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Automation Technology and Robotics in Fisheries and Aquaculture Sector

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ABSTRACT

The world's biggest facing problem is the increase in population and the difficulty of feeding them healthy food. Globally, agriculture, fisheries, and aquaculture play a vital role in producing food for human consumption on land and in the ocean. Over the past decades, the aquaculture industry has been the fastest-growing food-producing sector in the world, but currently, the sector is facing many problems due to improper management, traditional techniques, and expensive labor. Therefore, the industry and rich farmers have adopted the use of automation and robotic technology in a variety of tasks to address current and future challenges in aquaculture with the overall goal of improving efficiency, reducing risks and costs, as well as increasing production and sustainability. Increasing automation in high-risk processes of aquaculture will have positive social and ethical impacts in addition to economic ones. This article discusses the use of automation and robotic techniques in the fisheries and aquaculture sector by reviewing the problems, processes, and applications in this field. From the review and analysis of the current situation and issues it is clear that automation in the aquaculture and fisheries sector will take it forward in the future with lower costs and more profits.

KEYWORDS

Automation, robotics, fisheries, aquaculture, future challenges

Introduction

Human populations continue to grow and pressure on the world's fisheries is also increasing (Merino *et al.,* 2012; Clavelle *et al.,* 2019). Compared to other sectors, including agriculture, the fisheries sector performs poorly. Farmers face many challenges like manual water testing, water restoration, sudden climate change, etc. It is extremely difficult to manually assess thousands of culture organisms on a regular basis for behavior and health in aquaculture (Andrewartha *et al.,* 2015). Other issues include inadequate site selection, poor record maintenance, low water quality, and incorrect management techniques. Recently developed technologies, such as the Internet of Things (IoT), robotics, big data, cloud computing, and artificial intelligence (AI) are being used to overcome the problems faced by aquaculture and fisheries sectors. These technologies help in increasing fish production by reducing human intervention and facilitating sustainable development, proper management, and efficient use of resources (Mustapha *et al.,* 2021). Currently, fisheries and aquaculture are expanding rapidly with the help of this technology, and providing sources of nutrition, food, and income to millions of people around the world (Teja *et al.,* 2020).

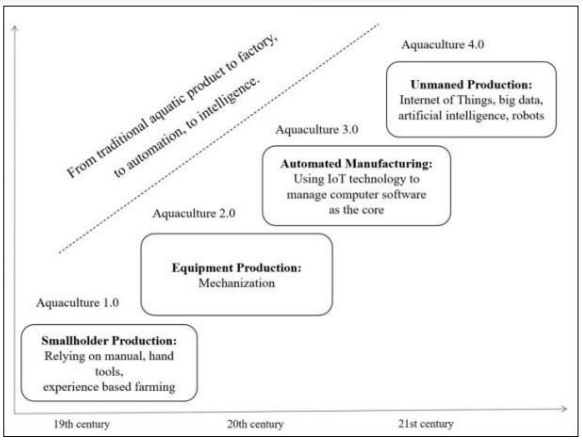

Fig. 1. Aquaculture Developing Generation 1.0 to 4.0 (Daoliang, 2018)

Automation and Robotic Devices

1. Drones (also named as Un-Manned Vehicle)

The use of drones in aquaculture and fisheries management has grown in popularity in recent years as a result of their ability to monitor and manage aquatic resources in innovative and creative ways. These offer potential solutions to some of the problems facing the aquaculture and fisheries management sectors, such as monitoring fish populations, evaluating water quality, and enforcing regulations. Apart from this, they are used to prevent illegal activities in large water areas and collect important information related to them through photographs and video records (Source: online).

Challenges and limitations: Strong winds and rain can damage the stability and performance of drones, affecting drone operations in aquatic areas. Additionally, it is not suitable for all locations as it may disturb or displace aquatic species

Three main types of the drone may be distinguished:

- **UAV:** Unmanned Aerial Vehicle
- **USV:** Unmanned Surface Vehicle
- **UUV:** Unmanned Underwater Vehicle (where the distinction is made between ROV (Remotely Operated Vehicle) & AUV (Autonomous Underwater Vehicle).

2. AI Feeding Devices

In aquaculture, about 60% of the cost is feed cost. High or lower feeding can cause various problems in the culture system. Due to the high feeding feed wastage occurs which deteriorates the water quality. Due to the less feeding, various problems are developed like- cannibalism, mutual attack, appetite, etc. So the use of an accurate amount of feed is very necessary for the culture system and it is possible when we use modern technology like- AI feeding devices. The AI feeding device is a sensor and acoustic-based device that differentiates the appetite of fish and gives the right amount of feeds to them. The AI feeding device also saves feed and labor. It is also useful to maintain water quality through proper utilization of feed (Chrispin *et al.*, 2020).

