Lab 4

LIDAR

This lecture is part of the RACECAR-MN introductory robotics course.
You can visit the course webpage at mitll-racecar-mn.readthedocs.io.

Objectives

Main Objective: Use LIDAR to detect objects around the car in all directions

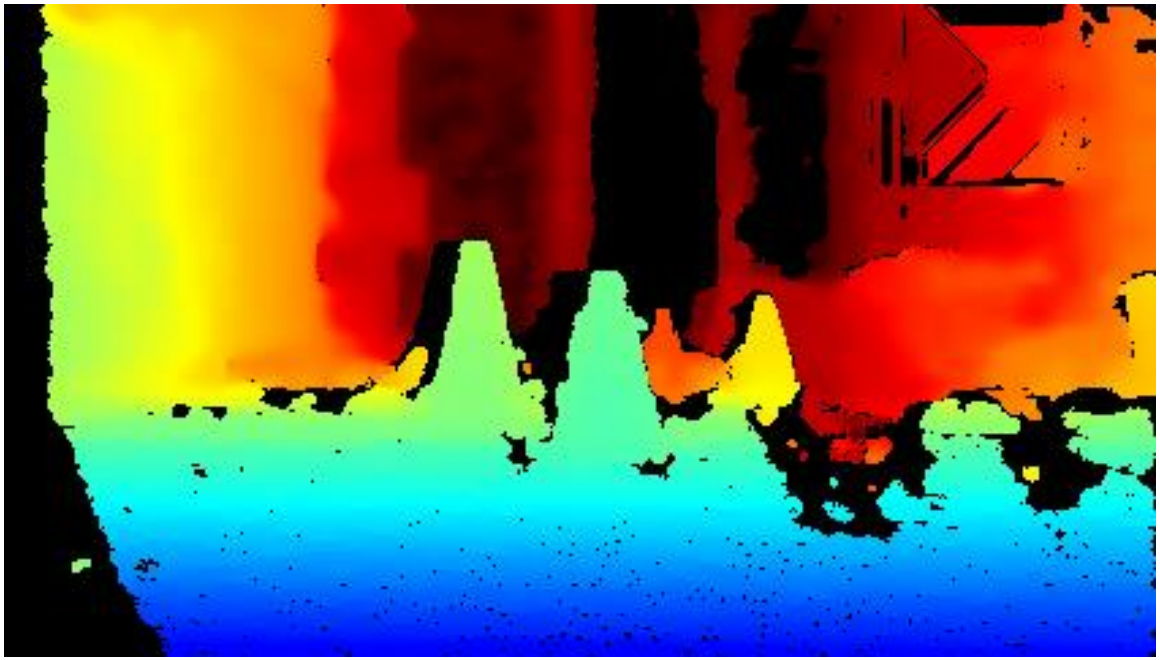
Learning Objectives

- Compare the advantages of the depth camera and the LIDAR, and identify ideal situations for each sensor
- Convert raw LIDAR data into meaningful information about the surrounding environment
- Understand and implement rudimentary path planning

Depth Camera

Group activity

- What are some limitations of depth cameras?



Depth Camera

Group activity

- What are some limitations of depth cameras?
  - Can only see in front of the car
  - Do not work in the dark/poor lighting
  - Noise and missing data

