2024-2025 UCSB Senior Capstone Project

Millimeter Wave Passive Radar Receiver: Leveraging 5G mmWave and/or Starlink.

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Introduction: Scientists and engineers at HRL Laboratories, LLC (previously known as Hughes Research Laboratories, established in 1948) have been on the leading edge of technology, conducting pioneering research, providing real-world technology solutions, and advancing the state of the art. Our research collaborations with our LLC Member companies (General Motors and Boeing), government, commercial and academic institutions are realizing groundbreaking advances in ultra-high-performance circuitry, robust computing and communications, automated data extraction, and innovative architected materials. Our technologies operate in space, on aircraft, in automobiles, and in a variety of consumer products.

Background: The background level of electromagnetic signals from many sources at many frequencies is looking to increase year after year. If the signals have enough incident power level, are widely available, and are transmitted often enough, this energy can be used as a source of illumination in a passive radar system. Signals such as those present via Starlink down/upload signals as well as upcoming 5G millimeter wave (24-29GHz) transmit towers make good candidates for reference signals. Directly captured energy in these bands can be compared to signals captured after bouncing off objects of interest (such as a neighboring car in an automotive application) and digitally processed to provide range and doppler information from nearby objects in the vicinity. In addition to system design and radar data processing, effort is needed in characterizing illumination signal properties and establishing utility as reference signals for passive radar.

Project description:

The scope work for executing a fully functional system to accomplish this whole project is likely too large for a single team over the course of a year. HRL will work collaboratively with interested project groups to define subprojects that are more appropriate in scope for a Capstone development effort. HRL & interested students will develop:

- Project scope for an effort in this area
- Key metrics and requirements for development efforts
- Available resources & HRL mentorship/collaboration structure

If some part of this overall problem fits a team's interests and skillsets, please brainstorm a few potential focus areas and we can work together to curate a project in this area. A well-defined project in this area should seek to:

- Capture system design challenges from at least one engineering focus area. For this effort these include but are not limited to:
    - RF System Design & Prototyping
    - Radar System Design & Processing
    - Spectrum Sensing
    - Antenna Design
    - Digital Signal Processing
- Have a project scope that addresses a key technical challenge, is separable from the larger effort, and that is easy to build upon in future works.
- Have a demonstratable output product.

Reference:

- https://ieeexplore.ieee.org/document/8768105/
- https://ieeexplore.ieee.org/abstract/document/9905046
- https://ieeexplore.ieee.org/document/9661315