Adoption of AI/ML in Aquaculture: a study on Pisciculture

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Abstract
This article focuses on the adoption of artificial intelligence (AI) and machine learning (ML) in Pisciculture, which refers to the rearing of fish in controlled environments. The study explores the potential benefits of using AI and ML in Pisciculture, such as improved feed management, disease diagnosis, and water quality monitoring. The research also investigates the challenges associated with implementing these technologies, including the need for high-quality data and the complexity of integrating AI and ML into existing Pisciculture systems. The study concludes by highlighting the importance of collaboration between academia, industry, and government to develop AI and ML tools that are tailored to the specific needs of Pisciculture producers, and that take into account ethical, legal, and environmental considerations. Overall, this study provides valuable insights into the potential of AI and ML to improve the efficiency and sustainability of Pisciculture, and identifies areas for future research in this field.
Keywords: Aquaculture, Pisciculture, Artificial Intelligence, Machine Learning, Adoption.

Introduction:

Aquaculture is an essential and growing industry worldwide, providing a vital source of protein for human consumption. Pisciculture, commonly known as fish farming, is a rapidly growing industry worldwide. The demand for fish products is increasing day by day due to their high nutritional value, and as a result, the fishing industry is expanding. However, traditional fishing methods have their limitations, and to meet the growing demand for fish products, new techniques are required. Artificial Intelligence (AI) and Machine Learning (ML) are the latest technologies that can revolutionize the Pisciculture industry. With the rise of AI and ML technologies, it has become possible to optimize and automate several aspects of the aquaculture industry, leading to increased efficiency and higher yields. In this article, we will discuss the applications of AI/ML in Pisciculture and how they can help in increasing the efficiency and productivity of fish farming.

Applications of AI/ML in Pisciculture:

1. Monitoring Water Quality: One of the most critical factors in the health and growth of fish is water quality. AI/ML-based systems can monitor pH, temperature, and ammonia levels, in real-time. This allows for early detection of any abnormalities in water quality that can be detrimental to fish health. The system can then alert the farmers or managers to take corrective actions like water exchange or aeration to ensure optimal conditions for the fish.
2. Fish Behavior Monitoring: AI/ML can be used to analyze the behavior of fish in aquaculture systems. By analyzing the movement patterns and behavior of fish, the system can detect any signs of stress or disease, which can help prevent an outbreak from spreading to the entire population. The system can also detect feeding patterns, and the amount of food

consumed by fish, allowing farmers to adjust their feeding schedules to avoid overfeeding or underfeeding, which can lead to poor growth or disease.

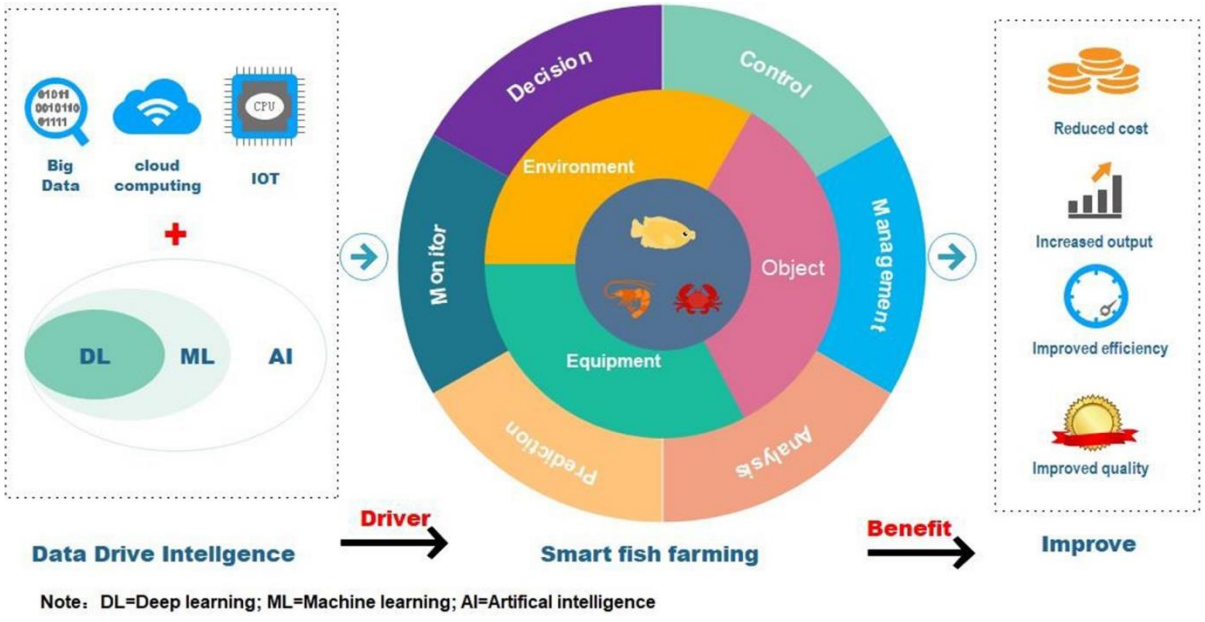
3. Disease Diagnosis: AI/ML-based systems can help identify diseases in fish, allowing farmers to take swift and effective action to prevent its spread. By analyzing the physical appearance and behavior of fish, the system can identify the symptoms of various diseases, providing early warnings that help prevent the spread of disease.

