IMPROVING RAINFALL ESTIMATION FROM GROUND BASED RADAR MEASUREMENTS USING NEURAL NETWORKS

Amin Alqudah , Yanting Wang and V. Chandrasekar

Colorado State University
1373, Campus Delivery
Fort Collins CO 80523-1373
{amin, ytwang, chandra}@engr.colostate.edu

The key challenge in radar rainfall estimation is the space-time variability in precipitation microphysics, such as Drop Size Distribution (DSD) and drop shapes. The empirical *Z-R* relation is not sufficient to capture this variability and has large parameterization uncertainty. The parameterization of Z-R relation needs to be adaptively adjusted. To this end, rainfall observed on the ground can be related to the four dimensional distribution of precipitation aloft. In principle, the functional relation between rain rate on the ground and the four-dimensional radar observations aloft can be obtained. However it is difficult to express this in a closed form. Previous research has shown that neural networks are capable of fitting complex relations and can be used to improve radar rainfall estimation. Using rain gauge measurements, neural network is a nonparametric method to map the relationship from radar measurements to rainfall rate in an adaptive manner. Radial basis function (RBF) neural network is known to be capable of learning complex functional relations from a high dimension input space to the target space efficiently. Its efficiency is very important in operational systems because a large amount of radar data can be acquired in a short time. In this paper, radar rainfall estimation using RBF neural networks is investigated based on the measurements from Melbourne-Florida WSR-88D ground radar.

The performance of neural network based rainfall estimation is subject to many factors such as the representativeness and sufficiency of the training dataset, the generalization capability of the network to new data, seasonal change, and regional change. Improving the performance of the neural network in real time context is of great interest. In this paper, this is investigated from several aspects using RBF neural networks. The principal components analysis (PCA) technique is used to reduce the dimensionality of the training dataset. Reducing the dimensionality of the input training data will reduce the training time as well as reduce the network complexity. More importantly, the small scale uncertainty will be removed during PCA such that the network is less likely overfitted. The self organizing maps (SOM) technique is also used to classify the training data into different classes, over which specific neural networks are built. This SOM process groups the training data in multiple classes where members of each class have closer characteristics which will improve the network generalization In addition, “Rain/No Rain” detection is performed using an adaptive neural network running simultaneously with the rainfall estimation neural network. The “Rain/No Rain” detection can eliminate those “No Rain” data inputs from the training set.

Data from Melbourne WSR-88D ground radar is used to and processed to demonstrate the neural network based radar rainfall estimation. The performance of radar rainfall estimation will be presented, compared against rain gauge measurements. The improvement due to PCA filtering, SOM classification, and rain/no rain detection is quantitatively analyzed in detail throughout this study.