



Artificial Intelligence in Freshwater Fisheries: Applications, Opportunities, And Future Prospects

Dr. A. N. Dede

*Assistant Professor, Department of Zoology,
Dahiwadi College Dahiwadi, Tal. Man, Dist. Satara (M.S) India.*

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Abstract:

Freshwater fisheries are essential for global food security, nutrition, and the livelihoods of many people. However, these fisheries face several challenges, such as overfishing, disease outbreaks, climate change, and poor resource management practices, all of which threaten their long-term sustainability. Artificial Intelligence (AI) has become a valuable tool in tackling these issues by supporting data-driven decisions, automation, and predictive analysis. This paper explores how AI is applied in freshwater fisheries, covering areas such as fish population assessment, water quality monitoring, disease identification, feeding optimization, and ecosystem management. The study examines the advantages, limitations, and potential future developments of AI-based technologies in the sustainable management of freshwater fisheries.

Keywords: *Artificial Intelligence, Quality, Machine, Fish, Aquaculture.*

Introduction:

Freshwater fisheries play an important role in providing protein and supporting livelihoods, particularly in developing countries. Traditional methods of managing fisheries often depend on manual monitoring, field surveys, and decisions based on experience. These approaches can be slow and less accurate. The growing use of Artificial Intelligence (AI), including machine learning (ML), deep learning (DL), and computer vision, has introduced new ways to enhance efficiency, sustainability, and productivity in freshwater fisheries. AI supports real-time monitoring, accurate predictions, and automated systems, making it a useful tool for modern fisheries research and management. The application of AI and automation in conventional animal husbandry and aquaculture presents a promising approach. This can reduce the need for human labor, improve current production

efficiency, and contribute to higher output, better product quality, and more convenient operations.

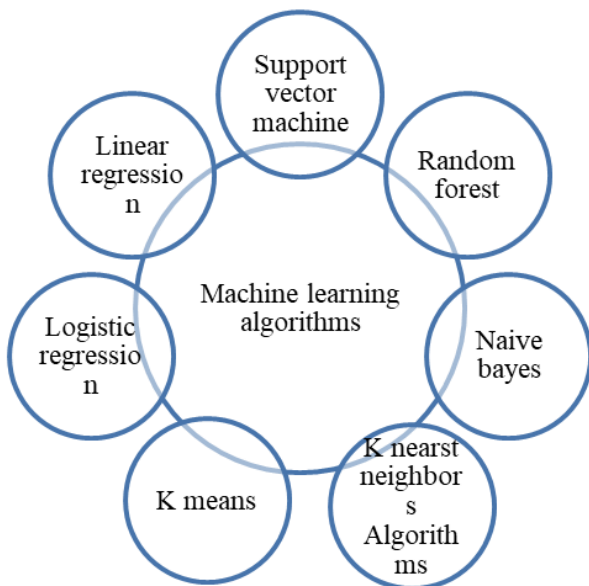
AI can identify animals of different weights and stages, feed them accordingly, and increase the efficiency of high-quality feeding through the use of modern animal husbandry and aquaculture technologies (Yongqiang *et al.*, 2019). The most well-known AI approach is solving problems by interpreting and executing automated intelligent tasks. The use of AI models based on modern data science methods is rapidly increasing in other areas. At the same time, within the aquaculture industry, these technologies have not yet been fully utilized (Yang *et al.*, 2020). The present study investigates the advantages, limitations, and potential future developments of AI-based technologies in the sustainable management of freshwater fisheries.

Concept of Artificial Intelligence in Fisheries:

Artificial Intelligence refers to the ability of machines to mimic human intelligence, including learning, reasoning, and solving problems. In fisheries research, AI systems process large amounts of data collected from sensors, satellites, cameras, and past records to find patterns and make predictions. Important AI techniques used in freshwater fisheries as given bellow.

A) Machine Learning algorithms:

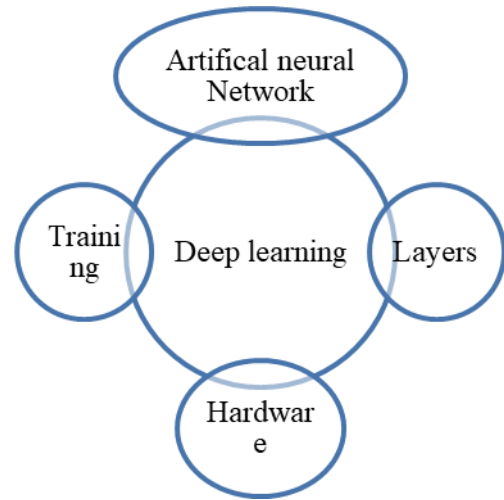
These techniques allow computers to learn from data and make predictions or take actions without being programmed step by step. Machine learning can examine large datasets from fish farming to find patterns, make predictions, and offer insights. Common methods used in fish farming include supervised learning, unsupervised learning, and reinforcement learning (Alzubi *et.al.*,2018).



