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SDRD SITE-DIRECTED RESEARCH & DEVELOPMENT

Detection and defeat of autonomous system sensors STL-044-21, Year 1 of 1

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Challenge

- Number of autonomous vehicles ramping up
- Expecting significant role in navigation in next 5 to 10 years
- Autonomous and semiautonomous vehicles potentially susceptible to disruption by targeted attack
- Successful detection, defeat, or disruption of vehicle navigation systems could provide situational advantages
- Potential uses:
  - Obstruct path of vehicle
  - Guide vehicle to a desired location

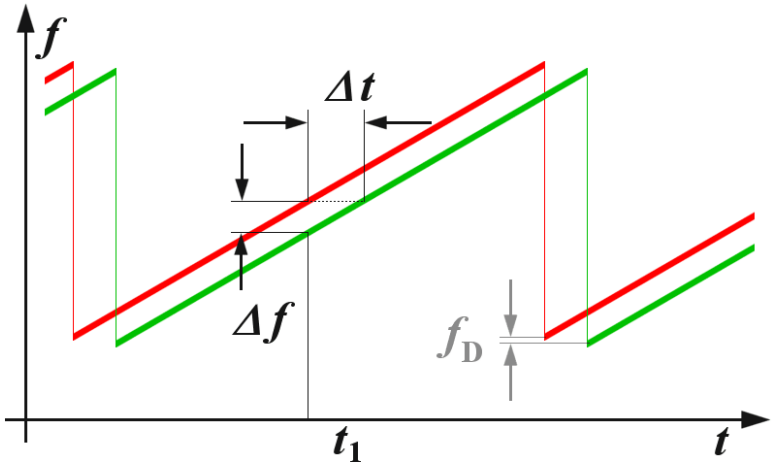
Innovation

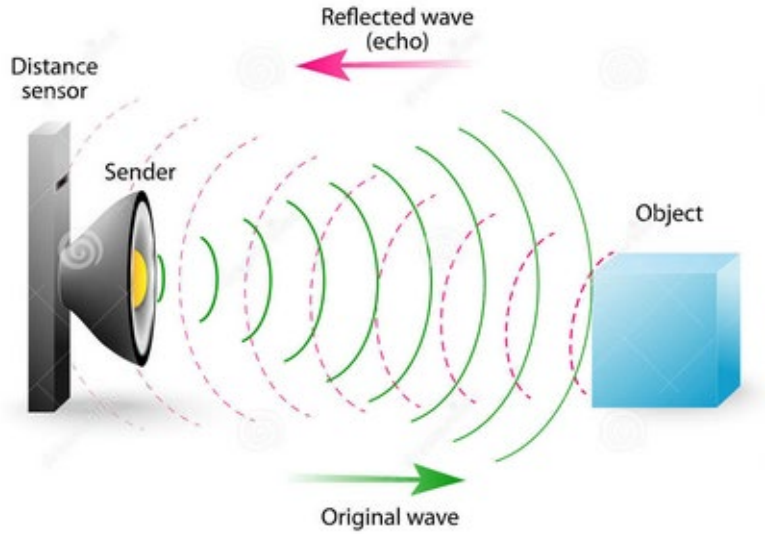
- First project in creating multimode sensor system targeting sensor fusion
  - Sensor fusion – Collecting data multiple sensors to make decisions for the system
- Potential sensor modalities targeted
  - Radar
  - Ultrasonic
  - LIDAR
  - Cameras

