LDRD #209208

SAND2019-14613C

GLOBAL SECURITY INVESTMENT AREA

Efficient Real-Time Cognition at the Point of Sensing

FUNDING

FY18: $358K
FY19: $512K
FY20: $146K (planned)

INFO

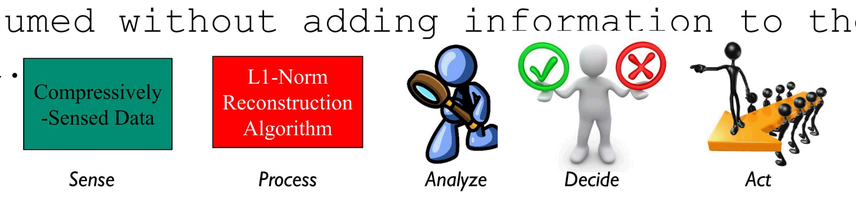
PI: Eric Shields
Org Number: 6773
Org Name: Proliferation Sensing Concepts

WHAT IS THE PROBLEM? WHY IS IT HARD?

The theory of compressive sensing (CS) provides a new paradigm for data collection systems. The CS framework allows fewer measurements to be made to recover the same amount of information. The raw data look nothing like traditional data, though, and a computationally-intensive reconstruction algorithm is used to put the data into its traditional form. This increases the computational requirements of data analysis systems.

HOW IS IT SOLVED TODAY, AND WHAT ARE THE LIMITATIONS?

In the traditional framework, the CS data are reconstructed into a form that a human can understand. Time and resources are consumed without adding information to the data.



WHAT IS YOUR APPROACH? WHAT IS NEW ABOUT IT? (16 L)

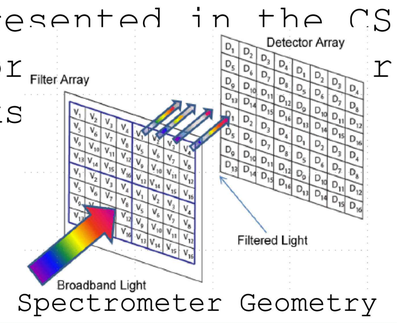
We are investigating the feasibility of teaching the machine to look at the data in its raw form. Why bother putting the data into a human-readable format when a machine is performing the task. This can potentially reduce computational requirements and allow cognition at the point of sensing.

We are leveraging advancements in machine learning to more efficiently and autonomously sense, process, analyze, and decide. This results in faster decisions from s[Compressively -Sensed Data] w[New Machine Learning] ro[Act] can be perfor[• Faster • Simpler • Autonomous] t[illegible]so

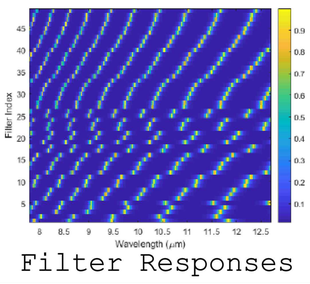
Sense Process Act

RESULTS?

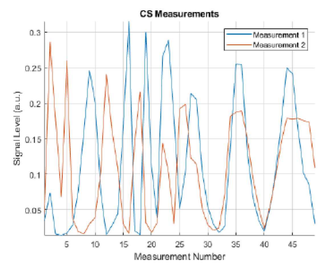
We have investigated a Sandia-patented snapshot imaging spectrometer based on CS principles. Radiometrically-accurate modeling of the system indicates that machine learning tasks perform *better* in the CS domain as compared to the reconstructed domain. The information is more compactly represented in the CS domain and hence the algor[illegible]r al[illegible] their tasks



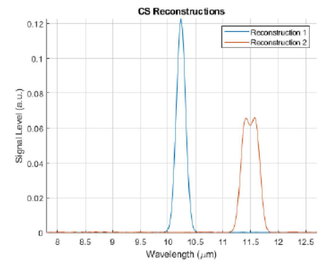
Spectrometer Geometry



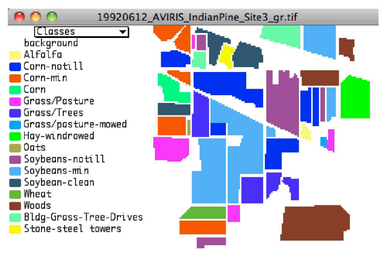
Filter Responses



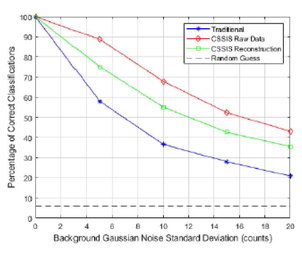
Signal in CS Domain



CS Reconstruction



Indian Pines Image



Reconstruction Accuracy

RISKS AND MITIGATION PLANS?

Over the first two years, risks were bought down by carefully increasing model fidelity. We have now demonstrated results for CS systems of different modalities (imaging and spectrometry), even using real-world data.

Our last risk is whether or not CS provides a benefit as the number of measurements becomes small. If the CS spectrometer does not outperform a traditional system for small (e.g., 2x2) filter arrays, then we will understand the lower bound of this framework.

QUANTITATIVE MEASURES OF PROGRESS? SCHEDULE FOR ACHIEVING THEM?

In the first two years:

- 4 conference papers have been presented and published.
- 3 meetings have been held with companies interested in licensing the patent.

We hope to publish results of the last year's study on CS systems with relatively few measurements.

LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

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