DIGITALIZING OF FISH FARMING & AQUACULTURE

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INTRODUCTION

Digitalization of fish farming is the evolving process by which today people are diversifying aquaculture models and businesses into new dimensions. It includes systems like intelligent water quality monitoring systems, innovative soil quality management systems, monitoring of weather forecasting, monitoring of fish quality, online training for the fish farmers, fresh fish delivery from farm to plate, Sensor-based feeding management technology, AI-based solar aeration technology, technology for pond management; deep sea fishing, etc. Digitalization of fish farming is now an integral part of AI and IoT technology, which are correlated with each other for diversifying Indian aquaculture, with a new face to boost this sector and provide a new dimension for economic growth.

IoT IN FISHERIES & AQUACULTURE

The Internet of Things (IoT) has revolutionized various industries, and fisheries and aquaculture are no exception. With the integration of AI and IoT technologies, these sectors have experienced a significant shift towards online and digitalized operations.

IoT devices such as sensors, cameras, and GPS trackers are being used to monitor water quality, track fish migration patterns, and detect potential issues in real time. AI algorithms analyze this data to provide valuable insights for fishery management. By leveraging these technologies, fishery operators can make informed decisions regarding stocking levels, feeding schedules, and disease prevention measures.

Similarly, IoT plays a crucial role in aquaculture in creating a connected ecosystem. Smart sensors embedded in fish tanks or ponds can monitor parameters like temperature, oxygen levels, pH balance, and feed consumption. This data is transmitted wirelessly to a centralized system where AI algorithms analyze it to optimize feeding regimes and detect anomalies or health issues among aquatic organisms.

Furthermore, IoT enables remote monitoring and control of fishery and aquaculture operations through mobile applications or web-based interfaces. This allows farmers or managers to access real-time data from anywhere. They can adjust environmental conditions or feeding schedules accordingly without physically being present on-site.

Overall, integrating AI and IoT in fisheries and aquaculture brings numerous benefits, including increased efficiency in resource management, improved productivity through optimized practices based on data-driven insights, and enhanced sustainability by minimizing environmental impact. As technology advances rapidly in this domain, the potential for further innovation is vast, and we can expect even more exciting developments that will shape the future of these industries.

UTILIZATION OF IOT-BASED SOLUTIONS IN AQUACULTURE & FISHERIES

Digitalizing fish farming has become increasingly important in modern aquaculture development and growth. With technological advancements, several areas of fish farming can benefit from digitalization (Table 1).

This includes AI-based fingerling detection, AI-based farm management, Sensor based feeding management, IoT in fisheries and aquaculture, and many more.

Table 1: IOTs in various Aquaculture Systems

S.No.	Aquaculture System	Parameters checked	Microprocessors	References
1.	Aquaponics System	pH, Temp., Turbidity, NH_3, NO_3^{2-}	Arduino	Udanor *et al.* (2022)
2.	Hydroponics with Aquaculture sytem	pH, Temp., Humidity	Arduino	Tamana *et al.* (2021)
3.	Recirculating Aquaculture System	Temp. & Water-level	Raspberry Pi	Al-Hussaini *et al.* (2018)
4.	Biofloc Technology	pH, Temp., DO & TDS	Arduino UNO	Rashid *et al.* (2022)

I. Smart Water Quality Monitoring System
II. Smart Soil Quality Monitoring System
III. Smart Fish Sensory Evolution System
IV. Smart Weather & Climate Observation Station
V. IoT Based on Farm Management
VI. Artificial Intelligence for Fish Health and Body Metrics
VII. AI-Based Fingerling Detection
VIII. AI-Based Farm Management
IX. Sensor-Based Feeding Management
X. Online Training to the Fishers
XI. Online Fresh Fish Delivery (Farm to Plate)
XII. Online Booking for Entertainment
XIII. E-Commerce Platform
XIV. IoT Based Fish Transportation Devices

XV. IoT Fish Counting Device
XVI. IoT Based Solar Aeration System
XVII. IoT Based Fish Diagnostic System Through Image Analysing
XVIII. Online Platform for Consultancy Services, etc.

I. SMART WATER QUALITY MONITORING SYSTEM

The digital transformation of fish farming has brought about innovative solutions to enhance productivity and sustainability. This section explores various technologies and systems that are revolutionizing the industry. One crucial aspect is the implementation of smart water quality management systems. These systems leverage IoT sensors and data analytics to continuously monitor water parameters such as temperature, pH levels, dissolved oxygen, and nutrient concentrations. By maintaining optimal water conditions, fish health and growth can be maximized while minimizing the risk of diseases.

