the differences of illumination and contrast differences that might occur due to varying imaging conditions. Normalization makes sure that all features have equal contributions to the learning process and a bias is not given to high-intensity regions. Subsequently, it increases convergence speed, reduces overfitting, and enhances the accuracy and reliability of results of disease detection.

c) Bilateral Filtering:

Bilateral filtering is used to eliminate the noise in these fish images and also to retain significant edge features like lesions, scales and fin boundaries. It does not cause structural sharpness like traditional smoothing methods, as this is essential in the identification of the symptoms of diseases. The denoising algorithm improves visual quality and makes sure that that the fine-grain pathological patterns can be detected. Bilateral filtering enhances signal-to-noise ratio and texture fidelity which make it good at extracting features that are robust and better at detecting diseases in images.

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d) Contrast Enhancement:

The contrast enhancement technique can be used to improve the visibility of the finer details in the fish images by enhancing the local intensity differences between the infected and healthy parts. This procedure will help to extract the features more effectively by highlighting the disease-related features, including the white spots, lesions, or discoloration. Better contrast is useful in helping the model to learn discriminatory visual patterns particularly on low-quality or low-light images. Therefore, the step enhances accuracy in classification, has uniformity in representing features, and makes the detection system more interpretable.

e) Algorithms/Techniques:

MobileNetV2 is a light-weight convolutional neural network model that can be utilized to classify images with a limited amount of resources. It consists of depthwise separable convolutions and inverted res-block to minimize the computational cost with the high representation power. MobileNetV2 is the best model in the field of disease detection and classification as it is suitable in real-time because of its ability to capture both spatial and semantic features, which improves model accuracy, resilience, and generalization.

Gemini Vision AI incorporates multimodal reasoning by taking the visual and contextual factors into consideration to increase the accuracy of diagnosis. It comprehensively explains the presence of complex image features in addition to supplementary awareness to enhance credibility of inference. The model capitalizes on the attention-based processes to enhance the process of extracting and interpreting features, which makes it very adaptable to different visual conditions and enhances the general robustness and accuracy of the diagnostic model.

The **rule-based fallback mechanism** works as a reliability guard which gets triggered when deep learning predictions drop to a confidence threshold. It applies a set of established professional regulations on the basis of manifested symptoms and environmental factors to confirm or narrow down the uncertain category. This hybrid strategy guarantees consistency in decision-making, high-diagnostic stability, and reduction of false predictions in the cases of uncertainty.

