

Artificial Intelligence and Its Role in the Fisheries Sector

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Introduction

Artificial Intelligence (AI) is transforming industries worldwide, from healthcare and finance to manufacturing and agriculture. One sector where AI is making a significant impact is fisheries. As the global demand for seafood rises and concerns about overfishing and sustainability grow, AI offers innovative solutions to enhance productivity, ensure environmental conservation, and optimize the fishing industry.

This article explores the fundamentals of AI, its key components, and its vital role in revolutionizing fisheries.

Understanding Artificial Intelligence

AI refers to the simulation of human intelligence in machines, enabling them to learn, reason, and make decisions. AI systems rely on vast amounts of data and sophisticated algorithms to perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, and solving complex problems.

Types of AI

Narrow AI (Weak AI): Designed to perform specific tasks, such as voice recognition (e.g., Siri, Alexa) or image classification.

General AI (Strong AI): A hypothetical AI system capable of performing any intellectual task that a human can do, including learning, reasoning, and decision-making at a human level.

How AI Works

AI systems function by mimicking human cognitive processes through the following steps:

Data Collection: AI requires large datasets to learn and function effectively.

Learning Algorithms: AI models use machine learning techniques, such as supervised learning, unsupervised learning, and reinforcement learning, to identify patterns and make predictions.

Neural Networks & Deep Learning: Inspired by the human brain, these systems process complex information for tasks like speech and image recognition.

Natural Language Processing (NLP): Enables AI to understand and process human language.

Decision-Making & Continuous Improvement: AI continuously refines its performance based on

new data and feedback. Figure 1 represents the working of AI

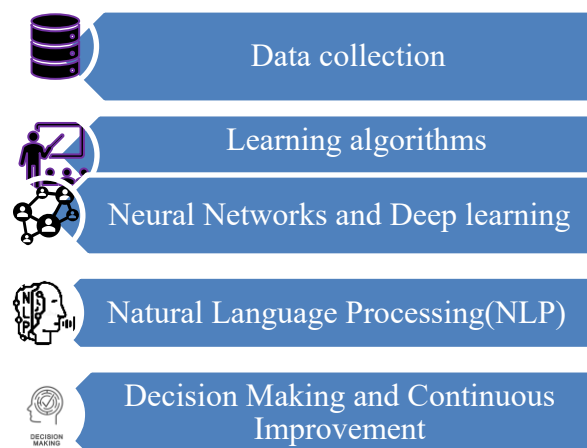


Figure 1: Working of AI

AI in the Fisheries Sector

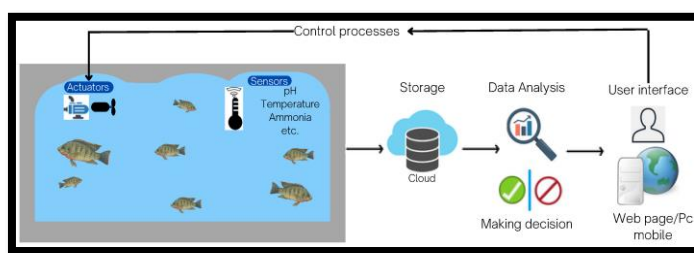
The fisheries industry faces multiple challenges, including overfishing, declining fish stocks, environmental degradation, and inefficiencies in aquaculture. AI-powered technologies provide solutions that enhance sustainability, boost productivity, and improve decision-making.

1. Fish Stock Assessment & Monitoring

AI plays a crucial role in tracking fish populations and assessing marine ecosystems through advanced technologies like sonar and radar systems, satellite imaging, and acoustic data analysis. By interpreting sonar signals, AI can more accurately estimate fish biomass. Machine learning models analyze satellite and aerial data to monitor fish movements and identify signs of overfishing. Acoustic analysis helps detect species-specific sounds, enabling researchers to assess population density and biodiversity. These innovations lead to more precise fish stock assessments, support the development of sustainable fishing quotas, and help prevent overfishing, ultimately fostering healthier marine ecosystems (Maurya et al., 2024).

2. Precision Aquaculture

AI-powered smart farming systems are transforming fish farming by using advanced technologies to optimize operations. IoT sensors are deployed to monitor essential water quality parameters such as pH, temperature, and oxygen levels, ensuring an ideal environment for fish. Automated feeding systems adjust the amount of feed in real-time, minimizing waste and maximizing efficiency. AI surveillance, including drones and underwater cameras, tracks fish behavior and detects potential diseases, enabling early



Source: (Contreras et al., 2024)

Figure 2: AI in precision

intervention and better management. As a result, the impact of these innovations includes increased fish yield, reduced feed waste, and improved water quality and fish health, fostering more sustainable and productive aquaculture practices. (Contreras et al., 2024). Figure 2 represents role of AI in precision aquaculture.

