DEVELOPMENT OF A MOUNTING SYSTEM FOR FMCW RADAR ON UGVs AND DRONES FOR DETECTING OBSCURED OBJECTS WITHIN THE GROUND USING MMWAVE RADAR SIGNALS

Eric Meza[1], Dr. Nirmalya Roy[2], Dr. Anuradha Ravi[2]

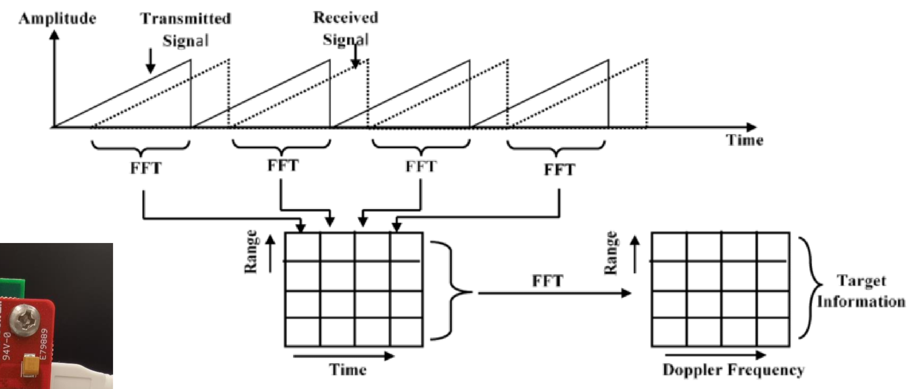
[1]Department of Mechanical Engineering, [2]Department of Information Systems, University of Maryland, Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250

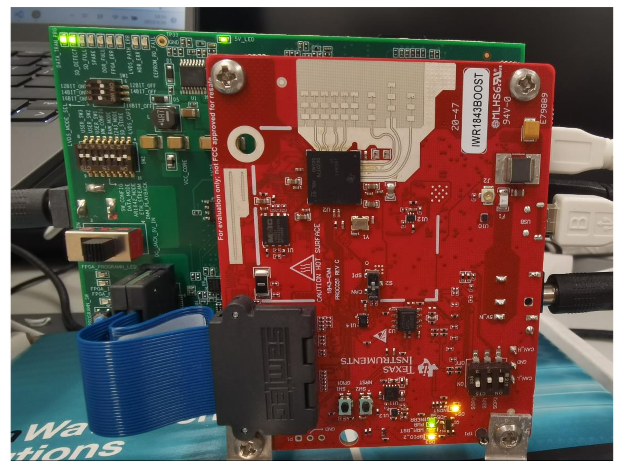
Problem Statement

Obtrusive objects are nearly invisible to the naked eye, especially when underground with obstructions like snow, tall grass, mud, and branches. Most detection systems such as camera, LiDAR and Infrared fail to penetrate through the surfaces. Thus, we engage Frequency-Modulated Continuous-Wave (FMCW) Radar on Unmanned Ground Vehicles (UGVs) and Drones to identify and map obscured objects.

We present the design and implementation of a robust mounting system for mmWaveRadar on UGV and drones to map the objects from different angles. The point clouds extracted from these angles serve as input to machine learning models, coupled with RGB image data to create Synthetic Aperture Radar (SAR) images of the objects.

