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One day International Conference

EMERGING TRENDS IN SCIENCE AND TECHNOLOGY (ETIST-2021)

27th October 2021

Jointly Organized by

Department of Biological Science, Physical Science and Computational Science

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ABOUT THE INSTITUTION

A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

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Data Mining and Technologies Utilized in Aquaculture

Gladju. J[1] - Kanagaraj. A[2] - Finny Belwin A[3] - Linda Sherin A[4] - Dr. Jackson Akpojaro[5]

ABSTRACT: India has a long coastline of 8118 km and also has backwaters, bays, estuaries, etc. The aquaculture and marine fisheries in India has pulsating economical activities, and is one of the fastest growing nutrition rich food production area. Generally the marine aquaculture is vitally important to the economy and good fortune of coastal community people that provides them job opportunities, food security, income and livelihoods and it is also provides their traditional cultural identity. Sustainability of marine aquaculture is significantly important in terms of social, political, ecological, and economic stability. Marine fishes are highly perishable commodity, so fish processing process always requires appropriate landing amenities, processing, stowage, transport and dissemination facilities throughout the process of supply chain from capture to purchaser. Oceanic fishes usually shows a wide-ranging response to spatial and temporal variations in the environment of the sea and these are shown in climate data and oceanographic data. The captured fishes and aquaculture provides more than 12.9 million tonnes of different aquatic organisms that are used to feed millions of people. Further, it is a central economic activity for the fisherman and coastal people, it also provides livelihood to more than 14.5 million people. Aquaculture has earned significant foreign exchange from fish and fishery products. Consistent rapid growth and technological progress in aquaculture, the large volume of information and scientific data currently available in fisheries, and aquaculture along with its allied activities are always increasing day by day along with the technology advancement. Many researches have been made to explore and extract the fullest essence of information from the available data sources to develop intelligent machine support systems for all the activities in aquaculture management, but still there is a need for more all-inclusive efforts to analyse and predict the patterns that are repeated in aquaculture. In this ambiance, we will illustrate and concisely discuss the data mining process and machine intelligent techniques and their scope of application in capture fisheries and aquaculture that includes 1.Overview of data mining utilized

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in aquaculture; 2.Computational methods in fisheries management; 3.Environment monitoring using machine intelligence; 4. Feed optimization using computer technology; 5.Socioeconomics in fisheries and aquaculture.

Keywords: Data mining, Fish, Fisheries, Aquaculture, artificial intelligence

1. INTRODUCTION

India is the third largest fish producing and second largest fishery and aquaculture nation after China in the world. The fishery and aquaculture sector has a significant role in the Indian economy. Fisheries in India can be classified as Marine Fisheries, Freshwater or Inland Fishery, Estuarine Fisheries, and Pearl Fisheries. Marine aquaculture process consists of breeding, rearing, and harvesting of aquatic plants and animals, these can take place in the ocean, or on land in tanks and ponds. Inland fishery is the rearing of fish in freshwaters like ponds, canals, rivers, and reservoirs. From the available marine resources, India has an estimated aquaculture potential of 4.41 million tonnes. India has 3.15 million hectares of reservoirs, 2.5 million hectares of ponds and tanks, cold water resources of hilly states, 1.25 million hectares of brackish water area, and altogether other inland fishery resources has a production potential of about 15 million tonnes. There are vast and diverse unutilized resources of 191,024 km of rivers and canals, 2.36 million Ha of ponds and tanks, 1.2 million Ha of floodplain lakes, 1.24 million Ha of brackish water resources, and 3.54 million Ha of reservoirs, these when utilized provides abundant opportunities for enriched production along with livelihood improvement and leading economic prosperity [1].

The fisheries and aquaculture resources when developed, managed, conserved periodically it is always provides improved livelihoods, and generates food and nutrition supply chain, employment, economic prosperity. These can be enhanced by precise strategies, partnership with public, private and community, participation of stakeholders, market support, and firming up research, convergence extension, and their linkages. The use of various information technology such as smart phones, data mining, artificial intelligence, big data, block chain, drones and camera in fishery farms has greatly improved the data collection, storage, analysis, processing, retrieval, and reporting capabilities, along with speed and accuracy of the data management process. Data mining techniques are used for robust evaluation and prediction tools in it are scientific aids to improve and promote the supply chain efficacy. Data Mining recognizes patterns that are used to describe about analyzing and predicting data using classification, clustering, regression, correlation, and machine learning. Technologically advancement in aquaculture data systems facilitates the traceability of catch for fisheries, reduces the cost of data collection, and improves the communication and teamwork between fishery managers and fishers to attain their common goals [2].

