AN AQUACULTURE DISRUPTED BY DIGITAL TECHNOLOGY

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ABSTRACT

Fish farming as a primary protein source is significantly more efficient than other protein sources, and demand for fish continues to climb. The future of fish farming is brighter, more traceable, and more profitable. This research aims to learn everything there is to know about the Internet of Things (IoT) systems, including their technology, protocols, and potential hazards. According to the literature, 3D printing, robotics, drones, sensors, artificial intelligence, augmented reality (AR), virtual reality (VR), and blockchain are the digital technologies affecting aquaculture. A wide range of industries is adapting and using it.

***Keywords**: aquaculture, digital technology, disrupt, sustainability*

1 INTRODUCTION

The blue economy was founded in the international sustainable development arena to generate economic and social opportunities while preserving and enhancing the marine environment. There has been little investigation into how these broad sustainability goals have influenced the rapid expansion of blue economy initiatives at the national and regional levels. (Niner et al. 2022).

Recent advances in computer vision technology, on the other hand, have made it possible to observe fish behavior more closely. This technology enables non-destructive, fast, cost-effective, consistent, objective inspection tools and images analysis and processing-based Evaluation approaches. The term "fish" in this study refers to the underwater vertebrate fish of the Pisces family, which can be found in practically every aquatic environment. Computer vision cameras are being used to study the behavior of fish all around the world. This study examines the development of computer vision related to fish behavior at all stages of production, from hatchery to harvest. According to the Elsevier database, from 1973 to 2018, computer vision technology was considered to exist. (Niu et al., 2018)

The rapid advancement of information technology has impacted both the development of work support software and the sophistication of computers. Today's computers are used in almost every aspect of business, including typing, drawing, computing, and today's popular buying, selling, and advertising trends through computer media, also in line with product design, which has to migrate from 2-dimensional to 3-dimensional design to keep up with technological advancements.

Aquaculture, often known as agriculture, is the fastest-growing animal food sector. Carp agriculture is said to have begun around 4,000 years ago in China. As the demand for fish grows, fishery resources and operations must become more sustainable, necessitating the innovative application of present and developing technologies. Fortunately, there is much hope for providing a long-term sustainable supply of this protein due to technological breakthroughs.

In recent years, machine learning technologies have become more widely used in aquaculture, opening up new possibilities for the deployment of digital aquaculture in a larger framework of automation and intelligence. This study looks into machine learning in aquaculture, covering data analysis, fish identification and categorization, behavioral analysis, and water quality parameter prediction. Finally, some current aquaculture difficulties are discussed as prospective development tendencies. (Zhao, S. et al., 2021)

Manual feeding is more cost-effective than using expensive machines for fish farming in developing countries. This project developed a low-cost human-powered raw fish feed kit to address feeding issues in freshwater aquaculture. The feeder's primary components are a cylindrical feed drum mounted on a pedal-powered shaft, a catamaran barge, propeller, and steering arrangement. The shaft rotates when the operator presses the pedal, and the feed in the feed drum is measured through the gauge bore. The strength of human muscles drives the process of eating and eating. This device uses the least amount of human power during operation and is energy-efficient, environmentally friendly, and economical. (Prem., R & Tewari, VK (2020)

Aquaculture relies on data on fish appetite to guide feeding and production tactics. The majority of approaches for determining fish appetite, on the other hand, are ineffectual and subjective. After collecting photographs throughout the feeding process, the data set was upgraded and increased utilizing a rotation, scale, and translation augmentation (RST) technique and noise-invariant data expansion. Following training on the dataset, the convolutional neural network (CNN) model was utilized to detect the degree of fish malnutrition. The method's performance was evaluated and compared to existing quantitative and qualitative methods to determine feeding intensity. The model was shown to have a 90 percent rating accuracy, indicating that it may be used to identify and evaluate fish appetite to change manufacturing operations. (C. Zhou et al. 2019)

As a result of the Advances in system technology on chips, platforms for monitoring critical elements such as water quality, range, speed and flow of water pumps have emerged. Fish longevity will increase if all parameters are correctly maintained. The relevant parameters are monitored using sensor-based technology, which is simple to set up and maintain at a minimal cost. (Hariprasath Manoharan, et al. 2021)

2. MATERIALS AND METHODS

This study used a qualitative research approach or literature review. Researchers as a data collection instrument. Journals, books and online news as research materials. The focus on the researcher's view is an important aspect. (Creswell, 2013)

3. RESULTS AND DISCUSSION

Like other agricultural businesses, aquaculture technology has piqued the interest of the agricultural community and investors. Consumers are increasingly paying attention to the nutritional value of their food choices, which is driving demand for fish, mainly because of its health benefits. Meanwhile, fish production as the primary protein source is six to four times more successful than other protein sources in feed conversion.

a) 3D printing is a life-saving technology.