Water Pollution is a major threat to any aquaculture farm, as it affects health, economy, and biodiversity. Different methods of water quality monitoring and an efficient IoT-based method for water quality monitoring systems are used in Aquaculture (Varsha Lakshmikantha et al., 2021).

II. SMART SOIL QUALITY MONITORING SYSTEM

Similarly, Smart Soil quality study systems are vital in optimizing fish farm operations. These systems employ advanced sensors to measure soil characteristics like moisture content, nutrient levels, and salinity. By analyzing this data in real-time, farmers can make informed decisions regarding fertilization and irrigation practices to ensure optimal growth conditions for aquatic plants or crops. In 2050, the global population will exceed 9.5 billion people, increasing food demand. Increased production necessitated a significant expansion in the land and irrigation water resources. Adequate soil and water management strategies were essential for sustainable agriculture management practices (John Havlin, Ron Heiniger; Soil Fertility Management for Better Crop Production, 2020).

To combat soil and water pollution issues, smart soil or water pollutant study systems are utilized. These systems employ advanced monitoring techniques to detect contaminants in the water, such as heavy metals or chemical pollutants. By identifying potential sources of pollution promptly, appropriate measures can be taken to mitigate their impact on fish health and overall ecosystem sustainability.

III. SMART FISH SENSORY EVOLUTION SYSTEM

Technological advancements have also led to the development of fish sensory evolution systems in recent years. These innovative tools enable farmers to better understand fish behaviour by monitoring their response to environmental stimuli such as light intensity or sound frequencies. This knowledge helps optimize feeding strategies and create a more natural habitat for aquatic species.

IV. SMART WEATHER & CLIMATE OBSERVATION STATION

Moreover, weather and climate observation stations with IoT devices provide real-time weather data for fish farm locations. This information aids farmers in making informed decisions related to feeding schedules, harvesting times, or implementing protective measures during extreme weather events. Lin et al. (2021) developed a system that integrates various sensors, including dissolved oxygen, pH, and water temperature in each water layer.

V. IOT-BASED FARM MANAGEMENT

IoT-based farm management platforms integrate various aspects of aquaculture operations into a centralized system. These platforms allow farmers to remotely monitor critical parameters such as water quality or feed consumption rates through mobile applications or web interfaces. Such streamlined management processes significantly enhance operational efficiency while reducing manual labor requirements. The soil and water samples are monitored and analyzed using the soil fertility prediction system (Aarthi et al., 2023).

VI. ARTIFICIAL INTELLIGENCE FOR FISH HEALTH AND BODY METRICS

Artificial intelligence (AI) has also been found to be applicable in fish farming, particularly in fish health and body metrics analysis. AI algorithms can analyze data from various sources, such as underwater cameras or wearable devices, to assess fish behavior, and growth rates or detect early signs of diseases. This allows for timely interventions and improved overall fish health management.

VII. AI-BASED FINGERLING DETECTION

AI-based fingerling detection is a significant development in the industry. It utilizes artificial intelligence to accurately identify and count fingerlings, which are young fish used for stocking ponds or tanks. This technology helps streamline the process of monitoring and managing fish populations.

VIII. SENSOR-BASED FEEDING MANAGEMENT

Sensor-based feeding management is another crucial aspect of digitalized fish farming. Sensors placed within the aquaculture system can monitor feed consumption by individual or groups of fish. This data helps optimize feeding strategies and reduce waste.

IX. ONLINE TRAINING FOR THE FISH FARMER

Online training platforms have emerged to provide remote education and guidance to fish farmers. These platforms offer courses on best practices in aquaculture techniques, disease prevention measures, sustainable farming methods, etc., empowering farmers with the knowledge necessary for successful operations. There are many Online E platforms user friendly come up to help farmers 24 x 7, such as the E-fish Tutor app.

X. ONLINE FRESH FISH DELIVERY SYSTEM

Digitalization has also extended to consumer-facing aspects such as online fresh fish delivery services. Customers can now conveniently order freshly caught or farmed seafood directly from producers through online platforms or mobile applications.

XI. ONLINE BOOKING FOR ENTERTAINMENT

Furthermore, online booking services have made it easier for consumers to plan their visits to entertainment facilities associated with fisheries, such as fishing resorts or recreational fishing spots. These platforms allow customers to reserve their spots, check availability, and plan their fishing activities.