Effect of dust and smoke on LIDAR

Technical Approach

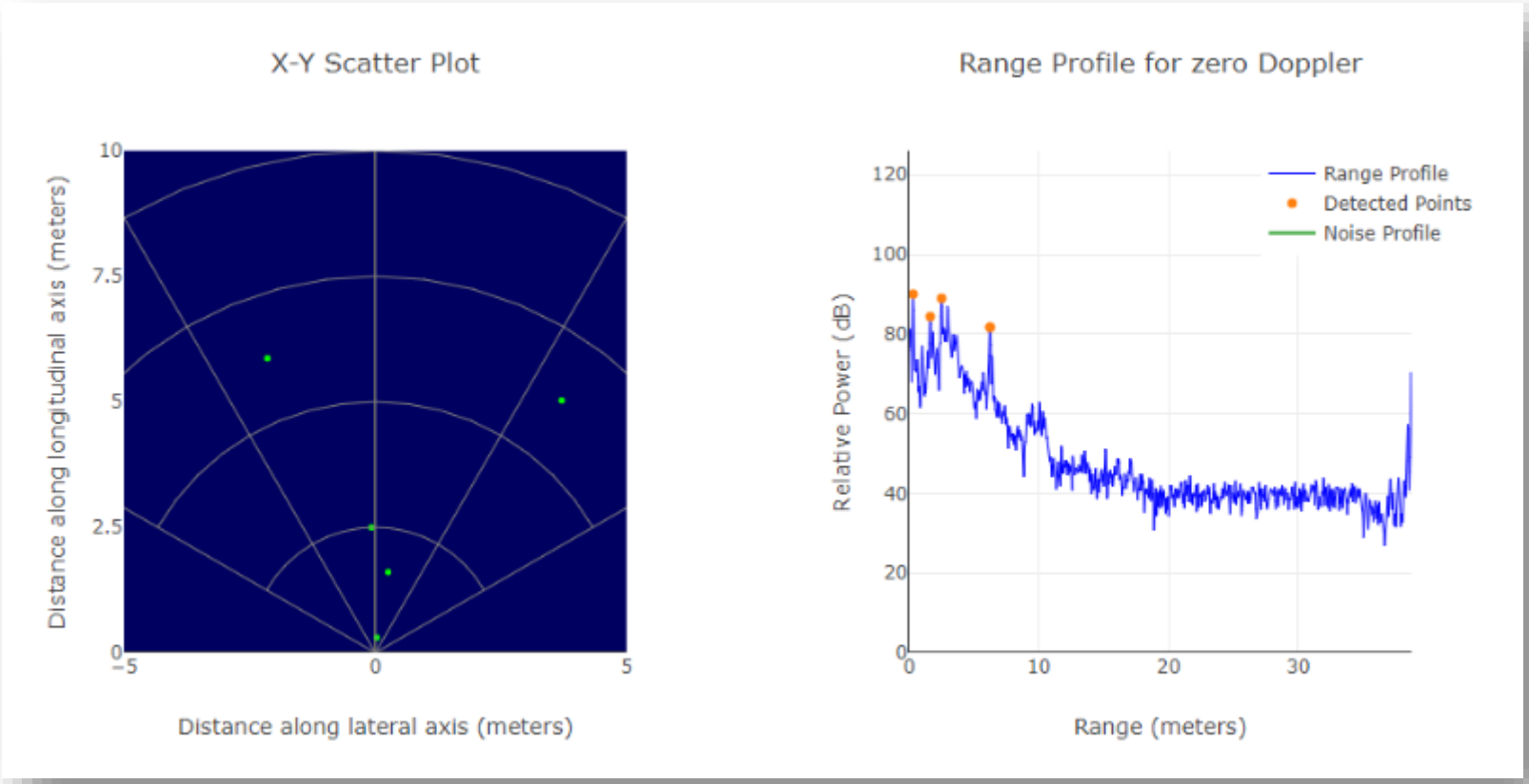
- 76–81 GHz FMCW signals are detected by radar from reflections off objects
- Ultrasonic uses 28–100 kHz pulses (42 kHz typical)
- Distance determined by delay between transmitted and received signals
- Can simulate a reflection
  - Synchronize remote and local radar clocks
  - Adjust timing of remote radar to simulate reflected signal for ghost object





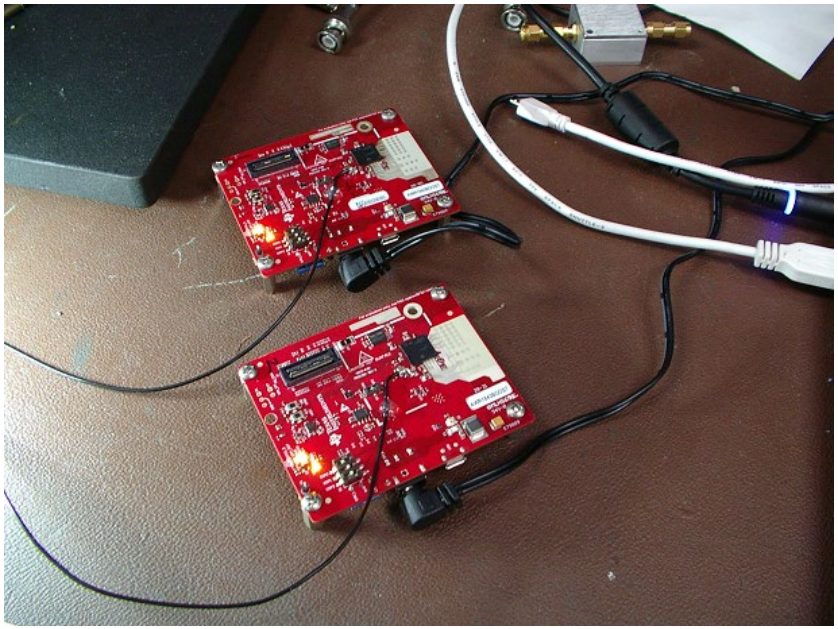
Results – Radar

- Hardware selected
  - Automotive radar, 76–81 GHz, 150 m capability
- Working with modified vendor development tools for visualization



