Improved Effectiveness Through DRFM-Based ECM Timesharing

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Introduction

The typical radar environment is quite complex and a modern ECM system can expect to receive multiple in-band (and out of band) signals that are both scanning and non-scanning in nature. Unfortunately most Digital RF Memories (DRFMs) are inherently single-threat in nature. This is primarily driven by the fact that the contents of the memory will be overwritten by extraneous signals unless preventative action is taken at the system level. ECM effectiveness can quickly drop to unacceptable levels when the desired signal is overwritten by another signal whether it is a spurious signal or simply another emitter. Using real-time pulse de-interleaving and judiciously selecting parameters, a single DRFM can be used to jam multiple radars on a timeshared basis resulting in good levels of effectiveness against multiple systems throughout an engagement. This paper describes a controller that can be used to perform real-time pulse de-interleaving for ECM applications, select or deselect specified emitters for ECM and control DRFM Write and Read signals to implement ECM timesharing on the selected systems. This controller has been designed by MC Countermeasures Inc. as an enhancement for the PRED series of PRI predictors and can be easily interfaced to existing DRFM-based ECM assets. This work has been conducted as an internal research and development project and practical applications include EW Training (e.g. EWTS, CATS, etc) as well as operational requirements.

A Problem

One reason that DRFM's are so effective in countermeasure applications is that they are capable of storing a copy of the radar pulse for (virtually) indefinite periods of time. This leads to the capability of generating false targets that appear to be up-range of the true skin return when delays approaching a full PRI are used. As shown in Figure 1, this works quite well in a single emitter environment since the DRFM memory content are valid during the entire PRI. Unfortunately this is not the case in situations where there are more than one signal being detected. Figure 2 shows what happens when there are two interleaved signals, pulse train #1 and pulse train #2. Since the DRFM write occurs on each received pulse, up-range false targets can rarely be generated since the memory contents are overwritten by the other pulse train before being read out. The solution to this dilemma is to de-interleave or sort the pulse trains so they can be handled individually.

A Second Problem

A serious consideration in countermeasure technique design is the basic design of the radar guided weapon system. There are many examples of systems that employ multiple radars (e.g. separate acquisition and tracking radars). In these cases it may not be enough to simply jam the tracking radar. Many systems are coupled in such a way that fairly accurate target position data can be automatically passed from the acquisition radar to the tracking radar in the event of ECM causing disturbances in the

target track. Since the acquisition radar is usually not jammed in this situation, this hand-off is generally perfect and can be all that's needed for the tracker to re-lock onto the correct target. The solution to this situation is to jam both the acquisition and the tracking radar simultaneous. One way of doing this efficiently is to timeshare a single DRFM between the radars.

Deal With it!

The approach that we have chosen to use to deal with these issues makes use of four PRI predictor channels. Each channel is preceded by an RF gate that allows some preliminary filtering based on information passed from the system DFD or IFM. This allows up to 4 emitters to be sorted into RF bins before PRI prediction begins. Prediction is used rather than simple PRI tracking for a number of reasons.

- First, it allows for false targets to be placed up-range of the true skin return despite the use of PRI agility.

- Secondly, true prediction helps to account for complications caused by pulse overlaps and missing pulses which can seriously impede any tracking algorithm.

- Thirdly, prediction can be used to acquire a PRI pattern of a scanning radar during the first illumination time and then only perform a fast reacquisition – typically taking only a few PRI – when the scan revisits. This generally decreases the time it takes to begin jamming which increases the effectiveness of the technique.

- Fourthly, it allows us to exclude other emitters from the field which makes it easier on the other system components to handle.

Timesharing

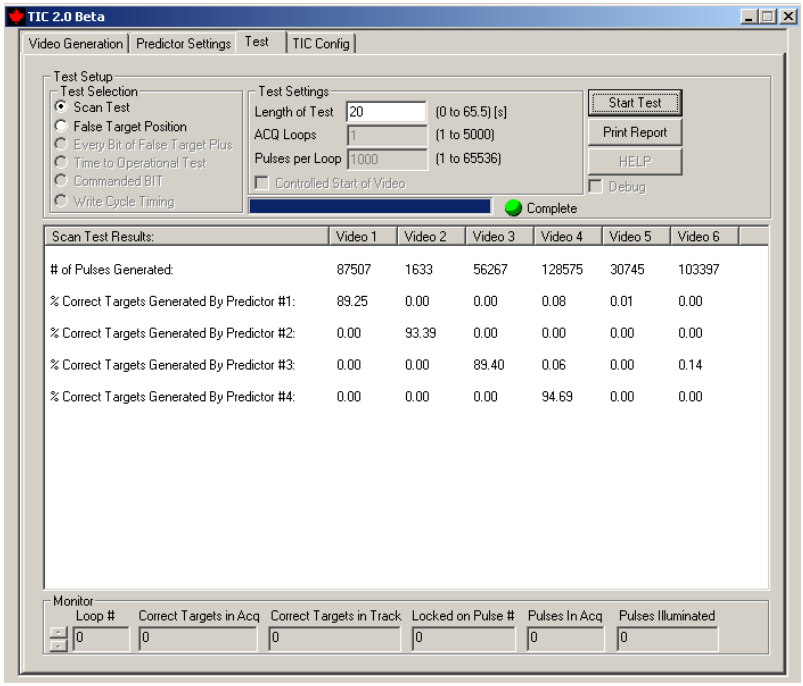
One possible timesharing algorithm is described here – although there are numerous permutations that can be tailored to the environment that may be encountered.