XII. E-COMMERCE PLATFORM

In today's digitalized world, E-commerce platforms have become vital for various industries, including the fishery and aquaculture sectors. An E-

commerce platform designed explicitly for fish allows fish farmers and suppliers to showcase their products online, reach a broader customer base, and streamline the buying process. With features like product listings, secure payment gateways, and order tracking systems, this platform enables seamless transactions between buyers and sellers in the fish industry.

XIII. IOT BASED FISH TRANSPORTATION

Transporting live fish from farms to markets or other destinations can be challenging. However, with IoT technology, fish transportation can be more efficient and reliable. IoT-based systems can monitor water quality, temperature, oxygen levels, and GPS tracking during transportation. This ensures that the fish are transported optimally with minimal stress or loss.

XIV. IOT FISH COUNTING DEVICE FOR FISH POPULATION STUDY

Accurate monitoring of fish populations is crucial for effective management in fisheries or aquaculture operations. IoT-based fish counting devices use advanced sensors and image recognition technology to automatically measure the number of fish in a tank or pond. This eliminates the need for manual counting methods and provides real-time data on population size for better decision-making.

The sonar imaging device has two cloud-based Artificial Intelligence (AI) functions that estimate the quantity and the distribution of the length and weight of fish in a crowded fish school. Because sonar images can be noisy and fish instances of an overcrowded fish school are often overlapped, machine learning technologies, such as Mask R-CNN, Gaussian mixture models, convolutional neural networks, and semantic segmentation networks were employed to address the difficulty in the analysis of fish in sonar images. Furthermore, the sonar and stereo RGB images were aligned in the 3D space, offering an additional AI function for fish annotation based on RGB images (Chang et al. 2022).

XV. IOT BASED SOLAR AERATION SYSTEM

Maintaining proper oxygen levels in ponds or tanks is essential for healthy aquatic life in fisheies or aquaculture setups. An IoT-based solar aeration system utilizes solar power to operate aerators that increase dissolved oxygen levels in water bodies where the electricity supply may be limited or unreliable. This sustainable solution ensures optimal conditions for fish growth while reducing energy costs.

XVI. IOT BASED FISH DIAGNOSTIC SYSTEM THROUGH IMAGE ANALYSING

Early detection of diseases is crucial in preventing outbreaks and minimizing losses in fisheries or aquaculture operations. An IoT-based diagnostic system uses image analysis techniques to identify signs of diseases or abnormalities in captured images of fish's external appearance. This system can provide quick and accurate diagnoses, allowing fish farmers to take timely actions to prevent the spread of diseases.

Verma et al. (2017) proposed a sensitive topic that is kidney stone detection. In this paper, the authors apply morphological operations and segmentation to determine ROI (region of interest) for the SVM classification technique. After applying this technique, they investigated the kidney stone images with some difficulties, such as the similarity of kidney stones and low image resolution (Ahmed et al. 2022).

XVII. ONLINE PLATFORM FOR CONSULTANCY SERVICES

The fishery and aquaculture industry often requires expert guidance and consultancy services for various aspects such as farm management, breeding techniques, disease prevention, and market analysis. An online platform dedicated to consultancy services provides a convenient way for industry professionals to connect with experts in the field. Through this platform, users can access valuable insights, seek advice, and receive personalized recommendations to optimize their operations and improve overall productivity.

MAJOR CONSTRAINTS

It requires more variables than we can currently monitor to obtain the most complete picture of farm activity. Creating new probes to measure microbes, micropollutants, or other physicochemical propeties makes this a technological challenge.

Another significant barrier to the IoT revolution in this industry is the capacity to transport a significant volume of data from the farm using the least amount of energy. By examining their behavior, activity, and potential diseases directly underwater, developing real-time monitoring using high-quality HD video feeds to enable deep image processing would create new prospects for livestock surveys. Additionally, it will be possible to scan the microenvironment, such as the weather or local activity, to stop poaching.

CONCLUSION

In conclusion, Digitalizing Fish Farming through various technologies such as AI-based fingerling detection, AI-based farm management, sensor-based feeding management, IoT integration, online training platforms, online fresh fish delivery services, and online booking for entertainment facilities brings numerous benefits to both farmers and consumers. It enhances efficiency, productivity, and sustainability and provides convenience in the industry with new job opportunities.

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