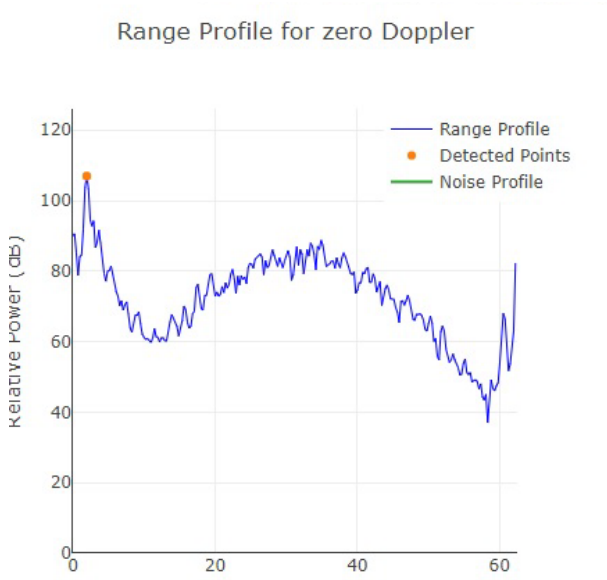
Results – Radar

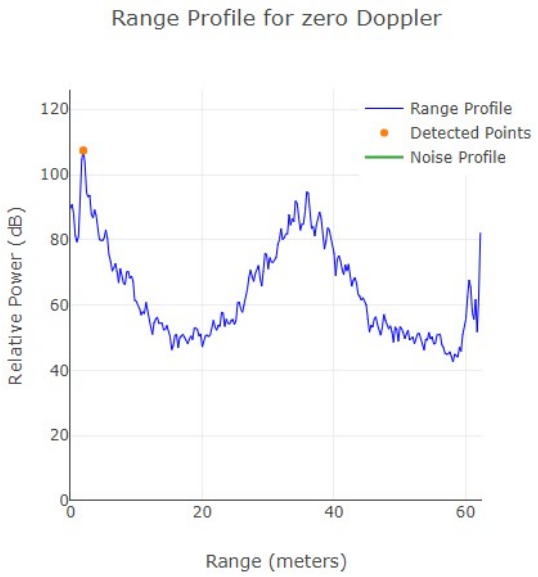
- Modified board HW, FW, and SW for external trigger and clock
  - Arbitrary function generators used for clock, triggering, and phase offset
- Verified external synchronization approach functions as expected

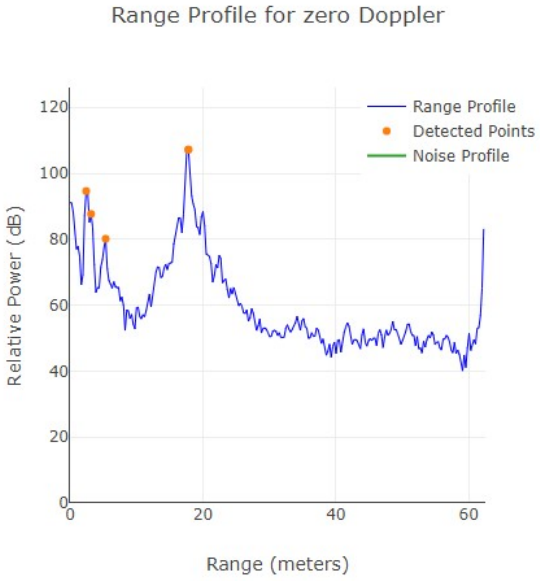


Results – Radar

- Able to create ghost object on adversary radar
  - Currently seeing high phase noise
- Currently working on isolating and reducing source of phase noise







Results – Ultrasonic

- Ghosting/interference capability
  - Aftermarket sensors
    - Able to set location at “min range” (tested up to 40 ft away)
    - Limited ability to set location between min and max ranges
  - Maxbotix
    - Able to set location at sensor “minimum range” (30 cm)
  - DF Robot
    - Able to disrupt sensor communications at “lower than minimum distance” (error)
  - Commercial vehicle sensor
    - Sensor measurements recorded
    - Interference capable of disabling assist feature
- Ghosting determined to be non-feasible in field
  - Multipath – Signals reflecting off nearby objects
  - Requires direct line of sight
  - Environmental variability (humidity, temperature, etc.)
  - Signal attenuation issues

Project Impact and Future Direction

- Impact of current work
  - Optimize ghosting methodology
  - Demonstration of ghosting of representative vehicle sensors
- Next technology spiral
  - Synchronize devices ad hoc
  - Testing with moving sensors
  - Fieldable prototype system
  - Combine sensor technology approaches to focus on “sensor fusion” algorithms
- Follow-on status
  - S&T Transition partner concurrence on funding follow-on – Broad market survey of vehicle radar implementations