Top 10 Radar Projects for Senior Thesis/Capstone Projects - 2025

Introduction

Here's an updated is or radar based projects for engineering student Senior Thesis, Capstone Project, or Master's Thesis. The projects are meant to provide both a means of gaining experience with millimeter wave radar sensors and create new features or capabilities valuable for others. All of the projects are built around the OmniPreSense OPS243 radar sensors which operate as either a Doppler radar (speed/direction, OPS243-A) or FMCW radar (Doppler and range, OPS243-C). Unique capabilities in the sensor API provide access to final speed/range information, post FFT data, or the raw sampled data. The API defined in the **AN-10 API Interface** application note describes the control the user has over the sensor to configure the data output and radar signal processing.

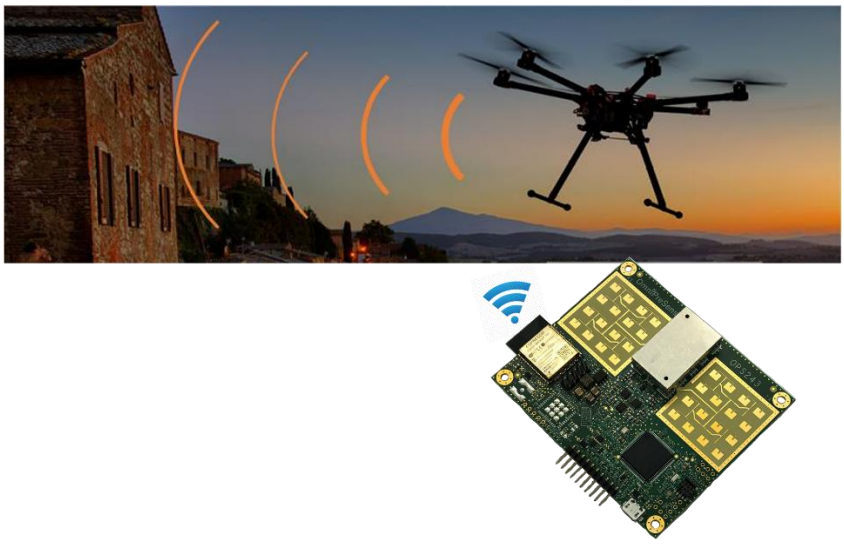
1) Drone Remote ID and Altimeter using OPS243-C WiFi

This project will implement a drone Remote ID solution using the OPS243-C Bluetooth/WiFi module. The OPS243-C performs double duty supporting both Remote ID and providing altimeter information for safe landing. Ground speed and speed of decent/accent are additional outputs from the sensor. Implement the Remote ID code for programming into the onboard ESP32 WROOM module. Code uses the WiFi/Bluetooth module to broadcast flight data including location, speed, and altitude.

Degrees: Electrical Engineering, Computer Science, Computer Engineering, Electromechanical Engineering

Year: Undergraduate

Sensor: **OPS243-C-FC-WB**



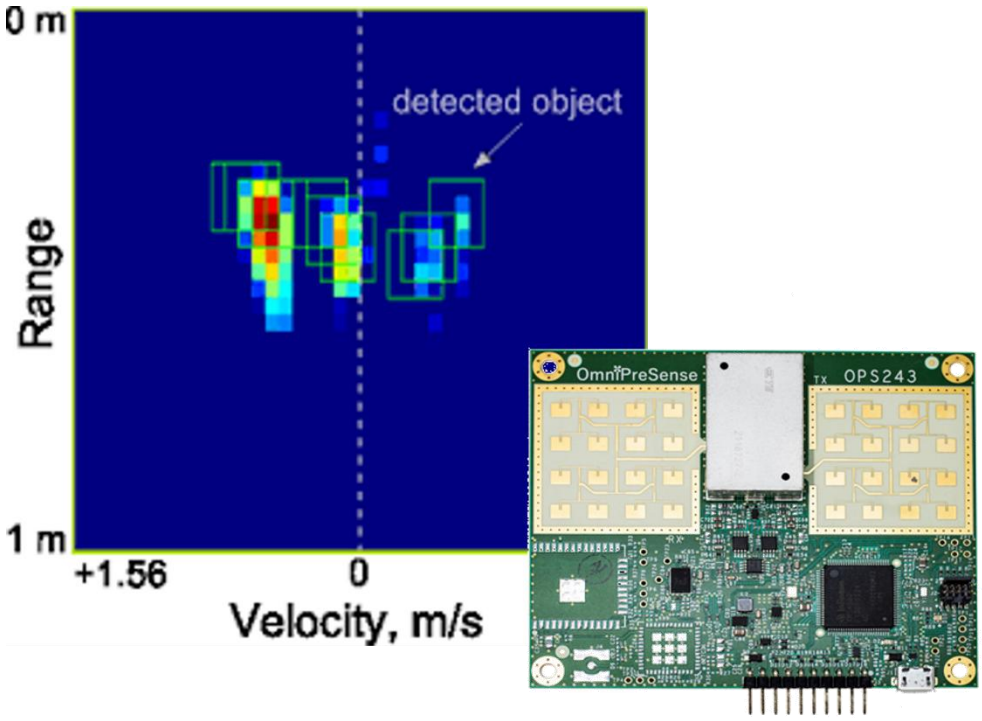
2) Range – Doppler Processing and Visualization