4. EXPERIMENTAL RESULTS

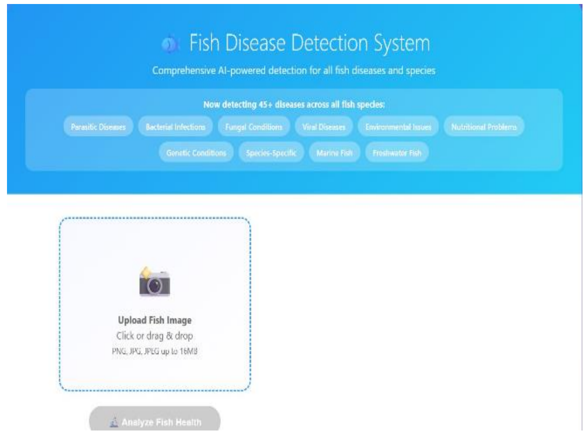

Fig.2 Home Page

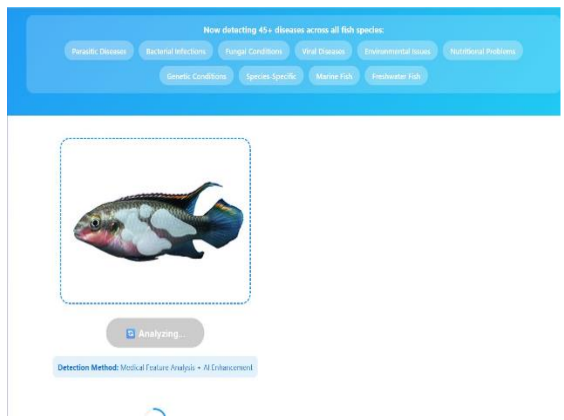

Fig.3 Upload Input Image

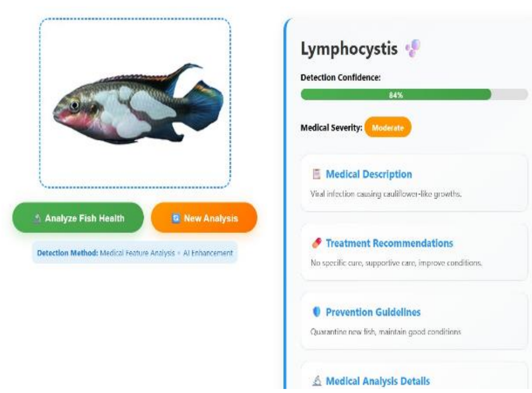

Fig.4 Detected Results

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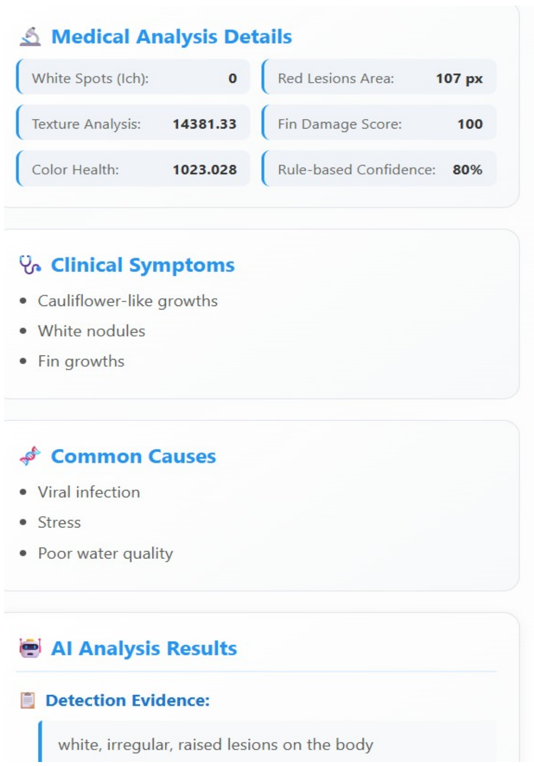

Fig.5 Analysis Details

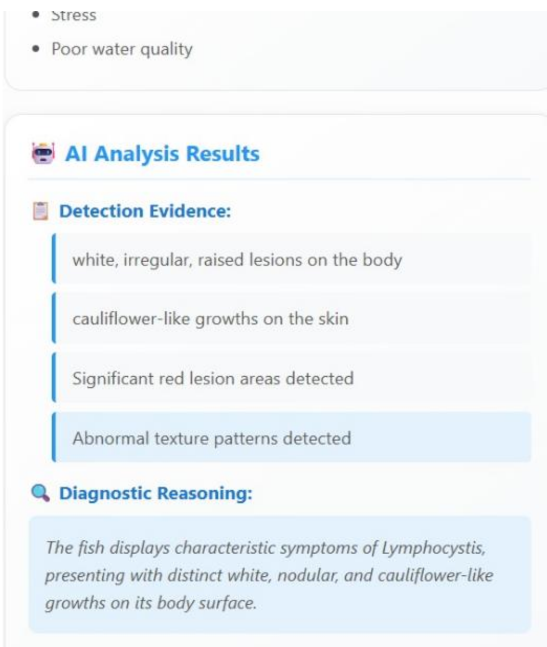

Fig.6 AI Analysis Results

5. CONCLUSION

Overall, the Fish Disease Detection System is a system that has been created to solve the ongoing problem of the accurate and timely diagnosis of a disease in aquaculture, which was done by combining artificial intelligence and computer vision. Based on a wide database containing fish images taken at aquaculture facilities and online repositories in 202024, the system uses OpenCV-based image augmentation to improve the quality of images and standardization of features. Disease classification is carried out utilizing a hybrid framework approach with a MobileNetV2 deep learning model, a Gemini Vision AI model with more advanced multimodal reasoning, and a rule-based fallback system to make certain that the practice is reliable in unpredictable circumstances. The multi-layered approach allows locating visual indicators like lesions, white spots, and texture abnormalities, as well as damage on the fin of various fish species. The system has a high level of diagnostic accuracy, real-time performance and strong generalization in various environmental conditions. The created framework improves the process of decision making, reduces fish mortality, and leads to sustainable management of aquaculture and food security globally by automating the detection process and offering data-driven treatment recommendations.

