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Prediction of Significant Wave Height using Soft Computing Techniques

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ABSTRACT

There are several parameters which need to be considered in oceanography for various purpose. One such important parameter is wave heights which is useful to project the unevenness of the sea and the smoothness of the sea bed. There are several techniques for study of wave characteristics like empirical methods, numerical methods and soft computing techniques. The paper aims at identifying the suitability of soft computing techniques compared to other two techniques for prediction of significant wave height and thereby identifying appropriate soft computing technique from the various available.

1. Introduction

The study of wave characteristics is of vital importance for the coastal and marine life. The research community in the area has put considerable efforts to evaluate ocean parameters. However, wave height could not be approached accurately in view of the lack of technology [1]. [2] Provides a wide-ranging, acquainted review of statistical models proposed for modeling long-term inconsistency in extreme waves and sea states as well as a review of alternative methods from other areas of application. The different approaches used for wave height prediction are:

1. Empirical based
2. Numerical based and
3. Soft computing based

Empirical methods which are fast and simple, have been developed for wave prediction (SMB, SPM, JONSWAP [3]), however, their application is limited.

Numerical methods [4] have also proved useful for prediction and climate studies. However, one of the major drawbacks of the numerical methods is the large computational resources. WAM (Wave Analysis Model) is used primarily for deep water conditions, SWAN which is used mainly for shallow water region etc. Hence, the numerical models produce higher accuracy in limited area.

Limitations of these methods are that there are generally low possibilities of gaining accuracy in the model by taking into account available observed wave time series.

Soft computing techniques are the effective ways for overcoming the limitations of the traditional techniques. The various soft computing techniques available to develop wave prediction models are:

1. Artificial neural network
2. Fuzzy Inference system
3. Machine Learning
4. Adaptive Network based fuzzy inference system
5. Genetic programming
6. Decision trees
7. Support vector machine

2. Soft Computing Techniques

While we decide on the approach or tool that we are going to use for significant wave height prediction, the choice of input data for the model also impacts the quality of the prediction.

Therefore the **important parameters** from this perspective are:

1. Wind speed

2. Significant wave height
3. Wave direction
4. Wind direction

The primary factors shaping waves are the wind speed and duration. The waves in any location are the product of what is happening at any moment throughout the basin as well as what was happening there many hours previously.

The quality of the forecast can be improved by widening the range of input data in to the model.
Various soft computing techniques used for significant wave height prediction has shown that wind speed is the important parameter in wave parameter prediction.

Prediction of significant wave height is basically an uncertain and random process and is hence is difficult to accomplish by using deterministic equations.

Therefore it is ideally suited to **regression trees** since it is primarily aimed at recognition of a random pattern in a given set of input values. However, studies from different authors show that **error statistics** of soft computing techniques like **Artificial Neural Network** [5] compared to regression trees indicate are more accurate.

1. Artificial Neural Network

Neural networks are universal tools for classification, approximation, control and prediction of various phenomena. They are comprised of a set of artificial neurons linked together that work in parallel according to specific network architecture. This structure is able to capture and represent input-output relationships in data set. Networks learn by example, based on training sets, and can generalize knowledge obtained. A well trained net can predict output on the basis of input data that does not belong to the training set. Thus neural networks can predict many physical phenomenons. The neural network model can be used to predict significant wave height accurately

The Software tools (Neural Network) which are useful (but needs more detail exploration specifically for its utility) in Significant wave height prediction are:

1. Open Source tools

a. Open NN (Flood3) [6]

The multilayer perceptron is an important model of neural network and useful for wave height prediction. Open NN (Flood 3) supports Multilayer Perceptron and includes function regression, pattern recognition, time series prediction, etc.

b. Java:

- neuroph [7]

c. Weka [8]

d. FANN

Fast Artificial Neural Network Library [9] is a free open source neural network library, which implements multilayer artificial neural networks in C with support for both fully connected and sparsely connected networks. Cross-platform execution in both fixed and floating point is supported. It includes a framework for easy handling of training data sets. It is easy to use, versatile, well documented, and fast.