It has the potential to be employed in the backyard and the aquaculture business to construct hybrid aquaponics systems. The MIT-printed robotic fish, which almost exactly mimics the movements of real fish, is another example of 3D printing in aquaculture. Aquaculture refers to cultivating plants in water, and algae have the unique ability to cause havoc and even save lives in such situations. Algae has been used to create gels that can be used to construct 3D printed medical implant devices that are affordable and ecologically friendly.

b) Robot will be in charge of our fish.

Although it is a more environmentally-friendly option for fishing, diseases and parasites in farmed fish can worsen stressful situations, resulting in poorer yields and significantly higher production costs. Cermaq is a fantastic company that employs this technology to sort sick or wounded fish for active service. According to Rolls Royce, robotic cargo ships will make deliveries more efficient, cleaner and cost-effective. This technology can be used to transport fish produced offshore to commercial enterprises. Ocean One is a bimanual underwater humanoid designed to protect the ocean. This technology can evolve into a human avatar, allowing the operator to work underwater while remaining on the ground. Meanwhile, Maritime Robotics and Deep Trekker offer robots with marine monitoring systems for aquaculture exploration and cultivation.

c) Drones risk their lives to collect data.

A virtual reality headset can be added to the PowerRay drone, allowing users to explore the high seas while remaining dry. Drones can also collect data that can be used to create algorithms that help improve current technologies and applications for aquaculture and offshore fish farming. One of them, for example, can be used for offshore aquaculture, data collection, fish stock analysis, and environmental monitoring. This underwater drone connects to a tablet, smartphone or computer manufacturer to collect and analyze data.

d) Aquaculture sensors that are smarter and more sustainable.

Drones and robots previously used sensors to navigate underwater and collected data such as pH, salinity, oxygen levels, turbidity and pollutants. Biosensors, such as those produced by Sense-T, increase efficiency by balancing oxygen levels and air temperature; they can even assess heart rate and metabolism. Shrimp farms in India use Sensorex to combine dissolved oxygen and pH levels to create the ideal environment for increasing shrimp efficiency and yields. In essence, fishing is a cutting-edge technology that uses sensors to evaluate fish and feed them accordingly. It can be used in various sizes and save up to 21% on feed costs. Meanwhile, Real Tech uses sensors to monitor air quality and UV transmission to sterilize airborne germs and clean aquaculture production facilities.

e) Artificial intelligence (AI) helps decision-making in agriculture.

Shoal, a robotic fish, detects AI contaminants using artificial intelligence or swarm intelligence. Robots are dispatched in groups and must be able to navigate their surroundings, avoid obstacles such as other robot fish, recharge at charging stations, and make judgments without the intervention of humans. Even industry leaders in simpler technologies like cameras and feed systems, such as Steinbeck, are incorporating AI and learning algorithms into their products to stay competitive and meet changing customer demands. According to The Economist, around 32% of seafood harvested in nature is caught in an unsustainable manner. AI can assist decrease overexploitation of fish species by using cameras and data gathering systems that employ AI to detect species and enable improved accountability of harvesting operations.

f) Augmented reality (AR) gives divers a new perspective.

AR has much potential in the aquaculture industry. The US Navy already uses the DAVD (Divers Augmented Vision Display), which overlays high-resolution sonar imagery over the world's visual rescue. NASA has also put Microsoft's HoloLens to the test. The Succubus S Indiegogo, which has a camera, and the Yanko Design Smart Swimming Goggles, which allow divers to communicate, are also similar masks.

g) Virtual reality introduces aquaculture to the next generation (VR).

Virtual reality can be used in the aquaculture industry, including training and education. Students can use the virtual reality aquaculture simulator developed by NTNU to learn about fish exploration. It is easy to see how these advances can be leveraged in the aquaculture business for teaching purposes.

h) Blockchain ensures longevity by increasing transparency.

Blockchain is a decentralized public ledger of transactions that any individual cannot change. It implies that transactions between aquaculture suppliers and customers can be completed swiftly and securely without exchanging money, saving money on transaction fees and currency translation. Details about harvest and manufacturing procedures can also be stored and shared with other producers and customers. Security has always been a significant concern, but the blockchain framework protects privacy while allowing for transparency. It is possible to determine whether a fish has been produced sustainably or not.

3.1 Research Results

Aquaculture technology is more environmentally friendly and has a more substantial future with a favorable environment.

