A Chebyshev polynomial radial basis function neural network for automated shoreline extraction from coastal imagery

Abstract:
This paper investigates the potential of using a polynomial radial basis function (RBF) neural network to extract the shoreline position from coastal video images. The basic structure of the proposed network encompasses a standard RBF network module, a module of nodes that use Chebyshev polynomials as activation functions, and an inference module. The experimental setup is an operational coastal video monitoring system deployed in two sites in Southern Europe to generate variance coastal images. The histogram of each image is approximated by non-linear regression, and associated with a manually extracted intensity threshold value that quantifies the shoreline position. The key idea is to use the set of the resulting regression parameters as input data, and the intensity threshold values as output data of the network. In summary, the data set is extracted by quantifying the qualitative image information, and the proposed network takes the advantage of the powerful approximation capabilities of the Chebyshev polynomials by utilizing a small number of coefficients. For comparative reasons, we apply a polynomial RBF network trained by fuzzy clustering, and a feedforward neural network trained by the back propagation algorithm. The comparison criteria used are the standard mean square error; the data return rates, and the root mean square error of the cross-shore shoreline position, calculated against the shorelines extracted by the aforementioned annotated threshold values. The main conclusions of the simulation study are: (a) the proposed method outperforms the other networks, especially in extracting the shoreline from images used as testing data; (b) for higher polynomial orders it obtains data return rates greater than 84%, and the root mean square error of the cross-shore shoreline position is less than 1.8 meters.

URI:

Authors:
RIGOS Anastasios
TSEKOURAS Georgios
VOUSDOUKAS Michail
CHATZIPAVLIS Antonios
VELEGRAKIS Adonis

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