What is FMCW Radar

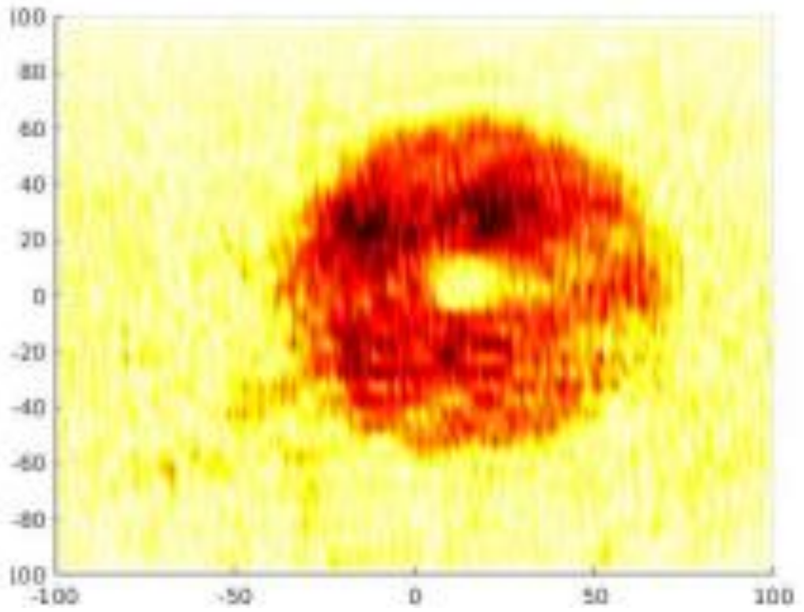


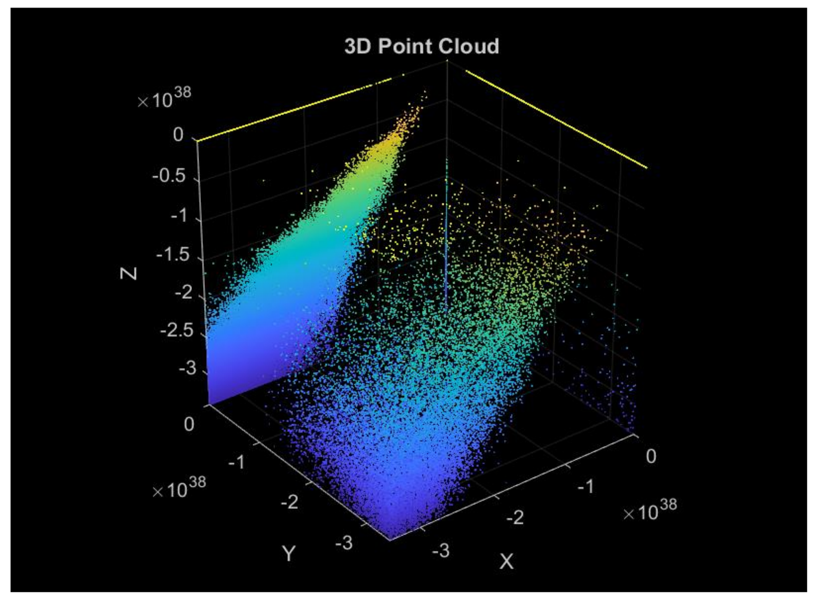


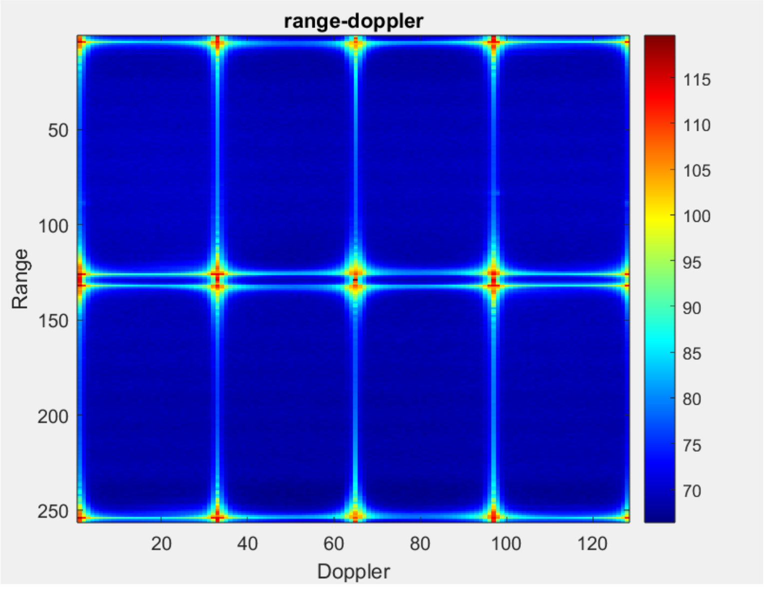
FMCW (Frequency Modulated Continuous Wave) radar is a type of radar system used to measure the distance and speed of objects. It works by continuously emitting a signal that hits an object and reflects back. It uses the difference in frequency to measure distance and change in frequency over time for speed.

