The application of Artificial Intelligence (AI) in fishing technology and aquaculture

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Abstract:

The utilization of Artificial Intelligence (AI) in fishing technology and aquaculture has emerged as a transformative force in the sustainable management and production of seafood. In fishing technology, AI-driven innovations such as autonomous vessels and intelligent fish locating systems optimize fishing operations, enhancing catch efficiency while reducing environmental impact. Real-time monitoring and predictive analytics aid in informed decision-making, ensuring responsible fishing practices and preserving fish stocks for future generations. Furthermore, AI fosters seafood traceability and supply chain transparency, instilling consumer confidence in ethically sourced products. In aquaculture, AI plays a pivotal role in precision farming by analysing environmental data, optimizing feed management, and monitoring fish health. This results in increased productivity, reduced resource wastage, and minimized environmental footprint. AI applications contribute to sustainable aquaculture practices, promoting environmental conservation and responsible resource management. However, as AI adoption accelerates, ethical considerations and data privacy concerns must be addressed. Striking a balance between technological advancement and environmental preservation is vital to safeguard marine ecosystems and support fishing communities' livelihoods. Future research and collaboration among stakeholders are necessary to maximize AI's potential benefits and navigate challenges effectively. Embracing AI in fishing technology and aquaculture offers unparalleled opportunities to meet global seafood demand sustainably, ensuring the continued health and productivity of our oceans for generations to come.

Keywords:- AI feeding device, Disease Prediction by AI, Artificial Intelligence Drones in fisheries, Fish Seed Selection by AI, AI in Fish Processing

technology, AI in Endangered aquatic animal Conservation, Control of IIU by AI.

Introduction:

Think of a world having robots that could independently think and work according to our needs. This is made acceptable by Artificial Intelligence (AI) and the Internet of Things (IOT). It is a computerised gadget that has been designed with a simulation of human thinking power.Today, almost 50 billion electronic gadgets use IOT, with a major fraction of them being AI devices. The use of artificially intelligent gadgets has also spread to the agricultural and fisheries sectors. Every aspect of the animal confinement may be monitored, and necessary measures can be taken without the need for human supervision. AI has the benefit of being able to learn via experience. This will aid in the great expansion of the fisheries sector, as the status of the cultural system varies regularly depending on the environment. AI in fisheries not only aids in farm management, but also in open sea fishing by tracking worldwide fishing activities using satellite data. In the last decade, global fish consumption has surged fourfold. Aquaculture has evolved into a field with growing demand and decreasing production. AI-based technology has the potential to increase output while requiring fewer labour.

The application of Artificial Intelligence (AI) in fishing technology represents a transformative shift in the fishing industry, ushering in a new era of efficiency, sustainability, and data-driven decision-making. AI, with its ability to analyze vast amounts of data, learn from patterns, and make intelligent predictions, is revolutionizing how fishing operations are conducted and managed. From autonomous fishing vessels to advanced fish locating systems and sustainable fishing practices, AI is empowering fishery professionals to optimize their processes, reduce environmental impact, and ensure the long-term health of marine ecosystem. In this age of increasing global demand for seafood, overfishing and unsustainable fishing practices pose significant threats to marine biodiversity and the livelihoods of fishing communities. Here, AI emerges as a powerful tool that enables responsible fishery management by providing real-time insights into fish populations, their habitats, and the impact of fishing activities. Moreover, AI-driven technologies are streamlining fish processing, improving traceability, and enhancing compliance with fishing regulations, fostering transparency in the seafood supply chain.

In this chapter, we will explore the diverse applications of AI in fishing technology, highlighting how it is revolutionizing the industry from catch to consumer. By leveraging the capabilities of AI, fishery professionals can navigate the complex challenges of the modern fishing landscape while working towards sustainable practices that preserve marine resources for future generations. From precision fishing and predictive maintenance to environmental monitoring and fish health assessment, AI is paving the way for a more efficient, ethical, and environmentally conscious fishing industry. The application of AI in fishery sciences has the potential to revolutionize the way we manage, monitor, and optimize fisheries, leading to more sustainable practices and improved productivity. In this discussion, we'll explore some of the key areas where AI is being applied in fishery sciences.