Currently some aquaculture activities have adopted artificial intelligence tools based on data mining and machine learning algorithms that is already making significant impact on aquaculture production systems. These are also helping the aqua farmers in optimisation of feed use without any waste, disease prevention in fisheries, surface temperature monitoring in ocean, biomass monitoring and intelligence in market management in both inland and aquatic farms. The emergent technology includes mobile phones and tablets; cloud-based computing for storing data and artificial intelligence for empowering and automating the data processing and analysis. Computer vision, GPS and on-board passive sensors provides integrated analysis, processing and transformation of large real-time spatial

and temporal data. These available data helps the fishers to optimize their fishing based on the information been received related to ocean dynamics [2].

2. Overview of data mining utilized in Aquaculture

Data mining is the extraction or mining of useful knowledge from a data set or database, through a multiple steps of iterations, it also discovers patterns in huge data sets that involves other machine intelligence methods such as artificial intelligence, machine learning, statistics and database system [3]. Data mining techniques can be mainly divided into supervised or predictive (classification, time series analysis and regression) and unsupervised or descriptive (clustering, association rules, summarization and sequence discovery) techniques. For instance, *k*-means is a data mining technique used for clustering, that aims to group data based on measure of similarities between data samples in an unclassified data set; *k*-means belongs to the category of expectation maximization algorithms, which are powerful for finding maximum likelihood solutions for models with latent variables, *k*-nearest neighbour is another classification technique that has known training set which is used to classify samples of unknown classification, with the assumption that analogous samples should have related classification., is the Artificial neural networks data classification system is more advanced to this which is inspired by the research on human brain [8], [7].

In ANN network, each node represents a neuron that perform simple tasks and each link represents the process of how two neurons interact to perform complex tasks. The arrangement of the neural network defines the capability of a network to perform a given task and the most commonly used type of artificial neural network is the multilayer perceptron neural network in which neurons are structured in layers. To classify data samples in two disconnect or linearly detachable classes, binary classifiers such as support vector machines are used [8], [4]. All these data mining techniques have numerous applications in the field of aquaculture and fisheries management. The various classification of techniques involved in data mining are depicted briefly in Fig.1.

