Artificial Intelligence Applications on Sustainable Growth of Aquaculture

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Abstract

Technology advancement has been essential in the aquaculture sector due to the current population rise in order to safeguard wild fish stocks, regulate fish prices, and boost output. Because of the increased demand and scarcity of seafood brought on by an increase in population, pressure on wild fish stocks is growing. Relying on cutting-edge aquaculture is now the best option for producing enough fish to meet demand. Unfortunately, the aquaculture industry has not benefited significantly from technical improvement compared to the agricultural and manufacturing industries. Solving issues by interpreting an automated intelligent task is the primary accepted paradigm of artificial intelligence (AI). There are now more opportunities than ever to use and incorporate information technology in many facets of life because to the development of cloud computing, the Internet of Things, and artificial intelligence (CIA). In conclusion, innovative techniques will play a significant role in the aquaculture industry's future development and should be considered in all contexts.

Introduction

There is a large yearly increase in the demand for the world's food supply due to causes such as expanding population, rising wealth, increased public knowledge of the health advantages, and others. Fish and fishery products, especially long-chain polyunsaturated fatty acids (LCPUFA) and micronutrients, are excellent sources of protein when compared to proteins from terrestrial animals. With an average intake of 20.5 kg per person in 2018, fish is the primary source of animal protein for more than a billion people worldwide. The Food and Agriculture Organisation (FAO, 2020) is the source of this data.

The goal of the present study team was to apply artificial intelligence innovation technology to create a practical smart cage culture management system. This system consists of components for an artificial intelligence feeding system, an underwater aquatic organism analysis, and an omni-IoT (Internet of Things) system. Consequently, it is possible to build an aquaculture sector that is very competitive globally. Fishery change may result from the economic advantages. Fishermen may utilise the management system to get real-time information, conduct aquaculture at their best, and refocus their efforts on developing scarce fisheries. (Mustapha *et. al*., 2021).

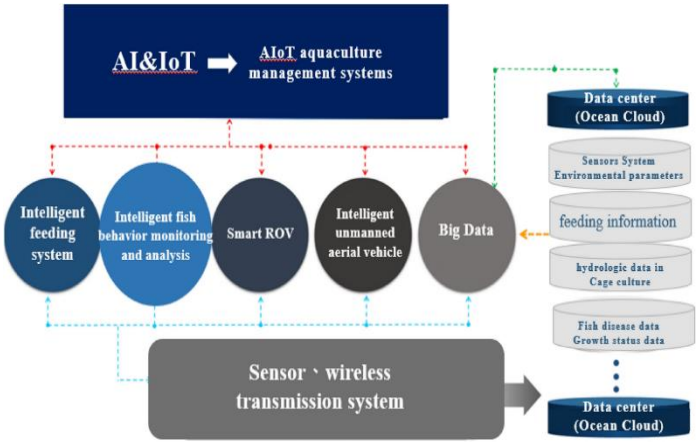

Fig. 1: IoT flow chart

Figure 1 demonstrates the flow of events for data collection by the Omni IoT system, data transmission to a cloud computing system, and system feedback. To construct a successful AIoT smart cage culture management system, all the big data collected is kept in the Ocean Cloud to aid the AI computations of the feeding system, fish behaviour monitoring and analysis system, ROV system, and autogiro AI calculation.

What is Artificial Intelligence?

Making intelligent devices, particularly intelligent computer programmes, is a scientific and engineering endeavor. Although it is connected to the related job of utilizing computers to comprehend human intellect, AI should not be limited to techniques that can be seen by biological means. Artificial intelligence is a topic that, in its most basic form, combines computer science and substantial datasets to facilitate problem-solving. Additionally, it includes the branches of artificial intelligence known

as deep learning and machine learning, which are commonly addressed together.

Application of AI in aquaculture

Aquaculture is a significant industry that has grown rapidly all over the world, but it is not as simple as it may appear. Fish farming technology has reasonably advanced to improve itself and pave the door for other technologies to enter its field with the appearance of novel aquaculture technologies. Artificial intelligence in aquaculture is one such technology that may be used and put into practise for longer-term, better outcomes and results. Here are some examples of aquaculture-related applications of artificial intelligence.

