Mitigation of Radio Frequency Pulse Interference on Dual-Pol Weather Radar
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Introduction
Radio frequency interference (RFI) has received growing attention across the weather radar community over the last decade. RFI can come from various radio devices (e.g., other radars, wireless internet devices, etc.) and display different interference characteristics on weather radar data. To date, there have not been well established methods to effectively mitigate all kinds of RFI signals. In terms of waveform type, RFI can be recognized as both continuous interference and pulse interference. Continuous interference generally causes strong contamination in the whole radar path stemming from the interference source. The weaker contamination may appear in other directions, depending on the antenna sidelobe pattern. Normally, if the location of the RFI source is known, the radial of contamination can easily be identified. The pulse interference, however, is more complicated. Pulse RFI may appear in all the directions and contaminate variable range gates in every radar scan. The contamination is dynamic, sweep by sweep, and related to the pulse repetition frequency (PRF) of both the weather radar and the interference source. This study investigates the characteristics of pulse interference seen in dual-pol weather radar data, including interference patterns related to PRF and the dual-pol characteristics of interference signals. Based on the analysis results, a signal processing method is proposed for identifying and mitigating the pulse interference contamination in a dual-pol weather radar. Enterprise Electronics Corporation’s (EEC) in-house C-Band radar, deployed in Enterprise, Alabama, is used for the experiments. The results well demonstrate the potential of proposed method for the RFI mitigation.

Current EEC Techniques for Mitigating Interference
- High-quality RF and IF band-pass filters: 80–48 dB out-of-band rejection
- Narrow passband
- Deep stopband
- Low loss
- Continuous Wave (CW) Interference Mitigation: Software Solution
  CW interference contaminates the radar data in radars. EEC has developed a signal processing module named “Strobe” to mitigate this CW interference. The module is integrated in EEC’s radar software (EDGE®), it can remove the strobes caused by the CW interference. Its general concept is to identify the contaminated radials and interpolate the “bad” region with adjacent “good” radar observations.
- Detection of Interference Source
  EEC provides professional instruments for the detection/analysis of RFI so that customers can efficiently locate the source.
  An example is shown in the figure (right). A WiFi network analyzer can easily identify the SSID, frequency/channel use, and signal amplitude for a WiFi interference. Connected to the processor, the direction of interference source can be detected.

Pulse Interference and Its Characteristics
Some interference devices might be a pulse system, such as pulse Doppler radars. Compared to the CW interference, the pulse interference has completely different effects on weather radar data. Therefore, the “Strobe” module is not capable of mitigating this type of interference. The typical features of pulse interference (e.g. on EEC’s C-band in-house radar) are shown in the following figures.

Identification of Pulse Interference
- A fuzzy logic approach is proposed to identify the contamination of pulse interference in weather radar data. Two categories are treated differently in the signal processing. The membership functions used for these two categories are given as follows.

Mitigation of Pulse Interference in Data
- A spatial filter is applied in order to replace the contaminated range bins with nearby un-contaminated bins within the influence range. The influence range might be adjusted depending on the pulse width of the interference. The default range is 2 km for this study. The results show good removal of pulse interference on moment data.

Summary
- EEC has employed several useful techniques for mitigating the RFI interference on weather radars.
- This study investigates the characteristics of pulse interference and proposes effective signal processing methods to mitigate the pulse interference on dual-pol weather radars.
- The pulse interference identification is based on a fuzzy logic approach and the interference removal is based on a spatial filter. Both functions are tested in this study and the preliminary results show the promising performance of the proposed methods.

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