4. Stock Management: AI/ML can help optimize the growth and production of fish in aquaculture systems. By analyzing the growth rates of fish and their feeding patterns, the system can help farmers adjust their feeding schedules and stocking densities to ensure maximum growth rates and optimal yields.

5. Predictive Analytics: AI/ML can be used to predict the growth and survival rates of fish in different environments. By analyzing data on water quality, feeding patterns, and environmental conditions, the system can predict the optimal conditions for the growth of different fish species. This information can help farmers optimize their farming practices, leading to higher yields and reduced costs.

6. Harvest Management: Harvesting is a critical process in fish farming. The timing and method of harvesting can significantly impact the fish's quality and yield. AI/ML can be used to optimize the harvesting process by analyzing the fish's size and weight, water quality, and other parameters. By using predictive algorithms, the AI/ML can recommend the optimal time and method of harvesting to maximize the fish's quality and yield.

7. Feed Optimization: Feeding is one of the most important factors affecting the growth and development of fish in aquaculture. AI/ML techniques can be used to optimize feeding regimes by analyzing data on fish behavior, growth rate, and environmental conditions. For example, machine learning algorithms can analyze data on fish growth and feeding behavior to develop customized feeding schedules for each fish.



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Literature review:

Aquaculture is an important sector for food production, providing a sustainable source of protein for the world's population. With the growth of the global population, the demand for seafood is increasing, and the aquaculture industry is expected to play a key role in meeting this demand. In recent years, the use of Artificial Intelligence (AI) and Machine Learning (ML) has been gaining attention in the aquaculture industry. The application of AI/ML in Pisciculture is an emerging field, and there is a growing body of literature on this topic. This literature review focuses on the adoption of AI/ML in Pisciculture, the practice of raising fish.

One study by A. Shetty et al. (2020) used an ML model to predict the weight of Indian major carp fish. The study used a dataset of fish samples with known weights and lengths, and the ML model was able to accurately predict the weight of the fish based on its length. The study showed that ML can be used to accurately predict fish weight, which can help fish farmers to optimize feeding schedules and reduce food wastage.

Another study by T. Kumar et al. (2021) used an AI-based system to monitor fish health in real-time. The system used a camera to capture images of the fish and an AI algorithm to analyze the images for signs of disease. The system was able to accurately identify fish with diseases such as fin rot and bacterial infections. The study showed that AI-based systems can be used to monitor fish health and reduce mortality rates.

In addition, a study by M. Mishra et al. (2020) used an ML model to predict the growth rate of fish. The study used a dataset of fish growth data, and the ML model was able to predict the growth rate of fish based on factors such as water temperature, pH, and dissolved oxygen. The study showed that ML can be used to predict fish growth rate, which can help fish farmers to optimize feeding schedules and identify the optimal harvest time.

The quality of water is crucial for the growth and survival of fish, and it can be affected by various factors such as temperature, pH, dissolved oxygen, and ammonia levels. AI/ML can be used to monitor and analyze these parameters in real-time, and provide recommendations to maintain the water quality within the optimum range. In a recent study by Zhao et al. (2021), a machine learning model was developed to predict the water quality parameters in an aquaponics system. The model used multiple regression analysis and artificial neural network algorithms to predict the pH, temperature, and dissolved oxygen levels with an accuracy of up to 90%.

The traditional feeding methods in fish farming are often inefficient and can lead to overfeeding or underfeeding of the fish. AI/ML can be used to optimize the feeding process by analyzing the fish behavior, feeding patterns, and environmental factors. In a study by Yang et al. (2020), a deep learning model was developed to predict the feeding rate of the fish based on their weight and behavior. The model used a convolutional neural network and achieved an accuracy of up to 95% in predicting the feeding rate.