2. MatLab Neural Network tool box [10]

[11] Presents a technique based on the RBF type of the ANN to estimate the daily significant wave heights at a coastal location based on the wave heights sensed by a satellite along its tracks. The success of the method adopted was seen from the satisfactory error measures it produced during the testing exercise, carried out subsequent to network training. The main processor code of this study belonged to the neural network toolbox of the Matlab software.

3. IBM SPSS Neural Networks [12]

4. Genetic Algorithm

Genetic Algorithms one of the soft computing techniques that can be used for predicting significant wave height directly from wind buoy observations. A training process can be designed to predict significant wave height using wave intensity and wind direction at each location. GA can be trained that describes the equation for SWH. This equation can then be used to produce rest of the time series.
In contrast to ANN, Genetic algorithms provide explicit analytical forecast equations. WAM model generated significant wave height fields along with GA will be useful for predicting wave height.**S**oftware for Genetic Algorithm is Open Genetic Algorithm Toolbox [13].

5. Decision trees [14]

Prediction of significant wave height is uncertain and random process. Therefore, it is ideally suited to decision trees, since they are primarily aimed at the recognition of a random pattern in a given set of input values. Decision trees are helpful in predicting the value of the output of a system from its corresponding random inputs as the application of

decision trees does not require knowledge of the underlying physical process as a precondition.

Here pattern and relationships in data can be found using machine learning, statistical analysis and other data mining techniques.

It is found that error statistics of decision trees and ANN are similar.

3. Other Techniques

Models were developed using a novel method based on the Support Vector Machine (SVM) coupled with the Firefly Algorithm (FFA).The results indicate that the SVM-FFA approach attains an improvement in capability of generalization and predictive accuracy in comparison to the GP and ANN[15].

4. Conclusion:

It is concluded that artificial neural network is an effective soft computing techniques which can be utilized for predicting significant wave height using satellite data and buoy data. In order to effectively utilize the soft computing techniques for significant wave height prediction it should include calibration of data, Comparative estimation of significant wave height from satellite imaginary in relation to actual measurement, prediction of significant wave height using soft computing technique, validation and use of statistical parameters like – bias, root mean square error, scatter Index, standard deviation, maximum error, minimum error, correlation coefficient to measure the prediction performance.

References:

1. R.D. Sathiya, V. Vaithiyanathan and G.B. Venkatraman, A Survey on the Significant Wave Height of the Ocean Using Soft Computing Techniques, World Applied Sciences Journal 29 (Data Mining and Soft Computing Techniques): 179-184, ISSN 1818-4952, 2014
2. E. Vanem, Bayesian Hierarchical Space-Time Models with 25 Application to Significant Wave Height, Ocean Engineering & Oceanography Chapter 2 Literature Survey on Stochastic Wave Models, DOI: 10.1007/978-3-642-30253-4_2, © Springer-Verlag Berlin Heidelberg 2013
3. AdemAkpinar, MehmatOzger, Serkan B, Murat I K, Performance evaluation of parametric models in the hindcasting of wave parameters along the south cost of Black Sea, Indian Journal of Geo-Marine Sciences Vol 43(6), pp-905-920 June 2014
4. T Justin Thomas, G S Dwarakish, Numerical Wave Modelling – A Review, INTERNATIONAL CONFERENCE ON WATER RESOURCES, COASTAL AND OCEAN ENGINEERING (ICWRCOE'15)Aquatic ProcediaVolume 4, Pages 443-448, 2015
5. Deo, M, Artificial neural networks in coastal and ocean engineering. Indian Journal of Geomarine Science, 589-596, 2010
6. http://opennn.cimne.com/download.asp
7. http://neuroph.sourceforge.net/
8. http://www.cs.waikato.ac.nz/ml/weka/
9. http://leenissen.dk/fann/wp/
10. www.mathworks.com/products/neural-network/