3. Disease Detection & Prevention

AI plays a crucial role in fish disease detection and prevention through image recognition, predictive analytics, and AI-assisted treatment. Image recognition detects early signs of disease by analyzing fish skin, gills, and eyes—often spotting symptoms invisible to the human eye. Predictive analytics monitors environmental factors like water temperature, salinity, and oxygen levels to anticipate potential outbreaks. Based on this data, AI-assisted systems suggest targeted treatments, minimizing the use of broad-spectrum antibiotics. This approach enables early detection, reduces fish mortality, and supports healthier, more sustainable aquaculture.

4. Automated Fish Sorting & Processing

AI significantly improves the efficiency of fish sorting and processing through machine vision, robotic automation, and defect detection technologies. AI-powered vision systems can automatically sort fish by size, species, and quality, offering greater precision and speed than manual methods. Robotic processors further enhance efficiency by automating tasks such as filleting and packaging, reducing reliance on human labor. Defect detection systems identify damaged or substandard fish before packaging, ensuring only high-quality products reach the market. This AI-driven automation results in faster processing, reduced labor costs, and consistent quality control, ultimately boosting productivity and product standards in the fish processing industry (<https://marel.com/fish/>)



Source :<https://marel.com/fish/>

Figure 3: Automated fish sorting and processing

5. Illegal Fishing Detection

AI plays a pivotal role in combating illegal fishing by strengthening fisheries law enforcement through satellite monitoring, AIS data analysis, and automated alert systems. Satellite monitoring helps detect unregistered or suspicious vessels even in remote waters, allowing early identification of illegal activities. AI analyzes Automatic Identification System (AIS) data to track vessel movements and flag patterns indicative of unlawful practices, such as fishing in protected zones. When violations are detected, automated alert systems notify coast guards or authorities for immediate action. These AI-driven interventions reduce illegal fishing, safeguard marine biodiversity, and support the effective enforcement of fishing regulations, thereby promoting sustainable and healthy marine ecosystems (Salvador et al., 2022).

6. Market & Supply Chain Optimization

AI-driven market and supply chain optimization in the fishing industry improves efficiency at every stage. AI helps forecast demand and prices by analyzing past data, allowing better planning and avoiding overproduction or shortages. With blockchain integration, fish can be tracked transparently from farm to market, ensuring authenticity and sustainability. AI-powered smart logistics further enhance delivery by optimizing routes and ensuring proper handling. These advancements lead to higher profits for fishers, reduced food waste, and more consistent prices for consumers.

7. Sustainable Fisheries Management

AI plays a crucial role in conservation and policy-making by offering advanced tools for monitoring and managing marine ecosystems. Through climate change analysis, AI predicts the impact of environmental shifts on fish populations, enabling proactive strategies to protect vulnerable species. AI-driven ecosystem monitoring detects pollution levels and harmful algal blooms, allowing for faster responses to environmental threats. Moreover, AI supports the enforcement of fishing regulations by promoting sustainable practices, thereby reducing overfishing and preserving marine biodiversity. These AI-enabled initiatives contribute significantly to long-term sustainability, the protection of marine ecosystems, and global food security by maintaining healthy fish stocks (Ebrahimi et al., 2021).

Challenges in Implementing AI in Fisheries:

Despite its potential, AI adoption in fisheries faces several challenges:

High Initial Costs: AI technologies require significant investment, which may be unaffordable for small-scale fish farmers.

Data Availability & Quality: AI models rely on large, high-quality datasets, which can be difficult to obtain.

Technical Skills Gap: Fishermen and aquaculture professionals may need specialized training to use AI tools effectively.

Ethical Concerns: AI automation may reduce employment opportunities in traditional fishing communities (Maurya et al., 2024).

Conclusion

Artificial Intelligence is revolutionizing the fisheries sector, making it more efficient, sustainable, and profitable. From monitoring fish populations and optimizing aquaculture to detecting diseases and enforcing fishing laws, AI-driven innovations are reshaping the industry. However, challenges such as high costs, data limitations, and skill gaps must be addressed to ensure AI benefits are accessible to all stakeholders with continued advancements, AI has the potential to balance economic growth with environmental conservation, ensuring a thriving and sustainable future for the global fishing industry.

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