In this simple routine, the highest priority emitter is assigned to PRI predictor channel #1 while the lowest priority signal is assigned to PRI predictor channel #4. Channels are selected on a first-come-first-served basis based on signal activity. Activity in multiple channels simultaneously is handled based on priority. Additionally, scanning emitters are permitted to interrupt non-scanning emitters but not vice versa.

Some Results

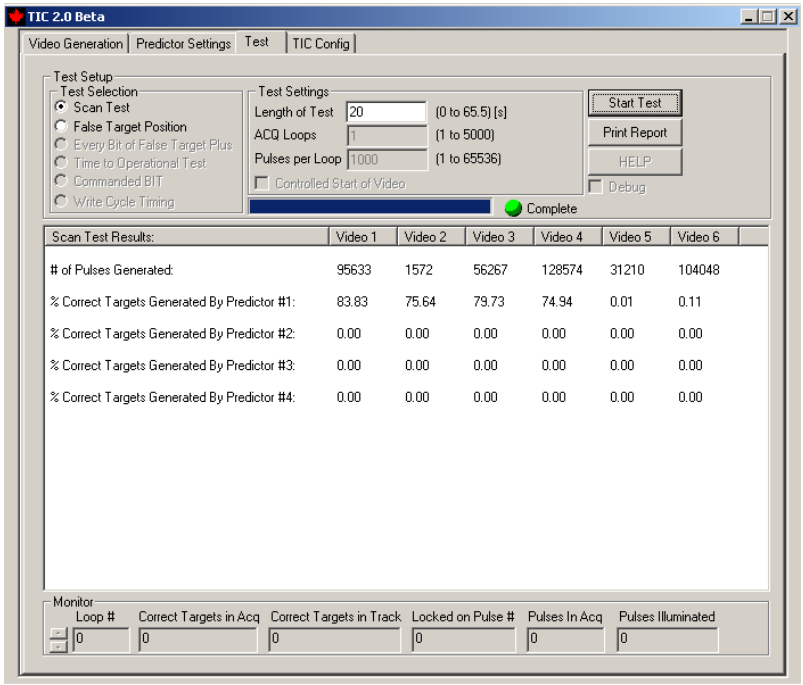
Multiple scanning radars

- 6 emitters
- track 4, ignore 2
- no timeshare



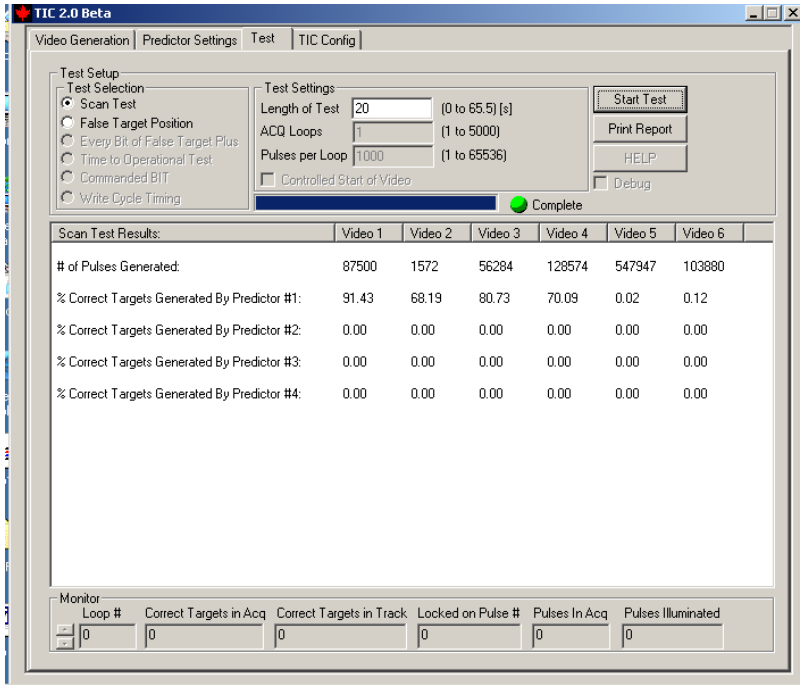
Multiple scanning radars

- 6 emitters
- track 4, ignore 2
- timeshare



Multiple non-/scanning radars

- 5 scanning emitters + 1 non-scanning
- track 4, ignore 2
- timeshare



Modification

The routine above can be modified slightly allow it to work with multiple non-scanning radars in addition to multiple scanners. Possibilities for timeshare parameters include number of PRI or fixed interval between emitter selections.

Conclusions

1. Predictor channels can be used to selectively track or ignore specific emitters in a multi-emitter environment.

2. PRI Prediction reduces the effects of overlapping or missing pulses in a dense signal environment.

3. Timesharing can be used effectively to jam multiple radars with a single ECM asset.

4. There can be little difference between results using multiple predictors/jammer channels and timesharing a single ECM asset with corresponding cost savings.

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Additional Information

If you would like additional information about Timesharing applications or PRI prediction in general, please feel free to contact us at:

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