This project involves post processing range data captured by the OPS243-C to generate a Range-Doppler image. Post process many range readings to calculate the speed of any moving objects in the sensor field of view. Post processing by a Raspberry Pi or similar using Python and outputting a graphical representation of the speed and position of detected objects. Additional processing can use machine learning to attempt classifying the objects.

Degrees: Electrical Engineering, Computer Science, Computer Engineering

Year: Undergraduate

Sensor: [OPS243-C-FC-RP]



3) Vehicle Classification Utilizing OPS243-A Classifier Object

The project utilizes the object classifier API command in the OPS243-A to output information about vehicles as they pass thru the sensor field of view. Data reported including signal magnitude (max, avg.), total detection time, speed, field of view transit time, length, etc. are used to build a machine learning (ML) model which can classify the detected vehicles as large truck/bus, car, motorcycle, or bicycle. Collected data is utilized to train a TinyML model which may be coded in Python to run on a Raspberry Pi or similar. Successful testing of live data from the sensor will report speed and classification while achieving greater than 95% accuracy.

Degrees: Electrical Engineering, Computer Science, Computer Engineering

Year: Undergraduate

Sensor: [OPS243-A-CW-RP]

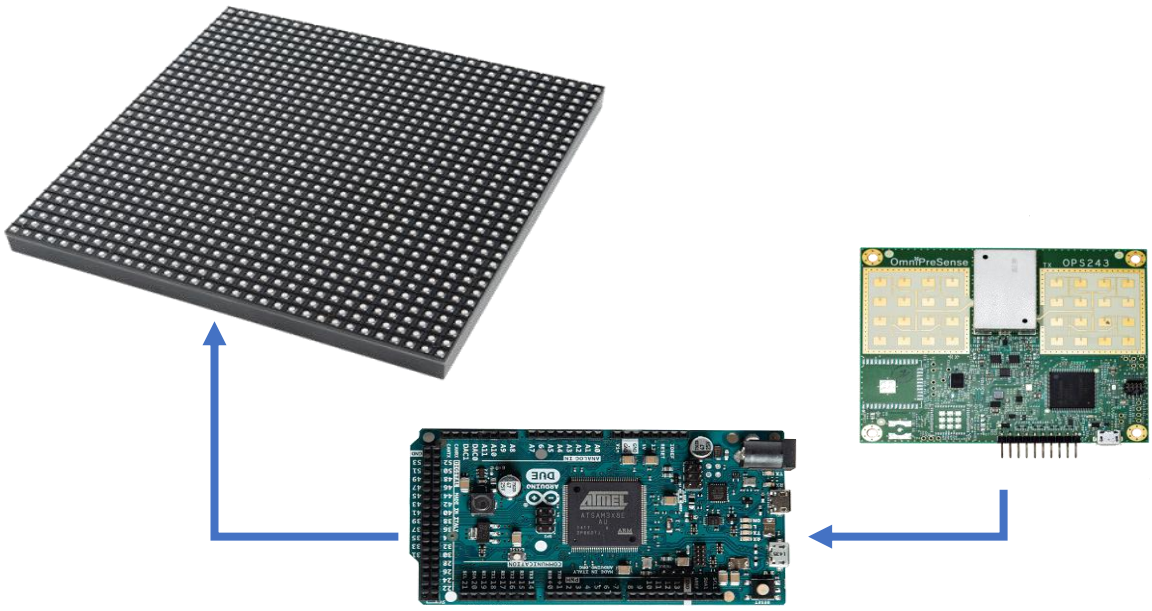
4) Radar Speed Sign LED Driver Board

This project involves reading speeds from an OPS243-A and processing it thru an Arduino Due to drive an LED display as a radar speed sign. As a bonus, if excessive speed is detected, special messages or flashing speed number and/or changing colors are used to encourage safer driving. The project utilizes a design write-up by Sparkfun found **here**.