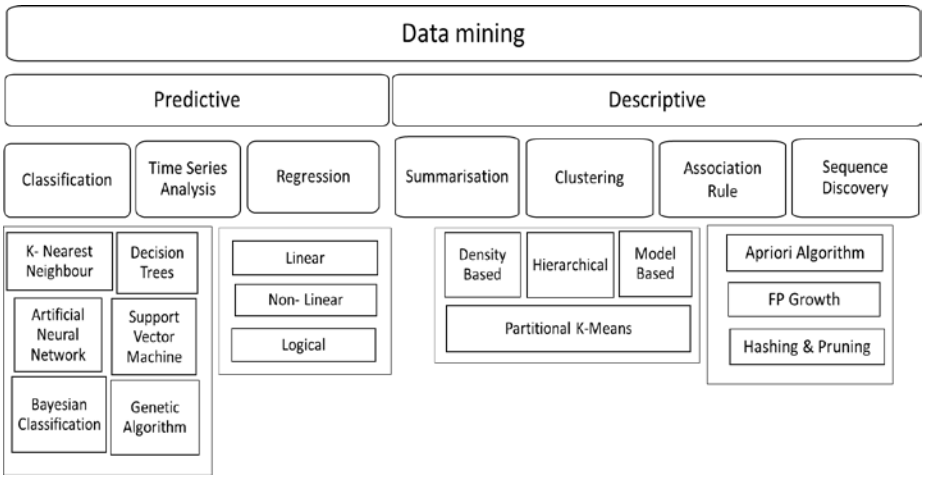

Fig 1. Data Mining Techniques

3. Computational methods in Fisheries Management

Early research in fisheries management describes about object-oriented modelling and simulation based on artificial intelligence for the aquaculture management. The various fishing developments are achieved by proposition to generate qualitative fisheries and aquaculture management and it is based on ecological, sociological and economic knowledge [18]. Some of the currently used expert system in aquaculture management are CANOFISH that is used for canonical fishery management expert system, ProTuna that is used for management of tuna fisheries, CLUPEX is used for management of herring fisheries, FISHMAP is used for fish stock assessment studies, SimerFish is used for total allowable catch determination and fish stock estimation and fishway design expert system is used for prediction of fish migration path and spatiotemporal assignment mining model (STAMM) is been used to study the spatiotemporal pattern of temperature that controls the assembling and distribution of fish based on spatio temporal value, Decision-Interval Cumulative Sum (DI-CUSUM) control chart are useful in monitoring fisheries indicators that includes large fish indicator and recruitment index and in fishery simulation [11], [14], [19].

Machine intelligence and data mining tools are also used in decision making process. Some technologies currently being used to decrease feed wastage includes Observe Technologies, eFishery and Umitron Cell; and AquaCloud, Aqua connect are used for detection and preventing fish disease; and XpertSea is been used for price tracking and growth prediction. Some of the techniques in data mining that includes nearest neighbour clustering and Apriori algorithm are used for fish stock assessment [13],[11]. Data mining tools mostly helps to predict future trends and behaviours, it can be always useful in fisheries and aquaculture researchers to take initiatives and make knowledge-driven decisions. In the immediate future, more erudite and appropriate data mining techniques will be required to discourse complex problems and provide enhanced solutions in aquaculture allied fields.

4. Environment monitoring using machine intelligence

An environmental monitoring system is the process that monitors the quality of the environment of freshwater, brackish water, and marine. Environmental monitoring assessment studies and environmental control of the production environment in aquaculture systems includes the process of measuring physico-chemical properties of the rearing water, predicting adverse changes and mitigating associated production-economic risks by supporting decision-making in aquaculture context [5]. The colossal biological integrity, diversity and socio-economic significance of marine and freshwater ecosystems are vulnerable by declining environmental conditions due to pollution, anthropogenic activities, territory degradation, and global climatic change [6]. The importance of environment monitoring system curtails from the close correlation between the environmental circumstances and dynamics affecting aquaculture production such as feed utilization, animal health, animal growth rates, aquatic stocking densities and feed and other waste management. Outline of such environmental parameters include salinity, temperature, pH, dissolved oxygen, ammonia, nitrates, nitrites, suspended solids, water flow rates and turbidity [12].

For illustration, the spatiotemporal dynamics of a living aquatic organism and its life progression processes are closely related with environmental elements. Another data mining approach to ascertain hydrologic pointers related

to aquatic species community was established on genetic programming using the Shannon index and the quantity of individuals of a fish community [9]. To research this ecological characteristic, a precise data-mining methodology i.e., the spatiotemporal assignment mining model (STAMM) has been used to excerpt the spatiotemporal pattern and consignment of environmental features (e.g. water temperature) which controls fish scattering in yellow sea, China. Neighbourhood guidelines and associations were used to paradigm a decision table, with recursively administered indices that expresses the possibilities of the ecological association [8]. In another perspective, data mining approach has been used for supply stock assessment of fisheries possessions based on species-wise fisheries statistics and catch per unit effort analysis. Similarly, artificial neural network based self-organising feature maps was found to be useful for exploring the relationship between fish community and water quality by clustering, analysing and visualizing heterogeneous datasets [10].

Further, data mining algorithms such as a grid density based clustering for high dimensional data (AGRID+) was found to be useful in the fortitude of prospective fishing zones based on daily aggregates of fishes and temporal in different spatial clusters [5],[11]. Data mining techniques like *k*-means clustering and multiple regression models have also been utilized to forecast and determine the economic well-being of fish farmers and coastal fishermen, using macroeconomic and microeconomic pointer. In the Indian aquaculture and fisheries perspective, the opportunities are plenty, but only less substantial exertion has been made to elicit expedient data patterns and information from the prevailing databases which can be monitored by doing further research.

