Mechanical Engineering Doctoral Defense

Direct Detection Time of Flight Lidar Sensor System Design and A vortex tracking algorithm for a Doppler Lidar

School for Engineering of Matter, Transport and Energy

Sreevatsan Bhaskaran
Advisor: Ronald Calhoun

abstract

Laser radars or lidar is an optical sensor that is used extensively today for a wide range of applications. For example, Doppler lidars are used frequently in wind resource assessment, wind turbine control as well as in atmospheric science research. On the other hand, a Time of Flight based (ToF) direct detection lidar sensor is used in an autonomous vehicle to navigate through complex terrains safely. These optical sensors are used to map the environment around the car accurately for perception and localization tasks that help achieve complete autonomy. The first part of this dissertation begins with a detailed discussion on the fundamentals of a Doppler lidar system. Starting with the pulse transmitter, pulse interactions with the atmosphere, the process of collecting the backscatter from the target and subsequent signal processing to estimate the Doppler shift (radial velocity) information from the optical returns are reviewed extensively. Next, a lidar simulator was built to generate raw data by scanning a 2D flow field with a pair of counter-rotating vortices. A physics-based technique was developed to accurately estimate the position and circulation strength. The second part of this dissertation begins to explore the details of a ToF lidar system. A system level design, to build a ToF direct detection lidar system is presented. Using off-the shelf components a working prototype of a 2D MEMS scanning lidar system based on the white board design was built. Finally, a range of experiments and tests were completed to align the optics of the system and to ensure maximum field of view overlap for the optical laser sensor. As a laser range finder, the optical sensor demonstrated capabilities to detect hard targets as far as 32 meters.

October 24, 2018; 2 PM; ERC 593