

# Weak Echo Signal Extraction in Space Debris Laser Ranging

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The echo signal extraction is a great challenge in debris laser ranging (DLR) due to the extremely low signal-to-noise ratio (SNR). It is very difficult to extract the signals from noises in the Observed-minus-Calculated (O-C) residuals using traditional ways. In this paper, we propose a new algorithm based on randomized Hough Transform (RHT) to extract the valid echoes automatically. With the data pre-processed using histogram method, we find the zonal area that contains all the possible signals to reduce most noises. Then the data is processed with RHT algorithm to find the curve that the signal points are distributed on. A new parameter update strategy is introduced in the RHT to get the optimal parameters. We also analyze the values of the parameters in the algorithm.

The algorithm was tested using the 10 Hz repetition rate DLR data from Yunnan Observatory and 100 Hz repetition rate DLR data from Graz SLR station. For 10 Hz DLR data with relative larger and similar range gate, we can process it in real time and extract all the signals with a few false readings. For 100 Hz DLR data with longer observation span, we automatically post-process DLR data of 0.9%, 2.7%, 8% and 33% return rate with high reliability. The extracted points contain almost all signals and a low percentage of noise. Additional noise is added to 10 Hz DLR data to get lower return rate data. The valid returns can also be well extracted for DLR data with 0.18% and 0.1% return rate.