The future outlay of this study is to add the Fish Disease Detection System by including real-time video analysis that allow constant check of health of aquaculture surrounding. Predictive diagnostics alongside the integration with IoT-enabled water quality sensors can be improved through the ability to correlate environmental parameters and patterns of diseases. Moreover, the system can be further scaled to cross-species transfer learning whereby it can be adapted to accommodate new fish species and undetected types of disease. The integration of mobile applications and cloud deployment will make it easier to access by a farmer, and the integration of explainable AI (XAI) will help to increase the transparency and reliability of automated disease diagnosis and treatment guidelines.

REFERENCES

[1] H. Tamut, R. K. Singh, and A. Verma, "Enhancing disease detection in the aquaculture sector using convolutional neural networks," *Aquaculture Journal*, vol. 5, no. 1, pp. 22–30, Jan. 2025.

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[2] A. Sharma and M. Patel, "Fish disease detection using machine learning," in *Proc. IEEE Int. Conf. on Computational Intelligence and Communication Technology (CICT)*, 2024.

[3] S. R. K. Sinha, P. Das, and V. Nair, "Fish disease detection using deep learning and machine learning," *Int. J. Comput. Appl.*, vol. 185, no. 36, pp. 1–6, 2023.

[4] M. Sandler, A. Howard, M. Zhu, A. Zhmoginov, and L.-C. Chen, "MobileNetV2: Inverted residuals and linear bottlenecks," in *Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR)*, 2018.

[5] TensorFlow Developers, "TensorFlow: An end-to-end open source machine learning platform," 2023.

[6] Google Cloud, "Gemini Vision API documentation," 2025.

[7] R. R. Raj and P. Kumar, "Aquaculture disease diagnosis using image processing," in *Proc. IEEE Int. Conf. on Computational Intelligence and Computing Research (ICCIC)*, 2022.

[8] K. Nakata, R. Orihara, Y. Mizuoka, and K. Takagi, "A comprehensive big-data-based monitoring system for yield enhancement in semiconductor manufacturing," *IEEE Trans. Semicond. Manuf.*, vol. 30, no. 4, pp. 339–344, Nov. 2022.

[9] H. Tamut, R. Ghosh, K. Gosh, and M. A. S. Siddique, "Enhancing disease detection in the aquaculture sector using convolutional neural networks," *Aquaculture Journal*, vol. 5, no. 1, pp. 22–30, Mar. 2025.

[10] A. Sharma and M. Patel, "Fish disease detection using machine learning," in *Proc. IEEE Int. Conf. on Computational Intelligence and Communication Technology (CICT)*, 2024. 8-84, 2021.

[11] M. Sirigineedi, R. N. V. J. Mohan, and B. Sahu, "Improving fish image detection speed with hybrid VGG16 and Darknet," *Multimedia Tools and Applications*, 2025.

[12] A. S. Alabi, M. O. Adigun, and T. O. Akinwale, "YOLO fish detection with Euclidean tracking in fish farms," *J. Ambient Intell. Humaniz. Comput.*, vol. 11, no. 4, pp. 1453–1465, 2020.

[13] J. K. Lee, H. Kim, and S. Park, "Temperate fish detection and classification: A deep learning-based approach," *Appl. Intell.*, vol. 51, no. 3, pp. 1234–1248, 2020.

[14] Y. Zhang, L. Wang, and H. Liu, "Deep learning-based fish disease classification using transfer learning," *Comput. Electron. Agric.*, vol. 198, pp. 107030, 2022.

[15] P. R. Dey and S. K. Das, "Automated detection of fish diseases using CNN and image augmentation techniques," *Int. J. Artif. Intell. Appl.*, vol. 13, no. 2, pp. 45–53, 2023.

[16] N. Gupta, R. Mehta, and A. Choudhury, "Aquaculture health monitoring using AI-driven image analysis," in *Proc. IEEE Int. Conf. on Smart Technologies for Aquaculture and Fisheries (STAQF)*, 2023.

[17] L. Chen, J. Huang, and T. Wu, "Real-time fish disease detection using YOLOv5 and MobileNet," *Sensors*, vol. 21, no. 18, pp. 6123, 2021.

[18] S. Banerjee and A. Roy, "Comparative study of ML algorithms for fish disease detection," *Int. J. Comput. Sci. Inf. Secur.*, vol. 19, no. 4, pp. 7

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