1.Fisheries Management and Conservation:

Artificial Intelligence (AI) is revolutionizing fish stock assessment by leveraging advanced algorithms to analyse vast and diverse datasets from acoustic surveys, fishing vessel records, satellite imagery, and environmental data. AI-driven applications enable automated image recognition, accurately identifying and classifying fish species from photographs and underwater video footage, streamlining data collection processes. Real-time monitoring using AI-powered sensors and underwater cameras allows for continuous observation of fish populations and their habitats, enabling timely responses to changes in stock abundance and environmental conditions. AI's predictive analytics capabilities analyse historical fishery data to forecast future trends, facilitating proactive fisheries management and conservation strategies. By integrating data and automating complex tasks, AI empowers fisheries to make informed decisions, promote sustainable fishing practices, and preserve marine ecosystems for future generations.

a.Data Integration and Analysis: AI can process vast and diverse datasets from various sources, including acoustic surveys, fishing vessel logbooks, satellite imagery, and environmental data. By integrating this information, AI algorithms can generate comprehensive and up-to-date assessments of fish stocks, providing a more accurate picture of their status.

b.Automated Image Recognition: AI-powered image recognition systems can identify and classify fish species from photographs or underwater video footage. This automation streamlines data collection processes, reducing the need for manual labor and increasing efficiency in identifying different species.

c.Real-time Monitoring: AI-enabled sensors and underwater cameras can continuously monitor fish populations and their habitats in real-time. This instantaneous data allows fishery managers to respond promptly to changes in fish stock abundance or environmental conditions, ensuring more adaptive and effective management strategies.

d.Predictive Analytics: AI can analyze historical fishery data to predict future trends in fish populations. These predictive capabilities enable fisheries to proactively respond to potential stock fluctuations, adjust fishing quotas, and implement conservation measures before issues escalate.

e.Species Identification: AI algorithms can distinguish between similar-looking fish species, improving the accuracy of stock assessments and enhancing our understanding of species-specific population dynamics.

2. AI Feeding Devices

Feed accounts for around sixty percent of the entire cost of an aquaculture system. Feeding too little or too much might produce a variety of problems in the confinement. Feeding less, on the other hand, might reduce muscle conversion and, in severe circumstances (in shrimps), can result in cannibalism and mutual assault. Excessive feeding, on the other hand, wastes feed and degrades water quality. Appetite measurement can assist in providing the appropriate amount of meal at the appropriate time. AI plays a significant role in interpreting fish using vibration-based sensors and audio inputs. This will aid in differentiating between hungry and overfed fish. An Indonesian aquaculture technology company called 'e Fishery' recently created an AI feed dispenser that distributes the appropriate amount of feed at the appropriate moment[10]. It detects the animal's hunger using a variety of sensors. The tool can save around 21 percent on feed costs. 'Observe technologies' is an organisation that develops artificial intelligence and data processing systems for measuring and tracking cattle feeding patterns. It gives objective and factual information on the amount of feed that farmers must feed. An aquaculture technology business called as 'umitron cell' in Singapore and Japan manufactures a smart fish feeder that can be operated by a remote[11].

Figure 1: e Fishery AI fish feeder

3. Artificial Intelligence Drones in fisheries

Drones connected with sensors may gather and analyse data on water quality such as turbidity, temperature, dissolved oxygen, and even fish heart rates(Jothiswaran et al, 2020).

These data are simply accessible via a Smartphone linked to the drone. With one step forward, scientists created 'shoal,' a robotic fish that aids in the detection of pollutants surrounding the farm site. A Robot-fish detects pollutants far more easily than humans(Jaber at al,2018). These autonomous swimming robots collect data on water quality. They can even converse by using low frequency sound waves.

Fig: robot fish

3. Disease Prediction by AI

Disease outbreaks pose the biggest hazard to fisheries. AI programmes can predict disease epidemics before they occur by comparing programmed data with site-collected data. They can even implement preventative measures. Norway's seafood innovation centre introduced 'Aquacloud' in April 2017, a cloud-based programme that assisted farmers in limiting the growth of sea lice in cages(Jothiswaran et al, 2020).. This lowered fish mortality and reduced the need for more costly treatments.

