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ROLE OF ARTIFICIAL INTELLIGENCE IN FISH HEALTH MANAGEMENT: A REVIEW

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ABSTRACT

Aquaculture is one of the fastest growing food producing sectors worldwide, contributing significantly to food security, nutrition, and the global economy. But disease outbreaks remain a serious problem, threatening sustainability and causing huge financial losses. Recent advancements in artificial intelligence (AI) provide new opportunities for early diagnosis, disease prediction, behavioral monitoring and decision support systems to improve fish health. This review examines the application of AI in fish health management, with an emphasis on machine learning, computer vision, sensor based systems and predictive modeling. The study also highlights current applications, limitations, and future prospects of AI in sustainable aquaculture practices.

KEYWORDS

Fish, Artificial Intelligence, Health Management, Sustainable Aquaculture.

INTRODUCTION

Aquaculture constitutes over 50% of the global fish supply; nevertheless, disease outbreaks consistently jeopardize productivity and profitability. For large-scale operations, traditional disease monitoring techniques like visual inspection and laboratory-based diagnostics are frequently labor-intensive, time-consuming, and less successful. Rapid digital change has made artificial intelligence (AI) a potent tool for transforming aquaculture health management through the integration of predictive analytics, automated illness diagnosis, and data-driven decision-making.

ARTIFICIAL INTELLIGENCE AND ITS RELEVANCE IN AQUACULTURE

Artificial Intelligence refers to computational methods that mimic human intelligence to solve complex problems. In aquaculture, AI technologies are increasingly used for: Disease detection and classification, Monitoring fish growth, health, and welfare, Water quality prediction and control, Optimizing feeding strategies and Risk assessment & decision support systems.

APPLICATIONS OF AI IN FISH HEALTH MANAGEMENT

Disease Diagnosis and Prediction

Machine Learning (ML) Models: Algorithms such as Support Vector Machines (SVM), Random Forest, and Deep Neural Networks have been used to classify healthy vs. diseased fish based on behavioral, morphological, and environmental data.

Computer Vision: AI-powered image recognition can detect early signs of diseases (skin lesions, discoloration, abnormal swimming) with high accuracy.

Predictive Analytics: AI models can forecast disease outbreaks by analyzing water parameters Like Temperature, pH, Dissolved Oxygen, Free CO_2, Alkalinity and Total Hardness etc., Stocking Density, and Historical Disease Data.

Behavior Monitoring

Stress or illness is frequently indicated by abnormal swimming patterns, decreased feeding, or crowding tendencies. Early intervention is made possible by AI-based video surveillance systems that can identify abnormal behavior and follow movement patterns.

Environmental Monitoring

Water quality is a critical determinant of fish health. AI integrated with Internet of Things (IoT) sensors enables continuous monitoring of parameters such as dissolved oxygen, ammonia, and turbidity. AI models predict threshold breaches and provide early warnings to farmers.

Feeding and Nutrition Management

Uneaten feed leads to water pollution and stress, indirectly affecting fish health. AI-based feeding systems optimize feed supply using real-time data, reducing stress, improving immunity, and minimizing disease risk.

Case Studies and Current Implementations

India: Pilot projects using AI-driven mobile applications help small-scale farmers diagnose fish diseases through uploaded images and water quality inputs.

Norway: Deep learning models are applied in salmon aquaculture for detecting sea lice infestations using underwater cameras.

China: AI-based monitoring systems track fish swimming behavior to predict bacterial disease outbreaks.

Advantages of AI in Fish Health Management

- Early and accurate disease detection.
- Real-time monitoring and automated decision-making.

- Reduced dependency on manual observation.
- Improved sustainability and profitability in aquaculture.

Challenges and Limitations

- High cost of AI infrastructure (sensors, cameras, computing systems).
- Lack of skilled manpower for AI model development and operation.
- Data scarcity and variability across species and environments.
- Limited adoption by small-scale farmers due to economic constraints.

Future Perspectives

- Development of low-cost, farmer-friendly AI tools.
- Integration of AI with big data, genomics, and biotechnology for precision fish health management.
- Cloud-based platforms for real-time disease forecasting and farmer advisory services.
- Increased collaboration between researchers, technology companies, and aquaculture industries.

CONCLUSION

Artificial Intelligence is transforming fish health management by enabling early disease detection, predictive modeling and efficient monitoring systems. While challenges such as cost, data limitations, and technical expertise remain, the potential of AI to enhance sustainability and productivity in aquaculture is undeniable. Continued research, innovation, and farmer-centric AI solutions will play a pivotal role in ensuring fish health and global food security.

In conclusion, artificial intelligence (AI) is a ground-breaking development in the management of fish health and has the potential to improve aquaculture's resilience, productivity, and sustainability. AI-enabled systems will be crucial in determining the direction of global aquaculture with ongoing innovation, favorable regulations, and easier access to technology.

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