Challenges and limitations: It's initial and maintenance cost is high so not every farmer can afford it, and another major disadvantage of AI is that it creates unemployment for workers.

3. Robotic fish

Robotic fish is sensor-based equipment that is used to collect and analyze water quality parameters like- temperature, turbidity, dissolved oxygen, carbon dioxide, etc. The robotic fish also measure the heart rates of fish. They can be connected to a smartphone, and through the smartphone, we can easily collect data. The robotic fish independently swim in the water and monitor all water quality parameters (Ogurtsov *et. al.*, 2014).

Challenges and limitations: Expensive and have limited wireless communication.

4. Robotic turtle

A robotic turtle is an artificial turtle where a camera and sensors are placed to monitor the activity of fish and other things. Generally, robotic turtles are used for large culture systems like cage culture in the sea. Monitoring cages in the sea is a very difficult task for farmers. So the robotic turtles are very useful for large farmers to monitor their cages

in the sea. In cage culture, various problems can occur like holes in the net, fish mortality, fish disease, fish feeding, etc. The net hole is the main problem in cage culture, through the hole the fishes can escape from the cage and mix with wild fishes where they can interbreed with the wild population. So we can say it is a very serious problem for farmers. So farmers may use robotic turtles for monitoring their cages. The robotic turtle also provides images and data of cages and fishes to farmers. The farmers can be assessed images and data through smartphones, computers, or other gadgets. When divers monitor the cages it causes various problems like- water disturbance and stress. But the robotic turtle does not disturb the water and does not cause stress to fish. They swim calmly and fairly close to the cage and fish. The small size and slow movements of turtle robots make it less disturbing to the fish (https://electronics360.globalspec.com/article/14925/robot-turtle-can-monitor-fish-without-stressing-them).

Challenges and limitations: Expensive and have limited wireless communication.

5. Robotic Fish Cages

Ocean Farm Technologies, Inc. of Searsmont, Maine, has developed self-propelled spherical aquaculture cages suitable for use in rough, open ocean conditions and designed to support a wide variety of aquatic species. The robotic fish cage can be fully or partially submerged in water. The robotic cage is very strong against the strong current. In normal cages, the main problem is a hole in the net but in robotic cages, this problem can be solved by robots, which examine cages and if necessary then repair the net. In a robotic cage, all activities of fish are monitored automatically by robots. In a robotic cage, various types of cameras and sensors monitor the cages. The price of robotic cages is very high. But if you buy and install it at sea then it will be very beneficial for you through the production increment and less input cost (https://thefutureofthings.com/6281-robotic-fish-cages/).

Challenges and limitations: Investments and maintenance on robotic fish cages are much higher.

6. Smart Boat

The smart boat technology is a smart technology that is a USV (Unmanned surface vehicle) platform. This technology can be used to monitor water quality. It is a sensor-based technology and is easily assessed by farmers. This is portable so we can transport them easily from one place to another places due to their less weight (3 kg) and dimensions (24*28*28 cm). The SMART Boat is also used in place to assess water quality

parameters where human intervention is less possible like- water enclosed by high mountains, deep water, and so on.

Challenges and limitations: Its maximum speed is approximately 40 cm/s. They can be used in normal environmental temperatures ranging from 20-25^{o} C. It collects data with maximum speed and the operating time is about 30 minutes.

7. Deep trekker

Deep trekker is an underwater remotely operated vehicle that's hand-held, battery-powered, and widely used by aquaculture companies internationally. Generally, it is used in rivers, lakes, and oceans for hull inspections, fish health inspections, and fish feeding, etc. Additionally, Deep Trekker's can be used for special operations, including recovery missions, surveying for enemy submarines or divers, or search and rescue operations. It provides images and videos to the farmers for better management.

Challenges and limitations: Deep trekkers can reach depths of only 200 meters and have a battery life of 8-10 hours.

Conclusion

The better management of fisheries can be done through the use of automation and robotic technology. These techniques also help in reducing the environmental problem, solving the shortage of laborers problem, and also increase economic benefits. But at the same time, various problems occur like- unstable sensors, inefficient robots, and lack of AI applications and equipment. Overcoming these problems requires joint efforts of government, entrepreneurs, and research institutes. The government should give various subsidies and security legislation and so on. Entrepreneurs should increase production and decrease input costs through smart technologies. The research institute should make an efficient robot and technology with fast response and stability.

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