Based on the results of the researchers' investigation, there is a list of statements and opinions, which include:

1) Disease resistance prediction is one of the most common applications of selective aquaculture breeding. As genotyping costs have decreased, genomic selection in aquaculture species and diseases has been implemented, with promising results. In some studies, machine learning (ML) models help predict crops and livestock. The ML model can be effective in investigating disease resistance in aquaculture. (Palaiokostas, 2021)

2) Using a mixture of image-perfect search methods and machine learning, we detect unhealthy fish caused by various diseases. In the first part, image pre-processing and segmentation are used as a starting point to remove noise and expand the image. Using machine learning techniques, the second component obtains the properties essential for disease categorization. Kernel functions for the Support Vector Machine (SVM). This pass model's starting point is the image (SVM). We next used the offered methodologies to run a complete experiment on the salmon photo collection used to investigate fish disease. We showed our method with and without picture augmentation on a new compromised data set. (Ahmed et al., 2021)

3) Environmental quality status (EQ) indicates molecular bioindicators based on standardized macroinvertebrate surveys. Machine learning (SML) and value evaluation are the most popular approaches for inferring EQ from biotic indices (BI) (IndVal). We employed bacterial and ciliate DNA meta barcodes as bioindicators to see how effective this method is. First, when inferring EQ from eDNA meta barcodes, SML surpasses IndVal's technique. The Random Forest (RF) method is less susceptible to data noise (as in large-scale environmental sequence data sets) and uneven data coverage across EQ classes (as in environmental compliance monitoring systems) than other approaches for inferring IndVals for BI calculations. Second, compared to ciliate e-DNA metabarcoding, it allows for a more accurate assessment of EQ. We recommend using meta DNA barcodes in conjunction with SML to construct EQ categories based on molecular markers to incorporate meta DNA barcodes into routine Monitoring programs to monitor EQ near salmon farm cages. (Frühe et al., 2021)

4) The Internet of Items (IoT) is a collection of technologies from various industries that connect things through the Internet, allowing for the

detection, monitoring, and control of many devices. HEMS-IoT is an intelligent home energy management system that leverages big data and machine learning to provide convenience, security, and energy savings. (Machorro-cano, I., Alor-hern, G., & Andr, M., 2020)

5) At the consumer level, Fused Deposition Modeling (FDM), also known as Fused Filament Fabrication (FFF), is the most extensively utilized type of Additive Manufacturing (AM) technology. The lack of online quality and customization methods significantly limits this technology. The authors split the surface quality into four groups based on the information provided: underpainting, overprinting, standard, and blank space. (Lyu et al., 2022)

6) Bayesian regression and machine learning approaches (supporting vector machines and linear bagging) in categorizing vulnerable and resistant people were tested. Machine learning algorithms, particularly linear bagging, demonstrated greater Matthew Correlation Coefficient (MCC) value and accuracy across both data sets, with a 20–70 percent boost in prediction performance. (Bargelloni et al., 2021)

7) The use of algorithms and machine learning techniques in intelligent fish farming for the last five years is discussed, as well as the application of machine learning in aquaculture, which includes Evaluation of fish biomass information, identification and classification of fish, behavioral analysis, and prediction of water quality parameters. (Zhao et al., 2021)

8) These technological advances allow robots to perform user-defined remote activities or send sensor data to manufacturers for review on smartphones, tablets and PCs. Aquaculture is a newbie, and we are only seeing the beginning of breakthroughs in aquaculture technology because it is the fastest-growing food sector. According to the UN's Food and Agriculture Organization, 27 million tonnes of fish products will be required. It is intertwined to maintain current consumption levels by 2030. (Tritsarolis et al., 2022)

4. CONCLUSION

Fish farming is significantly more efficient than other protein sources, and demand for fish continues to climb. The future of fish farming is brighter, more sustainable, and more profitable. According to the literature, digital technologies affecting aquaculture include 3D printing, robotics, drones, sensors, artificial intelligence, augmented reality (AR), virtual reality (VR), and blockchain. A wide range of sectors is adopting and implementing it.

According to the study, the government should implement policy by enacting suitable laws and combining all national regulations governing fisheries management in the Indonesian Exclusive Economic Zone (EEZ) into a single document. The purpose is to prevent duplication of agreements and simplify implementation. (Pramoda et al., 2021)

Also, research results that the increasing popularity of these IoT devices, which are more secure than desktop computers, has increased IoT-based cyber-attacks. A new approach is needed to recognize attacks carried out from hijacked IoT devices. (Asharf et al., 2020)

Another conclusion is that Industry 4.0 is being implemented via artificial intelligence (AI), the Internet of Things (IoT), Big Data, Machine Learning, and other sophisticated technologies. Thanks to scalable robotics, information, and communication technologies, Industry 4.0 provides a collection of concepts, instructions, and technologies for constructing new and existing factories, allowing consumers to pick from various models at the production level. Overall, Industry 4.0 technology appears to be environmentally friendly, as it increases industrial efficiency while reducing resource use. (Javaid et al., 2022)

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