Degrees: Electrical Engineering, Computer Engineering

Year: Undergraduate

Sensor: **OPS243-A-CW-RP**



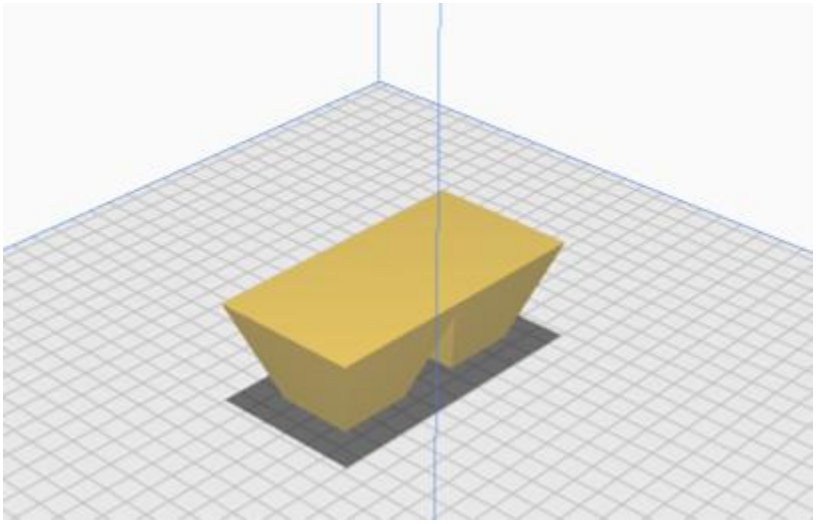
5) 3D Printed Waveguide for OPS243

Design a dual waveguide for the Tx and Rx antenna of the OPS243 which will increase the antenna gain and overall detection distance. Goal is increase an of 3-6dBi and doubling the detection distance. The waveguide is 3D printed and fits over or slide on top of the OPS243 antenna array. Post processing to smooth the waveguide and metalize it are required. Assistance with signal gain measurements available.

Degrees: Electrical Engineering, Optical Engineering, Physics

Year: Undergraduate, Masters

Sensor: **OPS243-A-CW-RP** or **OPS243-C-FC-RP**



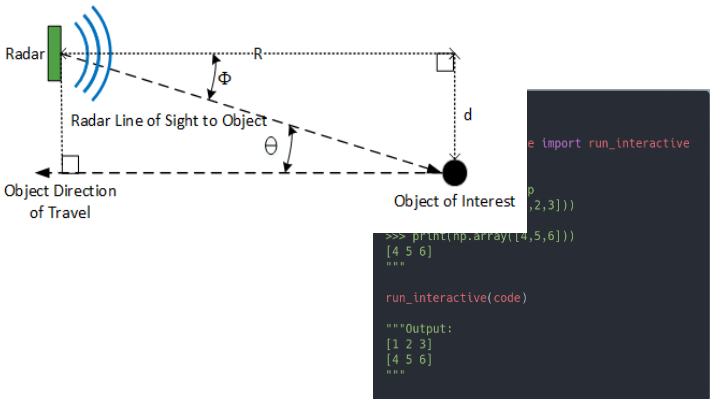
6) Automatic Cosine Error Detection and Correction

This project utilizes speed data from an OPS243-A to determine the path a vehicle makes relative to the sensor, calculating the cosine error in the speed readings, and enabling automatic correction of the final reported speed. Test data taken based on known object speed and position relative to the sensor is analyzed and equations are generated to determine the cosine error correction. The equations are coded in Python and run on a Raspberry Pi or similar to output correct speeds within ±1% of actual speed. An extension of the equations or algorithms may be used for determining the lane a vehicle is traveling in for multi-lane roads.