B) Neural Networks:

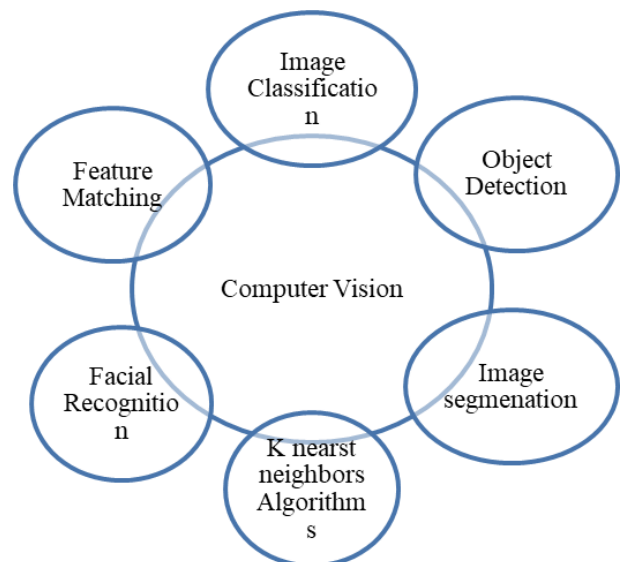
Deep learning is a type of machine learning that uses multiple layers of neural networks. It is good at handling complex and unstructured data, such as images, sounds, and text. In aquaculture, deep learning methods like convolutional neural networks (CNNs) are used for tasks like identifying fish, detecting diseases,

and monitoring fish behavior through images (Chase *et al.*, 2023).



C) Computer Vision:

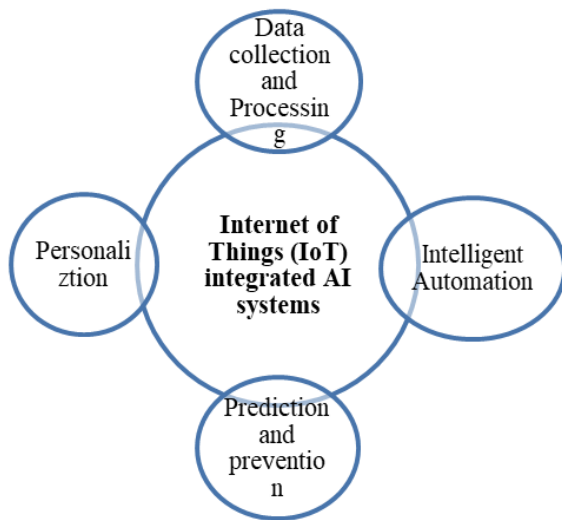
Computer vision combines image processing, pattern recognition, and machine learning to help machines understand and interpret visual information. In aquaculture, computer vision is used for tasks such as counting fish, estimating their size, detecting diseases, and monitoring their behavior and feeding patterns (Li *et al.*, 2022).



D) Internet of Things (IoT) integrated AI Systems:

Research in AI, cloud computing, and IoT is influencing every area of human activity.AI is

becoming stronger and more dependable, making it widely used to solve complex problems (Mohan *et al.*, 2017). IoT technologies have transformed fish farming by using sensor networks to measure factors like pH, temperature, and other important values. Fish farm management can be automated, allowing it to be monitored from a distance. This saves time and money, making fish farming more efficient and environmentally friendly.



Applications of AI in Freshwater Fisheries:

Fish Stock Assessment:

AI models use data on catches, growth rates, and environmental conditions to estimate the number and spread of fish. Machine learning improves the accuracy of stock evaluation compared to traditional methods, supporting sustainable fishing practices. These intelligent algorithms use statistical methods and mathematical models to estimate fish populations, check their health, and set sustainable harvest limits. This helps authorities and fishermen make informed decisions to ensure long-term sustainability (Mosallanezhad *et al.*, 2023).

Water Quality Monitoring:

AI-enabled sensors continuously track parameters like temperature, pH, dissolved oxygen, turbidity, and ammonia levels. Predictive AI models can foresee changes in water quality

and warn farmers of possible dangers, thus reducing fish deaths. The use of computer monitoring and automation in aquaculture opens up new opportunities for smarter fish farming. Aquaculture managers need to keep an eye on the environment, water quality (including dissolved oxygen, temperature, pH, ammonia, chlorophyll, nitrogen, nitrite, etc. (Sivakumar *et al.*, 2021)

Disease Detection and Health Management:

Computer vision and deep learning are used to identify fish diseases by analyzing images and videos. AI systems can detect unusual behaviors, injuries, or color changes early on, allowing for timely responses and lowering economic losses. By detecting early signs of illness, farmers can take proactive measures to prevent the spread of diseases and minimize the use of antibiotics or chemicals (Shivaprakash *et al.*, 2022).

Feeding Optimization:

AI-based feeding systems study fish behavior, appetite, and growth to adjust feed amounts and times. This reduces wasted feed, lowers production costs, and lessens environmental harm. AI can support the creation of fully autonomous aquaculture systems. Underwater drones with AI can track fish populations, inspect cages, and identify problems like fish escapes or damaged structures. Automated feeding systems adjust feed delivery based on current data (Wu *et al.*, 2022).

Habitat and Ecosystem Management:

AI tools assist in mapping freshwater habitats, predicting climate change effects, and assessing biodiversity. These applications support conservation planning and ecosystem-based fisheries management.

Advantages of AI in Freshwater Fisheries:

- More accurate and efficient data analysis
- Early detection of diseases and environmental stress

- Lower operational costs
- Higher productivity and sustainability
- Real-time monitoring and decision support

Limitations and Challenges:

Although AI has many benefits, its use in freshwater fisheries faces several challenges:

- High initial costs
- Limited technical skills among farmers
- Issues with data availability and quality
- Ethical and data privacy concerns

Future Prospects:

Combining AI with IoT, remote sensing, and cloud computing is expected to greatly impact freshwater fisheries research. Future advancements may include fully automated smart fish farms, AI-based policy support systems, and advanced strategies for climate-resilient fisheries management. Building capacity and making technologies more affordable will be crucial for widespread use.

Conclusion:

Artificial Intelligence has a great potential to change freshwater fisheries research and management. By improving monitoring, prediction, and decision-making, AI contributes to the sustainable use of resources and better fish production. Continuous research, innovation, and cooperation among stakeholders are needed to fully realize the potential of AI in freshwater fisheries.

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