5. Feed optimization using computer technology

Fish feeding is an important element of fish and aquatic farming, numerous researches are done for improving and optimizing the feed. Fully automated smart fish feeding system are well capable of monitoring food behaviour of aquatic organism using various sensors. These system also follows quantitative methodologies for ample understanding of fish growth. Micro-computer processor and BASIC program is an early automatic feed delivery and temperature control were used in experimental fish hatcheries [22]. Another data mining technique known as support vector machine based classifier and visual signal processing system is been used for continuous monitoring and automated control of fish feeding and are used in fisheries and aquaculture tanks; principal component analysis and k-nearest neighbour are used in classification of hunger behaviour of aquatic species by analysing the automated feeder and implementing image processing to improve utilisation of fish feed; adaptive neural based fuzzy inference system helps in decision making and assessing for feeding based on changes in various parameters of water quality; computing and spectral data processing provides proficient operation of algae production system by real-time bioreactor monitoring system that controls with relevant parameters to nutrient distribution, biomass harvesting, time, light and temperature [23].

The fish feeder in most of the smart feeding system has a horizontal cylindrical automatic dispenser food container with an adaptable gap at one end, then the food container should be connected to a stepper motor, that can be controlled by I/O multiplexer such as Raspberry Pi or Arduino, depending on the data from the web cameras, the container is rotated 360 to drop a small portion of food in the tank [20]. These advanced methods of fish feed generally comprises an intelligent feeding system based on fish behavioural activities. The recent smart fish feeding

architecture consist of a few number of components that comprises the software algorithm with the database of the fish and hardware design.

6. Socioeconomics in fisheries and aquaculture

The fisheries sector is generally précised by its contribution to the gross national product (3%), export earnings (11%) and employment (5%). Fishes are the major essential source of animal protein that provides 80% of the animal protein intake and 7% of total protein supplies [21]. Fishery exports have increased by 15% per year over the past ten years. There are some major socioeconomic problems in inland capture fisheries, inland culture fisheries, marine fisheries and coastal fisheries that are commonly in production/marketing cooperation of fishermen, reliance of fishermen on village moneylenders, traders, and boat owners for loans, dissatisfaction of sharing catch, traditional method of fishing, lack of insurance coverage fishing equipments and of fisherman life, pollution of fishing resources, prolonging to traditional method of pond fish culture, irregular maintenance, limited knowledge of aquaculture techniques, poor fish disease management, lack of aquaculture farming facilities, inadequate evaluations of existing stock, number of fishermen and gears for fishery, exploitation of deep sea resources, lack of facilities of native markets for marine species, marketing infrastructure, landing sites, auction yard, cold storage, ice factories, refrigerated vans, over-populated coastal zone, stumpy financial, social and educational status of the fishermen, and water pollution by toxic wastes, heavy metals.

Based on the available data sources, data mining and other machine intelligence technologies can be utilized to generate patterns and decision making systems [15], [16], [17]. The x-means clustering can be used for estimating factors that affect the profitability and income of coastal fishermen communities. Multiple linear regression, k-means clustering and support vector regression can be used to forecast or model the socio-economic welfare and purchasing power of aquacultures' and fishermen.

5. Conclusion

Consequently, fisheries and aquaculture are rapidly growing along with huge volumes of data, which provokes the dynamic expansion of technology. But, balanced analysis of these huge data is getting more difficult and complicated. Development and deployment of suitable data mining algorithms could be the solution for sorting out and using the hidden patterns and knowledge in the huge data. However, to produce useful and precise information, data collection and analysing methods should be consistent and standardised; security and data sharing protocols must be well defined; speed and effectiveness of data processing should be uninterruptedly upgraded; and data mining tools and techniques should be accessible and cost-effective. Existing uses of computer technology in fisheries and aquaculture highlight the large potential of technology to progress fisheries transversely fishing sectors. In immediate future, it is definitely potential to address the several challenges that confines fish production systems, this can be effectively done using data mining, machine algorithms and artificial intelligence for accurate smart use and prediction of the available aquatic and fisheries resources.

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