Current state-of-the-art unmanned vehicle obstacle avoidance requires an array of expensive time-of-flight sensors, LiDAR sensors, or ultrasonic sensors. Novel 60GHz RADAR sensors allows for the same functionality but at a drastically lower cost. These RADAR chipsets have more than a 100x improvement in measurable volume compared to time-of-flight sensors. These sensors are also solid-state and are smaller than a nickel.

**Design Specifications**

- Implemented custom drivers for Texas Instruments (TI) mmWave RADAR sensors
- Introduced PyMMWave, an open-source library for easy TI mmWave RADAR sensor programming
- Implemented Slamtec RPLIDAR sensor integration to create a continuous obstacle map using Simultaneous Localization and Mapping (SLAM) techniques
- Used RADAR and LiDAR to provide data to our system in order to avoid obstacles.

**Key Components**

- **Aion Robotics R1 UGV**
  - Pixhawk 2.1 Autopilot
  - NVIDIA Jetson Development Board
- **Texas Instruments mmWave RADAR**
  - 130-degree azimuth and elevation
  - Can detect objects 100m away
  - Emits pulses at 60-70GHZ
- **Slamtec RPLIDAR A1M8**
  - 360-degree laser scanner
  - 12-meter range
  - 2-10Hz
- **NVIDIA Jetson**
  - Self-contained Linux platform
  - Runs Robotics Operating System

**Collision Detection and Avoidance**

- Gets data from sensors. Modifies all input data to be oriented correctly
- Performs custom noise filtering based on RADAR sensor error patterns
- Constructs space constraints based on safety bounds
- Forwards data to vehicle manager, which manages state
- Attempts to estimate where vehicle will be by the time we get new data
- Modifies vehicle control to avert. If there is a safe new direction, veer away

**Obstacle Mapping**

Our sensors return spatial data which we use for obstacle detection. By knowing the direction at which an obstacle is coming towards us, we can try to turn towards empty space.

**Acknowledgements:**

Special thanks to our sponsors Phil Tokumaru and Scott Rasmussen from AeroVironment as well as Professor Yogananda Isukapalli and Teaching Assistants Boning Dong and Trenton Rochelle.