Automated Feeding system

In aquaculture, feeding is a key factor in determining production costs and water quality. Most of the large-scale farming uses automated feeding systems to cut costs and save time. Regardless of the state of the water, automatic feeding machines function on a timely basis; they only feed when it is time to feed. Consequently, utilising an automated feeding equipment might result in overfeeding and change the quality of the water Fig. 2.

Fig. 2. Automatic feeding system which are installed in shrimp farm

The input on environmental monitoring technology is integrated with an autonomous feeding control system in a system where fish feeding is automated. With the ability to manage feeding, culture systems may alter or stop feeding in response to changes in the water's quality or fish behaviour.

The Akvasmart CCS feeding system from AKVA Norway is one such. The system has a Doppler residual feed sensor, an environmental sensor, an aquaculture video camera, and other monitoring devices to keep an eye on the environment underwater and provide precise feed dosage management. The system is controllable from a PC or a smart device (phone or iPad), and it has the ability to handle more than 40 feed lines running in parallel and more than 1000 tanks per unit.

Remote Monitoring and Maintenance

Due to substantial fluctuation, particularly in the open sea, which can represent a serious danger to aquaculture, monitoring the environment is crucial. In the past, it has been difficult and time-consuming to detect water quality anomalies in a timely manner, which can occasionally put the planted species at danger. For aquaculture managers to act quickly and minimise hazards, real-time monitoring of the environment, water quality (dissolved oxygen, temperature, pH, ammonia chlorophyll, nitrogen, nitrite, etc.), and fish behaviour is required. Aquaculture environment monitoring may involve the use of sensors, drones, buoys, underwater robots, online remote monitoring equipment, etc. Offshore data includes wind direction and speed, wave height, and ocean current velocity.

Growth Statistics

The third use case for AI in aquaculture is the capability to monitor and grasp animal growth statistics so that you may totally evaluate the ideal techniques. This implies that farmers may use the capability of AI to not only discover the flaws in their agricultural practise but also to be aware of the impending actions and damage control to guarantee that their livestock turns out to be just alright. The usage of growth statistics is also a vital contribution to the collecting of big data and big data analytics in order to help others in assessing the right practises and methods for the same.

Sampling

Traditional artificial sampling techniques have proven to be time-consuming, difficult, and difficult for fish when it comes to quantity. Zhang et al. (2020) offered an automated fish counting strategy as a solution to the issues and to enable real-time, accurate, and lossless counting of fish populations in offshore salmon mariculture. By using a multi-column convolution neural network as a front end to gather

feature data from several receptive fields, they were able to develop a hybrid neural network model. The system's back end employs a bigger and deeper dilated convolution neural network to reduce the loss of spatial structure information during network transfer. The recommended hybrid neural network model's counting accuracy may reach 95.06%, according to testing results.

Temperature Optimization

Freshwater aquaculture is a centre for research and setting up different conditions to see what influences raising cattle. This necessitates a discussion of the importance of temperature. In aquaculture, temperature is crucial to maintaining the fish's ideal thermal habitat and maintaining its balance throughout time. Using artificial intelligence and machine learning algorithms, farmers may establish their preferences and extract specific models for their agricultural location. For instance, AI may assist farmers in controlling temperature by boosting it at night and decreasing it during the day when the sun is present.

Water Quality Regulation

AI in aquaculture also has the advantage of making water quality monitoring and management easier. The quality of the water is a critical factor that impacts the wellbeing and survival of cattle throughout farming. If any foreign object tends to lower the quality of the water the fish are living in, AI-enabled sensors can rapidly inform the farmer and trigger regulatory action. Purifying the water, switching the water, or even releasing antibodies can be necessary to mitigate the effects of polluted particles. Because of this use of AI, the aquaculture sector is tremendously developed and forward-thinking.

Consistent Aeration

As this site has already established, oxygen is crucial to cattle survival. In contrast to other circumstances where a shortage of oxygen can quickly result in the slaughter of animals, regular aeration and release of oxygen helps the fish to breathe and survive. AI is once again helpful in regulating and maintaining the oxygen level in the water that the fish are being raised in. This is made possible by a machine learning technique that facilitates the release of oxygen at regular intervals. Additionally, the sensors could quickly signal the same if the oxygen level rose or fell, creating a balanced environment for animals.

Identification and measurement

Since DL models are capable of learning distinctive visual traits of species that are immune to environmental changes and alterations, parameters like visual characteristics and sound frequencies may be used by DL to deliver reliable results in terms of species identification. The use of deep leaning (DL) has led to a more precise assessment of fish morphological parameters, including length, breadth, number, abundance, and other areas. Enhancing fisheries management productivity requires observation of these characteristics.

