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Effects of Data Normalization on Water Quality Model in a Recirculatory Aquaculture System Using Artificial Neural Network

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Abstract— **Water Quality remains one of the most important factor that influences the aquaculture system as it effects can make or mar the state of organisms as well as the environment. Furthermore, the use of Artificial intelligence especially the Artificial Neural Network (ANN) has greatly improved the forecasting capability of water quality due to better solutions produced as compared to other approaches. The performance of these AI techniques lies in the quality of dataset used for its implementation, which is in turn a function of the preprocessing (Normalization) techniques performed on them. In this paper, the effect of different normalization techniques namely; the Min-Max, Decimal Point, Unitary and the Z-Score were investigated on the prediction of the water quality of the Tank Cultured Re-circulatory Aquaculture System at the WAFT Laboratory, using the ANN. The Water Quality Index was based on the prediction of the Dissolved Oxygen (DO) as a function of the Temperature, Alkalinity, PH and conductivity. The performance of the techniques on the ANN was evaluated using the Mean Square Error (MSE), Nash-Sutcliffe Efficiency coefficient (NSE). The comparison of the evaluation of the various techniques depicts that all the approaches are applicable in the prediction of the DO. The Decimal point technique has the least MSE as compared to others, while the Min-Max technique has better performance with respect to the NSE.**

Keywords- aquaculture system; artificial neural network; dissolved oxygen; prediction; water quality index

I. INTRODUCTION

The processes involved in the cultivation and rearing of aquatic animals in controlled environment and conditions is referred to as Aquaculture [1, 2] In attaining a sustainable aquaculture system, the role and importance of water quality cannot be over emphasized as its effects can make or mar the entire cultivation process [2-4]. The amount of Dissolved Oxygen (DO) in the aquatic environment reflects the balance in the rate of production of oxygen and consummation of oxygen therein [5]. The amount of DO is used in estimating and quantifying the quality of the water in the environment [5].

Though, other environmental parameters such as temperature, salinity, turbidity, pH as well as water level in the system also plays significant roles in the estimation of the DO and consequently the water quality in the system [2, 6].

Over the years, there exist different approaches for the estimation and prediction of the water quality index in the aquaculture systems with respect to the DO level. One of such approach is the use of artificial intelligence based prediction algorithms [2, 5, 7, 8]. The successes of prediction algorithms such as Artificial Neural Network (ANN), Support Vector Machine (SVM) often lies in the quality of the data set used and as such the fidelity of the dataset used for prediction task must be guaranteed [9-11]. In real world applications, data acquisition processes are most often characterized by noise, inliners, outliners, missing data, inconsistent data that are needed to be removed before such dataset used[10-12]. Thus, data preprocessing techniques which includes data cleaning, data integration, data transformation and data reduction is required to improve the quality of the data [12]. Furthermore, the application of data normalization techniques have proven to improve the accuracy and efficiency of algorithms such as ANN, K-nearest neighbor and clustering classifiers [5, 8, 9, 13].

Past works depicts the suitability of various normalization techniques in predicting water quality. He and Che [14] used Min-Max normalization technique in the development of a water quality prediction model based on wavelet transform and support vector machine for a water monitoring station. Furthermore, [15] adopted the use of Min-Max normalization technique in the developing a particle swarm optimization algorithm for predicting water quality of Changjiang river.

In addition, [5] adopted the use of log-sigmoidal activation for the normalization of the dataset used in the comparative analysis of the different computational intelligence algorithm. The algorithms; the Multi-Layer Perceptron (MLP) ANN, Radian Basis Function (RBF) ANN, Linear Genetic Programming (LGP) and Support Vector Machine (SVM) was used for the prediction of dissolved oxygen level as a function of water quality in Delaware River. Antanasijevic, et al.[8] investigated the effect of three different normalization technique namely the Min-Max, Median and Z-score on various ANN models for the determination of Dissolved Oxygen in Danube River.