A Challenge Problem for SAR Change Detection and Data Compression.

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ABSTRACT

This document describes a challenge problem whose scope is two-fold. The first aspect is to develop SAR CCD algorithms that are applicable for X-band SAR imagery collected in an urban environment. The second aspect relates to effective data compression of these complex SAR images, where quality SAR CCD is the metric of performance.

A set of X-band SAR imagery is being provided to support this development. To focus research onto specific areas of interest to AFRL, a number of challenge problems are defined.

The data provided is complex SAR imagery from an AFRL airborne X-band SAR sensor. Some key features of this data set are: 10 repeat passes, single phase center, and single polarization (HH). In the scene observed, there are multiple buildings, vehicles, and trees. Note that the imagery has been coherently aligned to a single reference.

Keywords: SAR, SAR change detection, Radar, data compression, compressive sensing

1. INTRODUCTION

This document describes a challenge problem whose scope is two-fold. The first aspect is to develop SAR CCD algorithms that are applicable for X-band SAR imagery collected in an urban environment. The second aspect relates to effective data compression of these complex SAR images, where quality SAR CCD is the metric of performance.

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2. PROBLEM DESCRIPTION

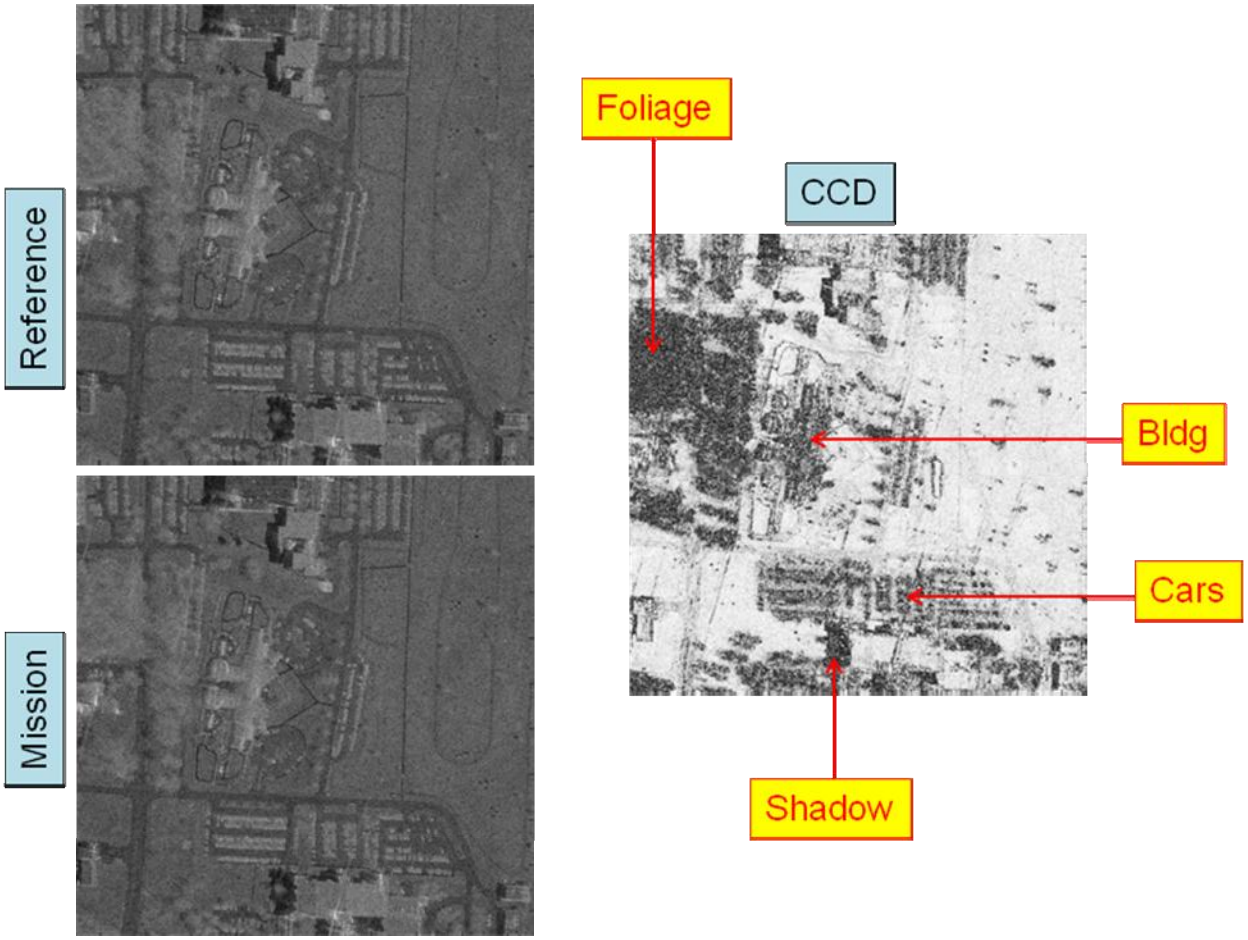

Figure 1 Reference and Mission SAR Images (left), corresponding CCD image (right).
In CCD image, white=correlated, black=uncorrelated.

To date, SAR CCD performance is often plagued by high false alarm rates when applied to urban scenarios. Radar shadows and moving foliage produce changes that are not of interest. Also, minor geometry differences between passes usually make cancellation of bright cultural clutter difficult (see Figure 1).
References [1]-[9] address SAR CCD and related research.

Additionally, the size of data products used for SAR CCD can be quite large. A number of compression schemes have been developed for SAR intensity images, and these schemes have been highly refined. Unfortunately, many of these schemes do not perform well for compression of complex images. These schemes generally use visual image quality as the metric of performance, which is much less stringent than a metric relating to quality SAR CCD.
References [10]-[22] address compression research for SAR.
References [23]-[30] address compressive sensing for SAR.

To guide potential research, four problems will be defined here:

2.1 Problem 1: Use two-pass SAR coherent change detection methods to reliably detect features of interest in the presence of urban clutter and foliage.

2.2 Problem 2: Develop algorithms that use more than two passes to improve change detection performance.

2.3 Problem 3: Develop methods to compress the complex SAR images while maintaining quality SAR CCD.

2.4 Final challenge: Go out and do great things with the data. We hope that people will use the data in ways that will both surprise and delight us.

Published Results: We would ask that the results of any research using this data be shared with ATR Division of AFRL Sensors Directorate and that the authors acknowledge AFRL/RYA as the source of the data in any resulting publications or presentations.

3. DATA DESCRIPTION

Data Package:

One DVD containing:

- **Complex SAR Imagery**
  - **Coincident parts of 10 passes**
  - **All images coherently aligned to same reference**
- **This SPIE paper, describing data in detail. Includes references to relevant published work.**
- **Matlab routines for generating CCD images.**

Brief Data Description:

- **Airborne SAR Sensor**
  - **Bandwidth 640MHz, 0.25m slant range resolution**
  - **Center Frequency 9.6 GHz**
  - **Number of phase centers: 1**
  - **Number of polarizations: 1, HH pol**
- **SAR images**
  - **Complex, 32-bit floating point (Matlab structure)**
  - **10 passes, all flown on same day**
  - **All images coherently aligned to single reference**
  - **Alignment included Digital Elevation Map (DEM)**
- **Scene**
  - **Contains foliage, buildings, and vehicles**
  - **45 degree depression angle to scene center**

To request a copy of the data set, visit the AFRL/RYA Sensor Data Management System (SDMS) Public Website https://www.sdms.afrl.af.mil/main.php.

4. SUMMARY

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