Smart Sensors

Imagine that nobody from your family is home, and someone is attempting to break into your house. How will you find out? synthetic intelligence. Long used to alert home owners, bank employees, and aquaculture farmers, smart sensors are a well-known use of AI. Intelligent sensors with integrated AI technology are able to alert farmers right away if toxin levels increase or oxygen levels decrease. Thanks to the speedy transfer of this real-time information, the farmer may learn as quickly as possible. Using smart sensors is really helpful and instructive for farmers, therefore it serves a benefit rather than a practical function.

Human-less Filtration

The modern period has improved significantly from past times when aquaculture producers had to physically filter the water and maintain the water quality. Water filtering without the need of humans is simple with the use of already-installed equipment, which is AI-powered. Thus, the application of AI in aquaculture eliminates the need for farmers to manually complete tiresome tasks and devote lengthy amounts of time to the same. It's crucial to remember that all of these activities can run concurrently in order to meet the needs of the cattle and improve the practise as a whole.

Predictive Measures

Do you know what predictive analytics is? Predictive analytics, one of the most important uses of artificial intelligence, provides the way for aquaculture professionals to not only plan their prospective activities but also perform in accordance with the projected conceptions so they can provide the greatest care for their animals. They can definitely obtain insights into potential future outcomes via predictive analytics and prepare for them. Aquaculture, like any other industry, may gain a lot from the use of just predictive measurements. AI can lead you in the appropriate way so as to provide superior outcomes based on historical data and discoveries.

Big Data Analytics

Big data analytics, which gather information records and assist others in making the right judgements, is the last use of AI in aquaculture. Big data may help farmers better understand the dangers and difficulties they may encounter during the process so they can take the necessary precautions to stay on the correct path. Big data analytics provides a description of the practise as well as a list of dos and don'ts to help farmers.

Disease detection

There is a wider variety of pathogenic species, including bacteria, fungi, parasites, and protozoa. Some sick fish exhibit a variety of outward symptoms, such as ulcers, exophthalmia, and emaciation, as well as lethargy, apparent granulomas, or no symptoms at all. Hookworms, for example, are an example of an external nematode. Changes in skin colour, head enlargement, protruding eyes, eroding fins, gills, and/or ulcers on the body are a few examples of outward indications of illnesses. Using CIA methods has demonstrated to be effective in identifying the majority of external fish abnormalities, which are indicators of fish illnesses. The majority of illness diagnostic methods are based on pattern recognition theory, with three primary objectives delineated:

(i) Segmentation, which seeks to isolate the lesions from the surrounding portions of the picture;

(ii) Feature extraction, which seeks to gather as much data as possible about the area of interest (typically lesions);

(iii) Flassification, which combines the data from the characteristics to provide a trustworthy identification of the disease.

The device employs a 2D or 3D camera to record fish behaviour (the fish's precise outlook and trajectory for sick signs on fish scales) in tiny tanks and cages. To determine the depth of the fish, the camera monitors the infrared light and light intensity reflected off the fish. This facilitates the thorough recognition and evaluation of distinctive fish skin patterns for behavioural changes (IPI Singapore 2019). The development of an IoT-based smart aquaponics system that integrates aquaculture and hydroponics for real-time environmental monitoring and disease diagnosis of aquatic leaves and plants utilising machine technologies. Adopting AI would allow for the prompt detection and treatment of fish infections that are harmful and likely to cause enormous damage in order to save further losses.

"Artificial intelligence is advancing aquaculture by helping farmers comprehend the analytics of how their inputs affect fish growth under different circumstances,"

Conclusion

Raising aquatic plants and a variety of aquatic animals for human use as food, medicine, and supplements is known as aquaculture. This business is continually growing as a result of the growing consumer demand for organic seafood and marine supplements like fish oil, marine collagen, seaweed, algae, etc. Establishing and maintaining the aquaculture industry is a highly difficult operation that needs a lot of adjustable fine-tuning to provide the best outcomes. The intelligent aquaculture sector is based on technology and efficient algorithms. In this case, sensing and machine learning algorithms are essential because they enable quick decision-making to minimise risks and automatic real-time environmental monitoring.

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