Automatic Ground Clutter Identification Technique based on Neural Networks

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In order to mitigate flood damages caused by torrential rainfall or tornados, the fast and precise detection of severe weather signs is very important. As a member of the Strategic Innovation Promotion Program (SIP), Toshiba has been developing X-band multi-parameter phased array weather radar (MP-PAWR) with the rapid 3 dimensional volume scanning. The radar system can observe upto a range of 80 km in less than 60 seconds by using a fan transmission beam and multi-pencil digital reception beams. On the other hand, because the radar returns of the fan beam type MP-PAWR are likely to be contaminated by ground clutter, high accuracy ground clutter identification and mitigation techniques are desired.

From the point of view of anomalous propagation clutter as well as changing the strength relationship between clutter and precipitation depending on the weather conditions, clutter should be identified automatically according to the weather condition. Many automatic identification algorithms are proposed and most algorithms use features, e.g. clutter to signal power ratio (CSR) and clutter phase alignment (CPA), which are generated by the observation data to detect the clutter contamination. In one practical algorithm, the clutter contamination can be identified automatically whether some features are clutter or not by being compared to features with thresholds. In this algorithm, the thresholds should be decided before operation, however the adjusting burden is large. To mitigate the burden, we propose the complete automatic ground clutter identification algorithm based on neural networks. The networks are trained using MP-PAWR I/Q data which is composed of clutter I/Q data collected in a clear-air condition and precipitation I/Q data collected with a slightly high elevation angle. After training, the validation I/Q data is fed into the networks and the ground clutter filter is applied in accordance with the identification result.

Figure 1. (a)-(c) show the example of power of weather echo plus clutter, weather echo truth and estimated by the proposed method. The data was collected by MP-PAWR installed at Saitama University in Japan. It can be seen that the proposed method can be suppressed clutter appropriately and the estimated result is similar to weather echo truth. To evaluate performance of the proposed method quantitatively, the estimation error against weather echo truth (power, velocity, and spectrum width) will be shown in this work.

Keywords: Multi-Parameter Phased Array Weather Radar (MP-PAWR), Ground Clutter, Neural Networks, Automatic Identification

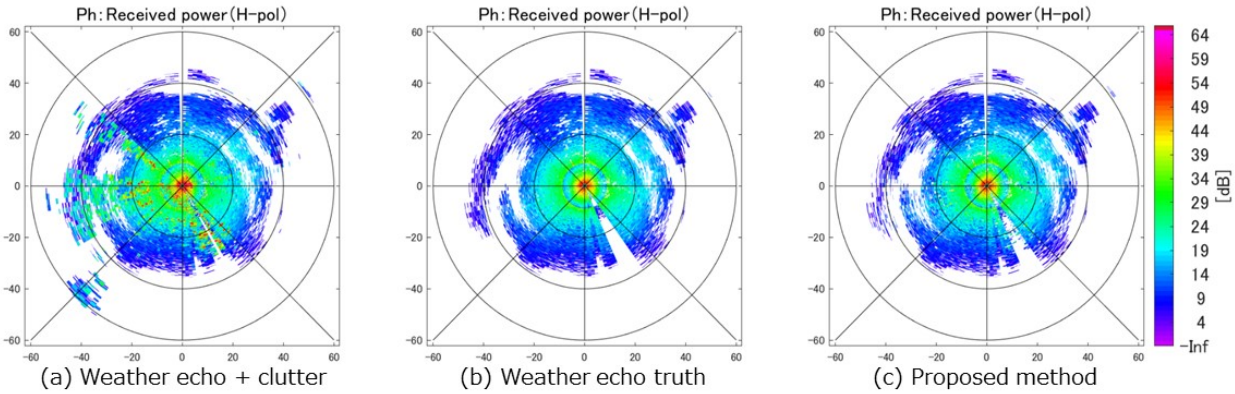

Figure 1. An example of power estimation
(Data was collected by MP-PAWR installed at Saitama University)