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A Novel Approach For Radar PRI Classification Based on Features Estimation

Pawan Barnwal [(1)], Dhaval Upadhyay [(1)], and Subhash Chandra Bera [(1)]
(1) Space Applications Centre, ISRO, Ahmedabad, 380058
Email ID: pawanbarnwal@sac.isro.gov.in

Pulse Repetition Interval (PRI) timing and its modulation types are significant features of any Radar to comprehend its capabilities and functionalities. In this paper, an algorithm has been proposed to classify PRI modulation by estimating features from time of arrival (ToA) and its difference (dToA) of a pulse radar. Performance of the proposed algorithm is also verified for different PRI modulations with different percentage of missing pulses. PRI modulation type classified covers Dwell and Switch (DS) of 2 to 64 level, Staggered PRI of 2 to 64 levels, Jittered PRI with 20% Gaussian deviation and Sliding PRI. Estimation of features is improved by selection of an optimal window of histogram. Level of staggered/ DS PRI has also been estimated using Kernel Density Estimator (KDE) with an epanechnikov window with length $N^{0.8}$ where, N is total count of dToA. Upon classification, PRI estimation for each modulation type is also estimated.

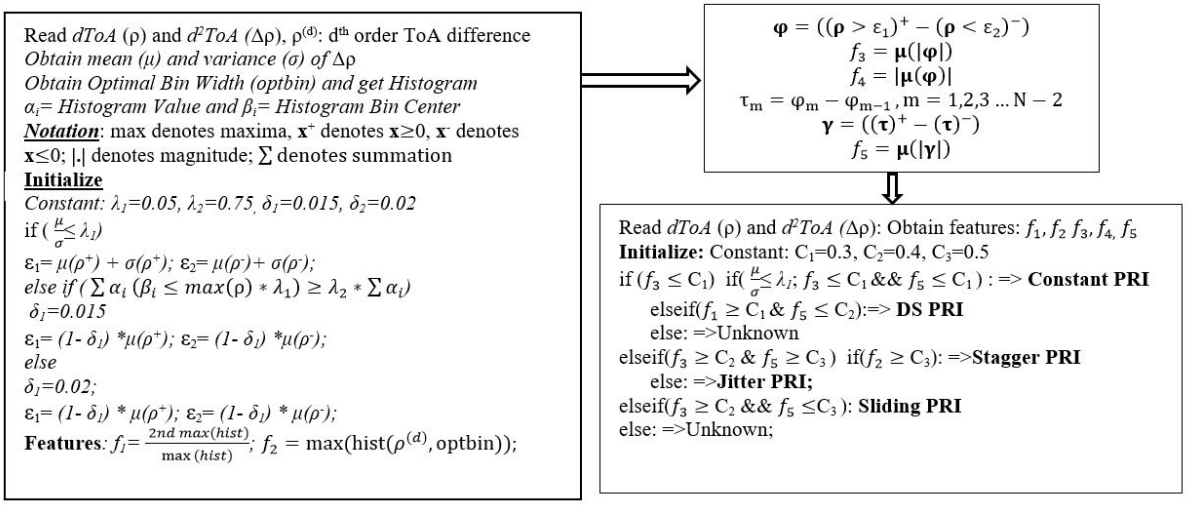

Figure 1. Algorithm to estimate the features and classify PRI modulation of Pulsed Radar

Features are estimated by applying biased histogram of dToA [1] with an optimal bin width. To obtain biased histogram dToA belonging to 2σ of bin center of maximum histogram value while 2^{nd} maximum is obtained by taking histogram of rest of dToA information . In proposed algorithm, constants assigned for features extraction is based on variance in dToA. Here, $\lambda_1 = 0.05$ is assigned because Constant and DS PRI has variance below 5% while $\lambda_2 = 0.75$ gives weights to maximum histogram value. Selection of an optimal bin width of histogram separates level of staggering from Jitter PRI even under 10% missing pulse scenario. Algorithm for features extraction for PRI modulation is shown in figure 1. Features threshold for classifying modulation type is shown in table 1. Threshold of each feature was estimated by considering above PRI modulation type.

Table 1. Features threshold for different PRI modulations

	PRI Modulation type				
Features	**Constant**	**DS**	**Stagger**	**Jitter**	**Sliding**
f_1	<0.25	>0.55	1	1	1
f_2	0	0	>0.9	<0.5	0
f_3	<0.3	<0.3	>0.4	>0.4	1
f_5	<0.4	<0.4	>0.6	>0.4	0

In proposed algorithm, an optimal bin width of histogram of dToA classify PRI modulation and PRI estimation even under 10% missing pulse scenario while KDE estimates levels of Stagger/DS PRI.

References

[1] Kauppi, Jukka-Pekka, Martikainen, Kalle, Ruotsalainen, Ulla, "Hierarchical classification of dynamically varying radar PRI modulation patterns Published by Elsevier," *Neural Networks*, , 2010, pp. 1226–1237.