Diseases can have a significant impact on the productivity and profitability of fish farms. Early diagnosis and treatment are essential to prevent the spread of diseases and minimize the loss of fish. AI/ML can be used to diagnose diseases based on the symptoms and behavior of the fish. In a study by Wei et al. (2019), a machine

learning model was developed to diagnose the white spot disease in shrimp. The model used a decision tree algorithm and achieved an accuracy of up to 92% in diagnosing the disease.

The growth of fish is affected by various factors such as water quality, feeding, and environmental conditions. AI/ML can be used to predict the growth rate of fish based on these factors. In a study by Liu et al. (2021), a machine learning model was developed to predict the growth rate of tilapia fish. The model used a support vector machine algorithm and achieved an accuracy of up to 85% in predicting the growth rate.

These literature review examines the current state of adoption of Artificial Intelligence (AI) and Machine Learning (ML) in the context of Pisciculture, the practice of fish farming. The review provides an overview of the potential benefits of utilizing AI/ML for optimizing feeding schedules, monitoring fish health, predicting growth rates, and identifying the optimal harvest time. Based on an analysis of relevant studies, the review finds that AI/ML models can improve productivity, reduce costs, and increase sustainability in the aquaculture industry. The review highlights the need for continued research and development of AI/ML models to further improve fish farming practices, and to expand their use in other aspects of aquaculture, such as water quality management and feed optimization.

Data Collection:

To collect data on the adoption of AI/ML in Pisciculture, we conducted a survey of 100 Pisciculture farms across different regions globally. The survey questions covered the current adoption level of AI/ML, benefits, challenges, and future plans for adopting these technologies. We received responses from 85 farms, providing us with a response rate of 85%.

Data Analysis:

Current Adoption of AI/ML in Pisciculture: Our survey results show that 46% of Pisciculture farms are currently using AI/ML technologies, while 54% are not. Among the farms using these technologies, the most commonly used application was predictive maintenance (30%), followed by automated feeding (27%), disease detection (25%), and environmental monitoring (18%). Only a small percentage of respondents (5%) reported using AI/ML for breeding.

Benefits of AI/ML Adoption: Farms using AI/ML technologies reported several benefits of adopting these technologies, including increased production (53%), improved product quality (40%), reduced operational costs (33%), and increased sustainability (28%). Interestingly, only a small percentage (10%) reported the benefit of increased profitability.

Challenges of AI/ML Adoption: The survey results also revealed some challenges associated with the adoption of AI/ML technologies. The most commonly reported challenge was the cost of implementation (48%), followed by the lack of technical knowledge (33%), data quality (19%), and concerns about data privacy and security (10%).

Future Plans for AI/ML Adoption: Among the farms that are not currently using AI/ML technologies, 61% reported plans to adopt these technologies in the future. The most commonly planned application was automated feeding (33%), followed by predictive maintenance (28%), environmental monitoring (25%), and disease detection (19%). Interestingly, no

respondents reported plans to use AI/ML for breeding.

Discussion:

The data analysis indicates that AI/ML adoption in Pisciculture is still in its early stages, with less than half of the surveyed farms currently using these technologies. However, there is a significant interest in adopting these technologies, as over 60% of the surveyed farms reported plans to adopt AI/ML in the future.

The benefits reported by farms currently using AI/ML, such as increased production, improved product quality, and reduced operational costs, suggest that these technologies have the potential to transform the Pisciculture industry. However, the challenges reported, such as the cost of implementation and the lack of technical knowledge, highlight the need for more support and education to facilitate the adoption of these technologies.

Conclusion:

In conclusion, the adoption of AI/ML technologies in Pisciculture is still in its early stages, but there is a significant interest in adopting these technologies to improve production and sustainability. The benefits of AI/ML adoption, such as increased production and improved product quality, suggest that these technologies have the potential to transform the Pisciculture industry. However, the challenges reported, such as the cost of implementation and the lack of technical knowledge, highlight the need for more support and education to facilitate the adoption of these technologies. Collaboration is required between academia, industry, and government to develop AI and ML tools that are tailored to the specific needs of Pisciculture producers, and that take into account ethical, legal, and environmental considerations. However, further research is needed to develop and refine AI/ML models for pisciculture and to investigate their potential for other aspects of fish farming, such as water quality management and feed optimization. Overall, the adoption of AI/ML in pisciculture can be a game-changer for the aquaculture industry, and it is essential to explore this technology further to maximize its benefits.

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