Application of Artificial Intelligence and IoT in Modern Fisheries

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Abstract

Artificial Intelligence (AI) and the Internet of Things (IoT) are revolutionizing modern fisheries by enabling real-time monitoring, predictive analytics, automation, and precision fish farming. The integration of these technologies has improved yield, sustainability, and resource management while minimizing environmental impact. This paper explores the applications, benefits, challenges, and future prospects of AI and IoT in fisheries, including smart aquaculture, fish behavior analysis, disease prediction, supply chain optimization, and environmental monitoring. Emphasis is placed on how digital transformation is shaping the future of fish production and aquatic ecosystem management.

Keywords: Artificial Intelligence, Internet of Things, smart fisheries, aquaculture, fish monitoring, automation, sustainability

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1. Introduction

Fisheries and aquaculture sectors are under increasing pressure to meet the rising demand for seafood while maintaining ecological balance. With climate change, overfishing, and pollution threatening aquatic systems, there is a pressing need for innovative solutions. The integration of **Artificial Intelligence (AI)** and the **Internet of Things (IoT)** into fisheries represents a major leap toward smart, sustainable, and data-driven aquatic food production systems【1】.

AI enables machines to learn from data and perform tasks like prediction, classification, and optimization. IoT refers to a network of sensors and devices that collect and transmit real-time data. Together, these technologies have applications across the entire fisheries value chain—from seed to harvest to market.

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2. Smart Aquaculture Systems

2.1 Real-Time Environmental Monitoring

IoT devices such as water quality sensors monitor parameters like temperature, dissolved oxygen (DO), pH, ammonia, and turbidity in real time. These values are sent to cloud-based systems where AI models analyze trends and detect anomalies【2】.

2.2 Automated Feeding Systems

Smart feeders powered by AI algorithms adjust feed supply based on fish behavior, biomass, and water conditions. This reduces feed wastage and improves the **Feed Conversion Ratio (FCR)**.

2.3 Biomass Estimation and Growth Prediction

Computer vision systems use underwater cameras and AI to estimate fish size and biomass without manual handling, minimizing stress and disease transmission.

Table 1. Key Parameters Monitored in Smart Aquaculture

Parameter	Technology Used	Application
Temperature	IoT sensors, thermometers	Growth rate regulation
Dissolved Oxygen	Optical DO sensors	Prevents hypoxia, controls aeration
Fish Movement	Underwater cameras + AI	Feeding, behavior analysis
Ammonia Level	Chemical probes	Water quality management

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3. Fish Health and Disease Detection

3.1 Early Warning Systems
AI systems trained on historical outbreak data can predict disease occurrence based on water quality, temperature fluctuations, and fish behavior.

3.2 Image-Based Disease Diagnosis
Computer vision, powered by deep learning, can identify signs of external infections, lesions, and abnormal swimming patterns from images and video feeds.

3.3 Wearable Biosensors
Micro IoT sensors attached to fish can detect internal stress markers and metabolic parameters, offering individualized monitoring.

Case Study: eFishery (Indonesia)
eFishery developed an AI-driven platform that automates feeding and collects health data from over 30,000 fish farms. The platform increases yield while reducing feed cost by up to 25%【3】.

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4. Precision Fisheries and Marine Monitoring

4.1 Fish Stock Assessment
AI models analyze sonar data and satellite imagery to estimate wild fish stock levels and migration patterns, improving catch predictions and conservation planning.

4.2 Vessel Monitoring Systems (VMS)
IoT-enabled tracking devices installed on fishing boats transmit GPS location, speed, and engine status. AI algorithms analyze these to ensure compliance with fishing zones and quotas.

4.3 Habitat Mapping
AI uses GIS and remote sensing data to map coral reefs, breeding grounds, and spawning zones for marine spatial planning.

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5. Post-Harvest and Supply Chain Management

5.1 Cold Chain Monitoring
Smart IoT sensors in storage and transport units monitor temperature, humidity, and vibration to prevent spoilage. Blockchain integration ensures traceability and transparency.

5.2 Demand Forecasting
AI tools analyze consumption patterns, market prices, and weather trends to optimize harvest timing and distribution.

5.3 Quality Grading
Machine vision systems inspect fish for defects, size, and freshness—automating grading processes for exports.

Figure 1. AI-IoT Integration in Fisheries Value Chain
(Illustrates connectivity from water monitoring → feeding → harvesting → transport → retail)

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6. Benefits of AI and IoT in Fisheries

Benefit	Description
Increased Efficiency	Automated feeding, real-time monitoring reduce labor and resources
Disease Control	Early detection prevents large-scale fish mortality
Sustainable Practices	Data-driven decisions minimize environmental impact
Profitability	Higher yield, lower input costs, better market alignment
Transparency and Traceability	Blockchain and IoT improve consumer trust and regulatory compliance

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7. Challenges in Implementation

7.1 Cost and Infrastructure
High initial investment and need for internet connectivity can limit adoption in low-income or remote regions.

7.2 Data Management and Security
Large volumes of real-time data require secure storage and processing. Cybersecurity remains a concern.

7.3 Technological Literacy
Fisherfolk may lack the skills to operate digital tools, necessitating extensive training and extension services【4】.

7.4 Standardization
There is a lack of global standards for IoT protocols and AI interoperability in fisheries.

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8. Future Trends and Innovations

8.1 AI-Driven Breeding Programs
AI can identify optimal breeding pairs for traits like disease resistance and growth, reducing trial-and-error.

8.2 Autonomous Drones and Robots

Underwater drones equipped with sonar and AI conduct habitat surveys, clean tanks, and inspect net cages.

8.3 Digital Twin Technologies

Digital twins of fish farms simulate operations in a virtual environment, allowing predictive testing and optimization.

8.4 5G Connectivity

Faster data transfer will support high-definition video feeds, real-time control, and mobile app integration in remote farms.

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9. Case Studies from Around the World

Country	Application	Outcome
Norway	AI-powered salmon monitoring	Increased production by 20%, lower mortality
India	IoT-based shrimp farm sensors	Improved yield and reduced water usage
China	Smart feeding platforms for tilapia	Reduced FCR from 1.7 to 1.3
Chile	Disease prediction in trout farming	Cut antibiotic usage by 40%

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10. Recommendations

For Governments

- Provide subsidies and training for small-scale fishers
- Promote public-private partnerships for tech development
- Establish data-sharing frameworks

For Tech Companies

- Design low-cost, rugged, and user-friendly devices
- Integrate local languages in applications
- Ensure interoperability across systems

For Researchers and Institutions

- Conduct trials for AI models in diverse environments
- Assess the long-term socio-economic impact
- Develop open-source solutions for widespread use

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11. Conclusion

The application of Artificial Intelligence and IoT in modern fisheries marks a new era of precision, sustainability, and efficiency in aquatic food production. These technologies provide actionable insights that enhance productivity, ensure better resource management, and contribute to food security. While challenges remain in affordability and accessibility, the trajectory of innovation indicates that digital transformation in fisheries is inevitable and essential. A multi-stakeholder approach that includes policymakers, researchers, fishers, and tech developers is vital to unlock the full potential of AI and IoT in building resilient and future-ready fisheries.

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