4. Fish Seed Selection by AI

Fish seed screening is necessary to make sure that fish can develop adequately in their adolescent years or throughout the harvest stage. Fish farming focuses heavily on recognising and selection of viable fish seed. Screening of healthy fish seed may be time-consuming and requires a large number of personnel. The Aquaculture Research Institute at Kindai University in Japan is using Microsoft Azure machine learning studio to recognise and remove odd-shaped fish seed from the rearing cage (Microsoft Asia News Center, 2019).

5. Artificial intelligence in Shrimp Farming

Eruvaka, an Indian startup, offers prawn farmers AI-based solutions like as real-time monitoring of the water's condition and voice call alarm, Appetite-based intelligent feeder, and autonomous regulation of aerators. Eruvaka's products have already been placed on around 1,000 hectares of shrimp farms scattered over Surat, Goa, Andhra Pradesh, and Pondicherry, and farmers are benefiting from AI-based shrimp farming solutions (Dhenuvakonda et al,2020).

6. AI Smartphone Applications in fishery

AI smartphone apps can substantially aid farmers in assessing water quality and detecting illnesses. Aquaconnect, an Indian aquaculture technology start-up, developed a smartphone application called 'FarmMOJO' that assists shrimp farmers in analysing water quality and forecasting illnesses (Dhenuvakonda et al,2020). Farmers may use these applications to avoid disease outbreaks before they occur.Farmers and developers input images of shrimp illnesses, parasites, and other pests into the app on a regular basis.Using these images, the programme may learn about the illnesses and save them for later use (Jothiswaran et al, 2020)..

7. AI in Fish Processing technology

AI can be utilized to automate fish processing and sorting tasks in fishery engineering. Computer vision systems combined with robotic arms can accurately assess the size, quality, and species of caught fish (Lim et al,2022). This automation not only increases processing speed and efficiency but also reduces human errors, ensuring that fish are handled properly to maintain their quality.

Processed seafood is consistently in great demand. Fish and shrimp processing plants have advanced to the point that automated robots complete the task more correctly and in less time, boosting output by several orders of magnitude. AI robots may be designed to cut, fillet, or clean items with high

precision in terms of size, shape, and cleanliness. AI programmes combined with visual image sensors and cameras may do quality control and grading. After being graded, the processed goods can even be packed and distributed by AI robots. This has no manpower expense and requires no human monitoring. 'Marel' is an Icelandic firm that manufactures fish processing machinery. They developed AI-powered robots capable of doing all of the tasks required in a manufacturing plant, including cleaning, filleting, and packaging[10].

Fig: fish felleting unit

8. Control of IIU by AI

The majority of the seafood we eat comes from open sea fishing. Overfishing and smuggling have developed rapidly in response to rising population and demand. Illegal, unregulated, and unreported (IUU) fishing has increased dramatically. To combat this, some organisations have traditionally recruited skilled observers to watch fishing activity aboard ships. However, in places like the Arctic, the temperature and geography made it impossible for observers to trace IUU vessels. AI plays a significant influence in several fields. Image identification and automated assessment of video footages can be used to monitor fishing vessels through satellite and AI programmes. This will aid in the reduction of IUU fishing and the restoration of natural populations. An independent company considered 'Global fishing watch platform' teamed with Google, Oceana, and Sky truth (a non-profit digital mapping agency) to integrate AI and satellite data to better recognise global fishing activities. This partnership enabled more exact tracking of IUU boats, poaching, overfishing, and at-sea transhipments (moving commodities from one ship to another). AI monitoring allows for the collection of data on the size of fishing vessels and the sorts of fishing gear employed (Cipparone et al,2023).

Autonomous Fishing Vessels:

AI-powered autonomous fishing vessels are a game-changer in the fishing industry. These vessels can navigate the seas using advanced GPS and sensor technologies, allowing them to identify optimal fishing grounds based on

factors such as fish density, ocean currents, and weather conditions. Once a suitable location is identified, AI-controlled fishing gear, such as smart trawls or intelligent nets, can be deployed to selectively catch specific fish species while minimizing by-catch and reducing environmental impact.

