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Aquaculture in the Modern Era: Application of Artificial Intelligence in Aquaculture

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The development and advancement of innovative technologies helps in the growth of the aquaculture industry. The world aquaculture production reached 87.5 MMT contributing 40% of the total fish production; with per capita consumption rate of 20.2 kg by 2020 which is expected to grow 14% increase in production by 2030 (FAO, 2022). Rather, the technology is also involved in the rise of competition of aquaculture production among the industry (Rock and Guerin, 1992). Among the technologies, the study of mental faculties with computational modules which is known as Artificial intelligence (Charniak, 1985) is popularised and already taken the major role in the farming system. AI is the simulation of the human intelligence processed by machines particularly computer systems that are programmed and mimic the human roles. In 1983, the first application of computer in agriculture was reported (Baker *et al*., 1983). AI system involves all the robotic application and the software application that reduced human effort. The AI system in the aquaculture industry helps the following: enhanced farming systems, monitoring the farming environment, feeding practices and feeding efficiency, seed selection monitoring growth, monitoring migratory behaviour, disease diagnosis etc. The following article gives a blueprint on how the AI helps in the growth of aquaculture in the modern era.

Role of Artificial Intelligence:

1. In enhancing farming system

As the population of the world increases, there also increases the competition of resources that are necessary for living beings such as space and food. So, there is limited resources for the adoption of aquaculture particularly space for fish farming. The used of water resources wisely is also necessary for a sustainable aquaculture. Scientist and researchers have been studying on various technologies for practicing aquaculture sustainably. Recently, various technologies like biofloc technology (BFT), integrated multi-trophic aquaculture (IMTA), recirculatory aquaculture system (RAS) etc. have been developed. Aside from that, AI has helped to develop some technology, such as the 'Aquapod' robotic cages developed by Ocean Farm Technology, Inc. of Searsmont, Maine. According to a document published in the future of things, it is a self-propelled spherical aquaculture cages made of individual triangular panels made from reinforced high-density polythene and tension venyl coated galvanised steel wire mesh netting. The panels help in size adjustment, accessing, fish transfer and grading, harvesting and mooring, and mortality recovered. The cages work in both full and partial submersion, and they maintain their size and shape in strong currents or undertow, making them ideal for a wide range of applications.

2. AI in feeding practices.

Feeding is the most important practices in an aquaculture industry. Feeds contributes around 60% of the total investment cost and contains high protein depending on the culture species. Improper maintenance of feeding practices not only affect economy but also degrade the culture environment. Over feeding leads to feed wastage that result to the deterioration of the culture environment and less feeding on the other hand slower muscle development and reduce growth. Feed also needs to be fed at the right time with proper ration otherwise, it will cause cannibalism in fishes particularly carnivorous fishes. In view to reduce such problems, AI has been introduced to aquaculture. For instances, an Indonesian aquaculture intelligence company known as efishery offers an AI mobile based smart feeder technology in which the sensors are installed to detect the appetite of fish and shrimp and automatically feeds them the optimal amount. Sensors collect and transmit data (such as feed volumes, feed consumption, and transactional data) to the cloud, where it is aggregated, stored, and analysed. Farmers

can then gain access to and track these actionable insights and data. Furthermore, eFishery's technology enables farmers to manage their ponds remotely via their smartphones. Another AI feed dispenser is Umitron cell developed by UMITRON PTE. LTD, Singapore and UMITRON K.K, Japan (Umitron) which has installed the first units at farm sites in Ainan City, Ehime, Japan. It is a smart automated aquaculture feeder that can be managed remotely via the cloud using a smartphone or desktop computer. It aids farmers to manage their feeding schedule and increase environmental sustainability. Another company called Observe technologies, for tracking measurable patterns when stocks feed, offered another play and plug AI and data processing system. Their objectives is to guide the farmers on how much to feed.

3. AI in disease diagnostic

a. Fish expert: It is a web-based intelligence system developed by Agricultural Information Technology Institute at China Agricultural University, which is capable of mimic human fish disease expertise and the diagnosis of a variety of fish diseases with an easy-to-use interface. The system consists of a large amount of fish disease data and images that are used for online disease diagnosis (Li *et al*., 2002). In the article by Li *et al*., 2002 it is also mention that a fish disease symptom photo base, a microscopic examination graphic base, and a diagnosing results graphic base are all part of the graphic image base. They are accustomed to keep images and graphics relating to symptoms, microscopic examination, diseases, and so on.

b. Aqua Cloud platforms: It is a cloud-based program launched by Norway's Seafood Innovation Cluster in April, 2017. It was developed aiming that it will predict and prevent lice development in sea cage so that it will reduce reliance on costly medical treatments.

c. Farm MOJO: it is an artificial driven mobile apps that helps farmer in disease prediction, monitoring water quality, increasing productivity, and, ultimately, increasing farmer income.