Data Extraction

Radar systems extract and transform data into SAR images, range-Doppler maps, and point clouds through a series of steps. First, the radar emits signals and receives their reflections, which are converted to a digital format for processing. These transformations enable accurate detection, imaging, and tracking of objects.

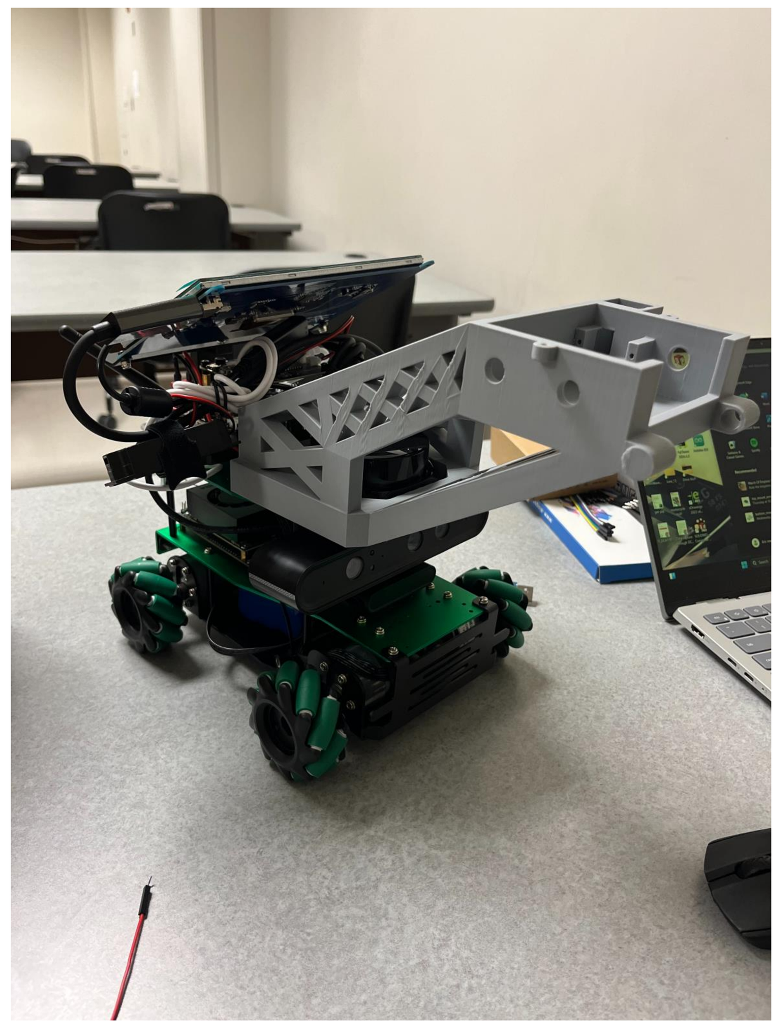


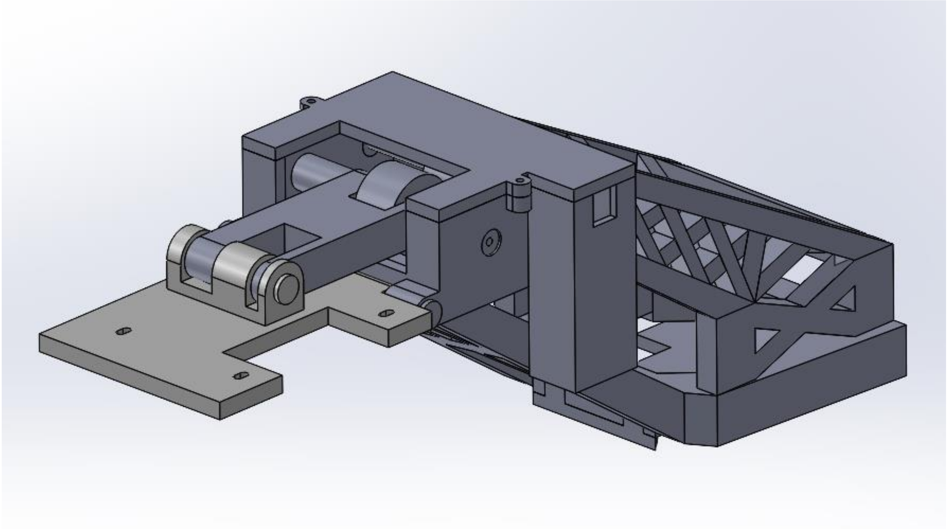


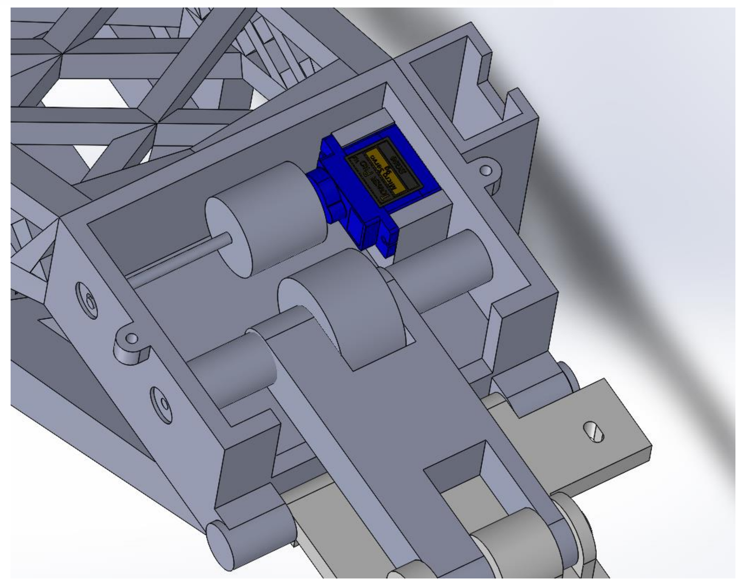


Creating the Radar Mount

- The mount for mmWave Radar is equipped with an interlocking arm extended from the top of the robot to remove the possibility of obstruction during data collection.
- The end of the mount consists of a gear system that connects the radar to programmatically driven servos allowing the radar to actuate and collect data from various angles.
- The mount was designed to maximize and adhere to all specifications of the mmWave Radar. The arm extends out of the back of the robot positioned to be around the LiDAR. This way there is no obstruction by the UGV during data collection, and we are not obstructing or removing existing hardware. A servo motor connected to a belt gear system actuates the radar's angular position to efficiently collect data on varying surfaces.







References

David Montgomery, Gaston Holmén, Peter Almers, and Andreas Jakobsson, "Surface Classification with Millimeter-Wave Radar Using Temporal Features and Machine Learning," in Proceedings of the 16th European Radar Conference, Paris, France, October 2019, pp. 1-6.eatures and Machine Learning," in Proceedings of the 16th European Radar Conference, Paris, France, October 2019, pp. 1-6.

David Montgomery, Gaston Holmén, Peter Almers, and Andreas Jakobsson, "Soil Moisture Sensing with mmWave Radar," in Proceedings of the 16th European Radar Conference, Paris, France, October 2019, pp. 1-4.

Acknowledgements

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