Unmanned underwater vehicles (AUVs) are pre-programmed submersibles that can travel in three dimensions below water. Over the last decade, technology developments necessary for AUV deployment, mission control, performance, and recovery have advanced significantly. Several vehicles are now working effectively in the offshore sectors, as well as in applied and academic oceanographic sciences (Fernandes et al,2003).

9. **AI in Endangered aquatic animal Conservation**

The number of aquatic creatures is quickly declining as an effect of human activity. Many conservation efforts are done, but the vast water makes human monitoring challenging. AI drones, using vision sensors and cameras, can follow and analyse endangered fishes far quicker than people. Larger fishes, such as sharks and humpback whales, can be monitored by attaching transmitters to their fins (Isabelle et al,2022). This makes researching the behaviours of the creature more easy and helps to conserve the Better.

- **Advantages of Artificial Intelligence in fishery and aquaculture**

I. **Improved Efficiency:** AI can automate various processes, such as data collection, monitoring fish health, feeding, and water quality management, leading to increased operational efficiency and reduced labor costs.

II. **Precision Aquaculture:** AI-powered systems can analyze vast amounts of data, enabling precise monitoring and control of factors like feeding schedules, water temperature, oxygen levels, and nutrient supply. This results in optimized conditions for fish growth and health.

III. **Enhanced Fish Health Management:** AI algorithms can detect early signs of disease or stress in fish, allowing for timely intervention and reduced losses. This proactive approach can lead to improved overall health in fish populations.

IV. **Intelligent Fish Feeding:** AI can predict fish feeding patterns and optimize feeding schedules based on real-time data, reducing food wastage and ensuring fish get the right nutrients at the right time.

V. **Environmental Monitoring:** AI can assist in monitoring environmental factors that affect fish populations, such as ocean currents, temperature

changes, and pollution levels. This information helps in making informed decisions to protect the ecosystem and fisheries.

Disadvantage of AI in fishing technology & aquaculture

1. **Initial Investment and Maintenance Costs:** Implementing AI systems requires significant initial investment and ongoing maintenance costs, which might be a challenge for smaller fishery or aquaculture operations.
2. **Technological Dependence**: Relying heavily on AI systems could create a technological dependency, making fishery and aquaculture businesses vulnerable to disruptions if the technology malfunctions or fails.
3. **Data Privacy and Security Concerns**: AI systems collect and process large amounts of sensitive data, including environmental information and business data. Ensuring data privacy and protecting against cyber threats become crucial concerns.
4. **Limited Adaptability:** AI models might struggle to adapt to unexpected changes in fish behavior, environmental conditions, or disease outbreaks. This limitation could lead to suboptimal decisions and potential losses.
5. **Job Displacement:** The automation of various tasks through AI could lead to job displacement for some workers in the fishery and aquaculture sectors. However, it might also create new job opportunities in AI-related roles.
6. **Ethical Concerns**: The use of AI in aquaculture should consider ethical aspects concerning animal welfare. AI systems must be designed with care to ensure that fish are treated humanely throughout the process.

Conclusion

Even though AI is being developed, total automation is still not possible. Scientists are developing technologies that can function without human intervention.AI aquaculture farms can be maintained and controlled far more easily, with almost 95% operational accuracy.Aquaculture product production may significantly grow if AI is implemented correctly. As a result, unlike in any other industry, the use of AI appears to be inescapable in the ongoing expansion and intensification of fisheries and aquaculture.In fishing technology, AI-powered autonomous vessels and intelligent fish locating systems are optimizing fishing operations, reducing fuel consumption, and minimizing by-catch. Real-time monitoring and predictive analytics enable informed decision-making, promoting responsible fishing practices and ensuring the long-term health of fish stocks.Similarly, in aquaculture, AI is driving precision farming by analyzing environmental data, optimizing feed management, and monitoring fish health. By leveraging AI's capabilities, aquaculture farmers can enhance

productivity, reduce waste, and minimize environmental impacts, advancing towards more sustainable seafood production. In the coming years, continued research and collaboration among stakeholders will be crucial to maximize AI's benefits and address challenges effectively. By harnessing the power of AI, we can forge a more sustainable future for fishing technology and aquaculture, ensuring a balance between meeting global seafood demand and safeguarding the health of our oceans for generations to come.

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