4. Drones in aquaculture

As the fishes are living in the underwater, the phenomenon associated with fish and the culture environment is not familiar to the farmers and researcher. This creates a problem in detection of the loss of feed, predators of the culture fishes, moribund fish, defection in cages etc. Now some companies had invented the underwater drones to get rid out of the problem. Drones also helps in monitoring water quality. Some underwater drones is given below

A) **DTX2 ROV:** An underwater remotely operated vehicles (ROV) developed by Deep Trekker Inc., Ontario, Canada. It is roughly a basketball size with a camera inserted connected to a controller. It can detect dead fish and collect soil and water samples that aids in environmental monitoring. The integrated screen displays the live feed also.

B) **Shoal robo fish:** It is a robotic fish which is one and half meter long covered by a neon yellow plastic shell. It is used to monitor water that causes pollution such as leaking boat or industrial spillage. It has sensors that detect pollutants like heavy metals such as lead, copper and other polltrants. At the same time, it measures water salinity.

C) **Pond monitoring and Field analysis:** Vast fields and low efficiency in crop monitoring together create farming's largest obstacle (Veroustraete, 2015). Drones have served as a deterrent to poachers.

D) **FIFISH underwater drones:** FIFISH underwater drones in aquaculture can significantly reduce labor intensity and risks, achieving automatic underwater inspections. The FIFISH underwater drone is equipped with a 4K high-definition camera and high-brightness LED lights, which can monitor the underwater situation in real-time. It can easily monitor the feeding process and the health of fish populations. Its 360-degree underwater motion capability allows comprehensive inspection and complete control of the underwater situation in the aquaculture facility. Potentially damaged areas can be detected timely, and damaged fish nets can be repaired, reducing losses, and maintaining the facility.

5. Cloud computing, internet of things and artificial intelligence (CIA)

Cloud computing can be employed on the cloud, on-site, or in a combination of both. It also includes three main service models that cover various portions of the cloud computing components; There are three types of services: software as a service for customers, platform as a service for developers, and infrastructure as a service for system administrators (Mustapha et al., 2021). Aquaculture follows some certain protocols and cloud computing helps in generating data for efficient, flexible and enhancement of optimal performance. Cloud computing is ideal for integrating applications such as water quality monitoring, data intelligence, and fish pest knowledge bases.The Seafood Innovation cluster in Norway colla borated with IBM and other organisations developed the cloud-based platform Aquacloud (Mustapha et al., 2021).

IoTs utilise integrated technologies, including sensors, processors, and communication gear, as well as artificial intelligence, to facilitate data processing a nd interpretation (Mattern & Floerkemeier, 2010). The application of IoT has been gaining attention the aquaculture sector but due to association of water its installation has become a major drawback but improvement has been done to access to it. Automating the aquaculture sector with IoT devices like bionic robots, remote cameras, micro- and nano sensors, intelligent sorting, and cost-effective processing machinery can save labour and increase productivity in areas like production, fishery monitoring, environmental monitoring, and automatic inspection (Mustapha et al., 2021).

Application of Artificial Intelligence (AI) Techniques is also one major area gaining a lot of interest which helps in timely forecast of information for preventive measures. AI application has been done to observe the Practical Smart Cage Aquaculture Management System where the research team utilizes the Ocean Cloud of National Taiwan Ocean University (NTOU) as the data collection center (Chang et al., 2021). They installed sensors, an underwater camera, and a communication system on a platform and placed it in a cage. Data from an autogiro and a remotely operated vehicle (ROV) were connected into an Omni IoT system, allowing for the monitoring and sensing of feed supply. All data collected is transferred to an onshore base via communications technologies and then to a cloud system via an Internet connection. The combination of cloud computing, IoTs and AI together gives a precise understanding on how to optimize the culture system for better production with less human intervention.

Conclusion

The increasing scale in AI development and application in aquaculture sector has benefitted in many aspects and helped in better growth and production. The most important considerations in the design and purchasing of process control and artificial intelligence software are functionality/intuitiveness, compatibility, adaptability, upgrade route, hardware requirements, and price. Among these, intuitiveness and compatibility are the most crucial (Lee, 2000). As information technology advances, the aquaculture business will experience rapid expansion. Innovative approaches are crucial for the aquaculture industry's future growth and should be prioritised in all aspects. Aquaculture powered by artificial intelligence of things (AIOT) can help fish farmers strategically control and manage various fishpond equipment distantly, as well as aquaculture operators perform professional aquaculture, lowering the industry's entry barrier and fostering aquaculture. Emerging and innovative technology will undoubtedly increase the aquaculture industry's resource and energy efficiency. These advances in technology will also create new chances for businesses and jobs, particularly for women and young people. However, it is important to emphasise that some innovative and disruptive technologies may create challenges for small/family-owned fish farmers that lack the financial wherewithal to use them. It is critical to ensure that effective management is in place so that emerging technologies are used to improve, not harm, the sustainability of aquaculture (FAO,2020)

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