Degrees: Electrical Engineering, Computer Science, Computer Engineering

Year: Undergraduate

Sensor: [OPS243-A-CW-RP]



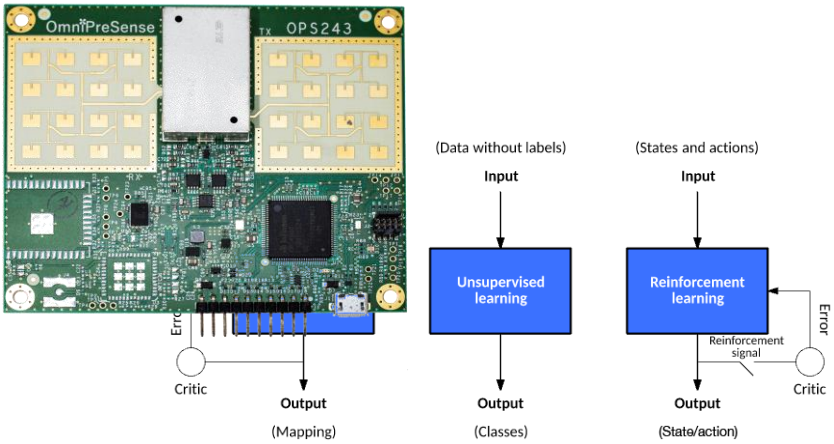
7) Material Classification using FMCW Radar and Machine Learning

A material classification sensor is developed based on the OPS243-C making use of its FMCW operation. Returned signals from the OPS243-C are captured for various material types (metal, brick, wood, flesh, etc.) and a machine learning model is developed to correctly classify the material. Signal analysis makes use of the raw and FFT data provided by the sensor API for processing and may leverage the ability to adjust the chirp ramp rate and/or bandwidth used. The ML model is implemented in Python to run on a Raspberry Pi or similar for testing with target accuracy of >95%. Real world applications for such classification include determining rocks in grain, quality of plywood construction (glue, voids), and metals hidden under garments.

Degrees: Electrical Engineering, Computer Science, Computer Engineering, Materials Engineering

Year: Undergraduate, Masters

Sensor: [OPS243-C-FC-RP]



8) Drone Based SAR Imaging

Utilize a drone with a ground facing OPS243-C and SAR (Synthetic Aperture Radar) to map the ground with high resolution. Capture data from the OPS243-C and pass to processor board (ex. Raspberry Pi) for post processing and running through algorithms such as range and azimuth compression. Integrate sensor range data with drone IMU data streams for accuracy in calculations. Utilize on sites where elevation information is changing or important to log (ex. Construction site, sea walls, battlefield, etc.). Bonus work to use the data to classify what objects are in the sensor field of view (vehicle, people, buildings).

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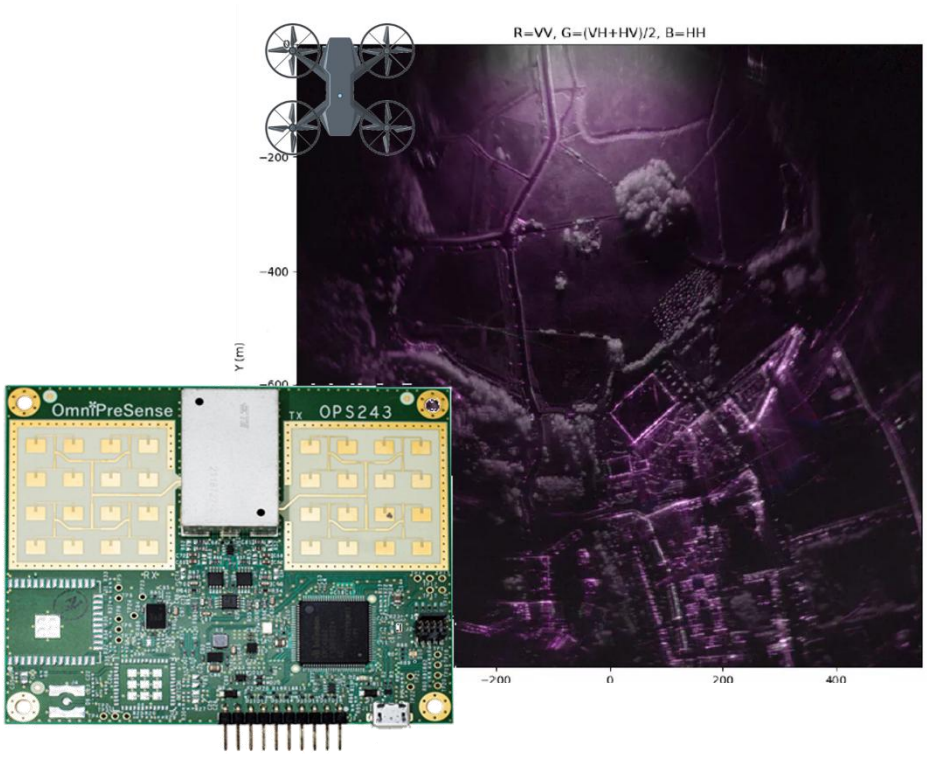
Year: Undergraduate, Masters

