SeaHealthUCD

Issue 44: September, 2023: This e-bulletin is aimed at personnel in fisheries and aquaculture, at fish packers, processors, distributors, retailers and finally, consumers.

Applications of the *Internet of Things* in the fisheries & seafood sectors

The Internet of Things (IoT) involves extending internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any non-internet-enabled physical devices. Embedded with software, sensors and other technology, the devices can communicate and interact over the internet. The concept of IoT was first mooted about 1985; it gathered momentum in 2008-2011 and snowballed in the last 5 years. IoT devices gather information which is processed, collated and distilled via a central server to the user's benefit, e.g., a familiar household application is a hub embracing internet-enabled thermostats, doorbells, smoke detectors and security alarms where data is shared between physical devices and users can remotely control the items in that hub via a mobile app or website. Of importance in this article is the application of IoT in the fisheries and seafood sectors.

Applications of IoT in the fisheries sector

IoT technologies can be applied to many aspects of the fisheries industry. Smart buoys provide trawlers with information on location and size of fish shoals and also the species. Satellite-connected devices enable fishermen focus on species they are allowed to catch and also avoid catching juvenile fish, thus promoting sustainable fishing. Electronic observation devices can monitor the activities of fishing fleets remotely and remove the necessity of having observers on board vessels. IoT also has application in fishing vessel design where sensors collect information from the ship and find out how it operates/evolves over time thus facilitating more rapid problem solving and continuous design improvement and fine-tuning (Anon 2023). 'IoT for All' (Anon, 2020) highlights five ways that IoT is changing fishing practices/aquaculture: *(i) overfishing*---data are collected and used to monitor catches, location of vessels and enforce sustainable fishing practices thus ensuring/maintaining wild fish and seafood supplies; *(ii) precision fishing*---optimising when and where to fish, species selection, and on-board species sorting thus improving fuel consumption and trawler operating costs; *(iii) health and welfare of fish farms*---sensors in smart fish farms provide data on fish behaviour and water conditions, and also on detection of disease outbreaks thus ensuring early intervention and control; *(iv) optimising feeding*---improving operating costs via elimination of overfeeding. For example, efishery smart farms use feeders based on vibration and acoustic signals which facilitate accurate feeding regimes; *(v) harvest optimisation*---modelling the reproduction, growth, and maturation of a species helps optimise rearing and planning for optimum harvesting time.

Coronado *et al*. (2021) have shown that combining sensor management with data analytics facilitates supply chain digitalisation in the fisheries sector by presenting a conceptual approach that integrates sensor management using Wireless Sensor Network (WSN) theory coupled with analysis of high volumes of

sensor-generated data. This approach focuses at the point of origin/capture in the supply chain. The recorded data become part of the supply chain ledger/records that support supply chain control and embrace transportation, provenance tracking, handling, storage, tamper proof checks and product history. Dhunevakonda *et al*. (2020) have highlighted fish-farm-monitoring IoT systems in India for measuring pond pH, temperature, dissolved oxygen, ammonia content and also for automatic control of feed distribution. A recent review of scientific papers on IoT application to water quality monitoring gave a breakdown of 81 (inland aquaculture) and 19% (marine aquaculture) (*Prapti, 2022*). Temperature (20), dissolved oxygen (18) and pH (17%) were the most used water quality parameters in IoT-based aquaculture.

Applications of IoT in the seafood processing sector

Specific examples of the use of IoT in seafood processing are limited but there are a number of IoT applications in the broader food industry. IoT is one of the technical developments in Industry 4.0 (4th Industrial Revolution). Industry 4.0 increases operational efficiency via interconnection, information transparency, technical assistance and decentralised decisions. Soni (2021) reported nine potential applications of IoT in the food industry: (i) management of industry equipment; (ii) enhancing smart refrigerator performance; (iii) reducing energy consumption; (iv) facilitating stock management; (v) improving equipment design; (vi) reducing logistics charges; (vii) enhanced data analytics reporting; (viii) food safety regulations i.e. IoT enabled sensors/recorders help ensure premium food quality; (ix) providing updates on customer behaviour and requirements. Similarly, Dadhaneeya *et al.* (2023) reported that IoT has major application in the food industry in terms of improving overall sustainability practices, reducing energy consumption, reducing manufacturing costs, enhancing worker health and safety, creating eco-friendly products, and improving working conditions. IoT converts ageing processes into smart processes by better controlling real-time data detection and optimization.

Conclusions

IoT has, and will have major future application in all aspects of the fisheries and seafood processing sectors. User knowledge must keep pace with IoT developments in order to achieve maximum benefits.

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