Sensor: [OPS243-C-FC-RP]



9) Radar and Camera Integration for Vehicle Speed Detection

The project utilizes a Raspberry Pi with a camera and OPS243-A to detect the speed of vehicles and when excessive, takes a picture for license plate recognition (LPR). On board LPR algorithms may be run or images may be passed off to cloud based solutions (ex. Plate Recognizer) for license plate reporting. Enhanced algorithms may be employed which can perform object detection for classifying vehicle type (truck, car, motorcycle) and/or lane detection for assigning proper speed to vehicles when two or more are present in the field of view. For a head start, see following **GitHub** repository. The OPS243-C range information can be used to trigger the camera at the correct distance for optimal pixel count or size of the license plate.

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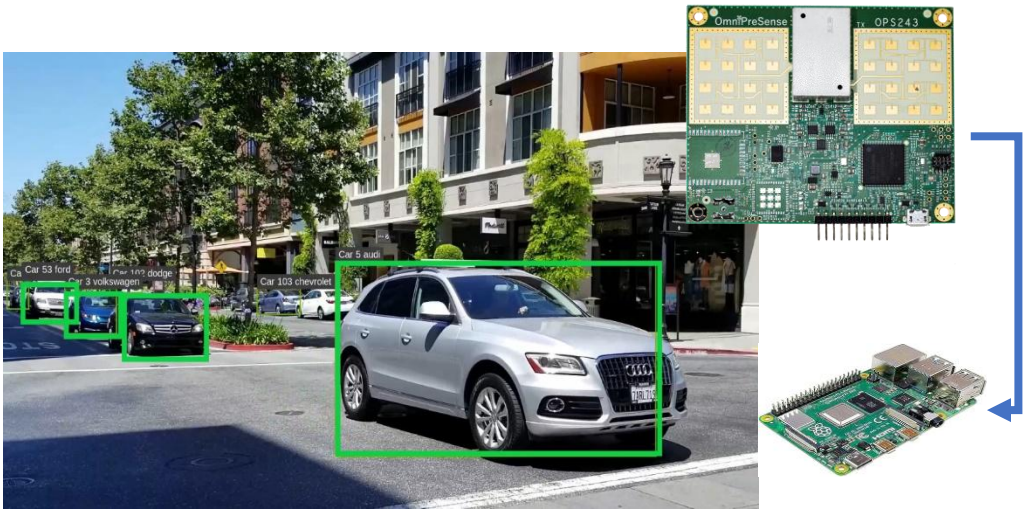
Year: Undergraduate, Masters

Sensor: **OPS243-A-CW-RP** or **OPS243-C-FC-RP**



10) Bullet Speed/Gun Muzzle Velocity Detection with Rolling Buffer

Utilize the OPS243-A with the new Rolling Buffer feature to capture the muzzle velocity of a bullet. The Rolling Buffer provides a continuous sampling of data at a very high speed rate. Use a trigger such as a microphone placed near the muzzle to trigger the sampling to stop and output the raw data. Python processing of the data including an FFT provides accurate speed measurements and possibly investigate if spin can be detected (fluctuations in the speed measurements).

Degrees: Electrical Engineering, Computer Science, Computer Engineering

Year: Undergraduate

Sensor: OPS243-A-CW-RP

Revision History

Version	Date	Notes
A	September 10, 2024	Initial release.
B	August 20, 2025	Updated for 2025 with new project proposals

Other Ideas

1) Displacement using phase difference
2) Lane Detection multi-object detect