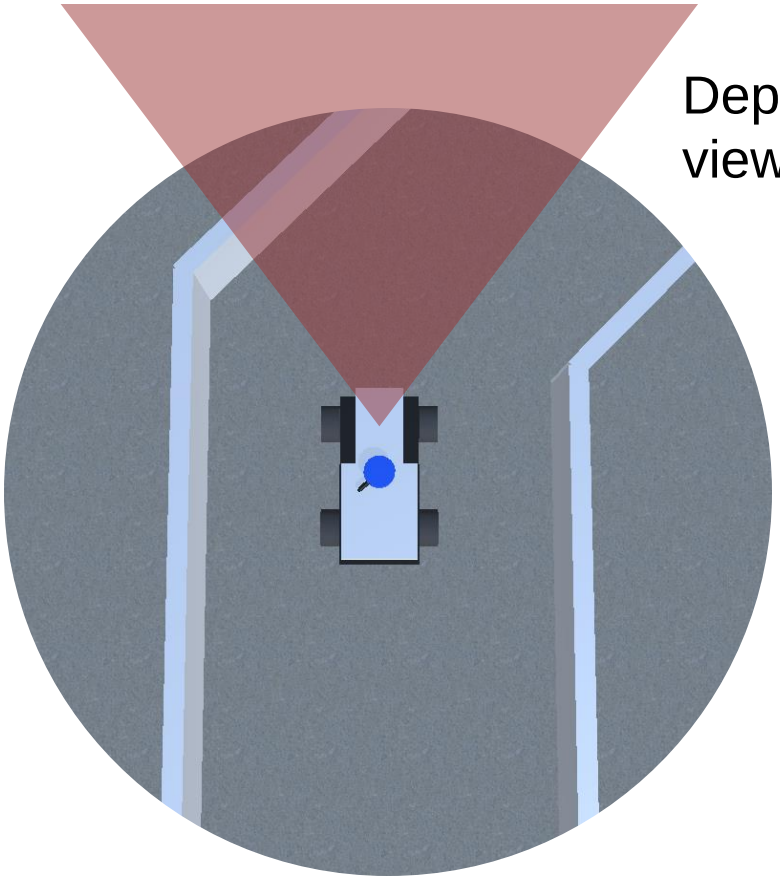
Depth Camera

Group activity

- What are some limitations of depth cameras?
  - Can only see in front of the car
  - Do not work in the dark/poor lighting
  - Noise and missing data
- On the other hand, LIDAR:
  - Provides 360-degree vision
  - Works in all lighting environments
  - Can provide a second source of truth

Depth Camera

Group activity

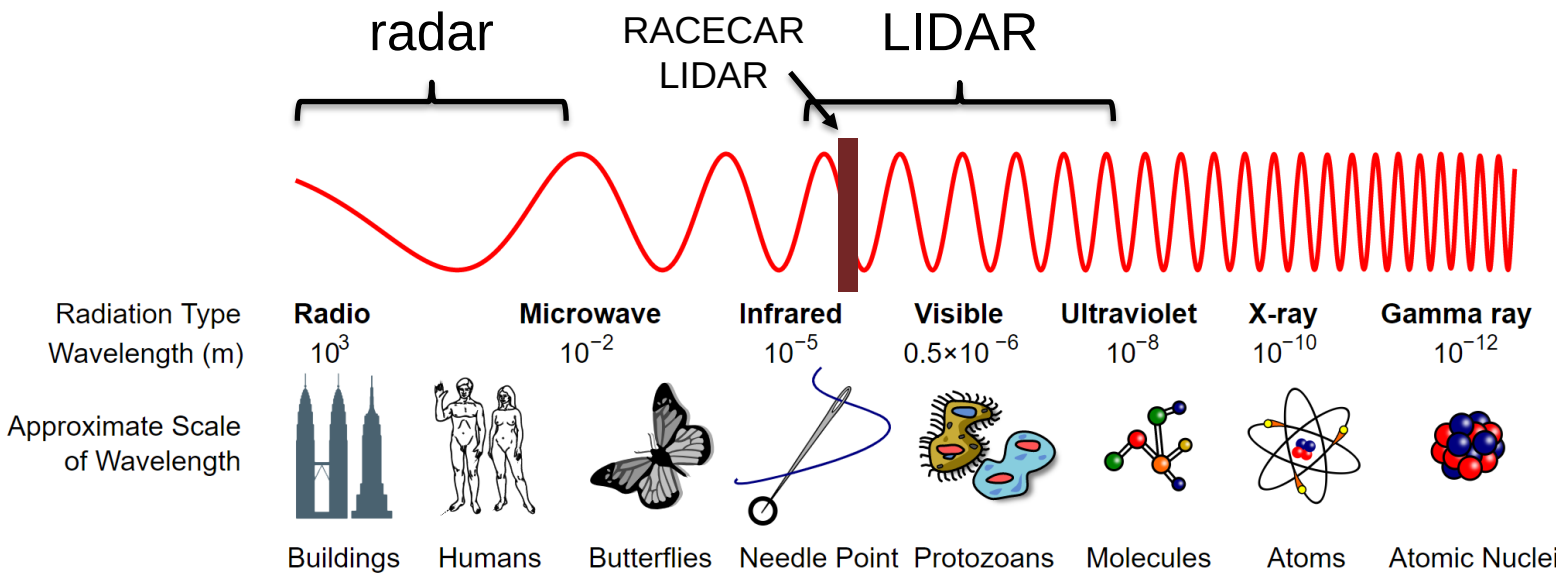


Depth camera field of view = 74 degrees

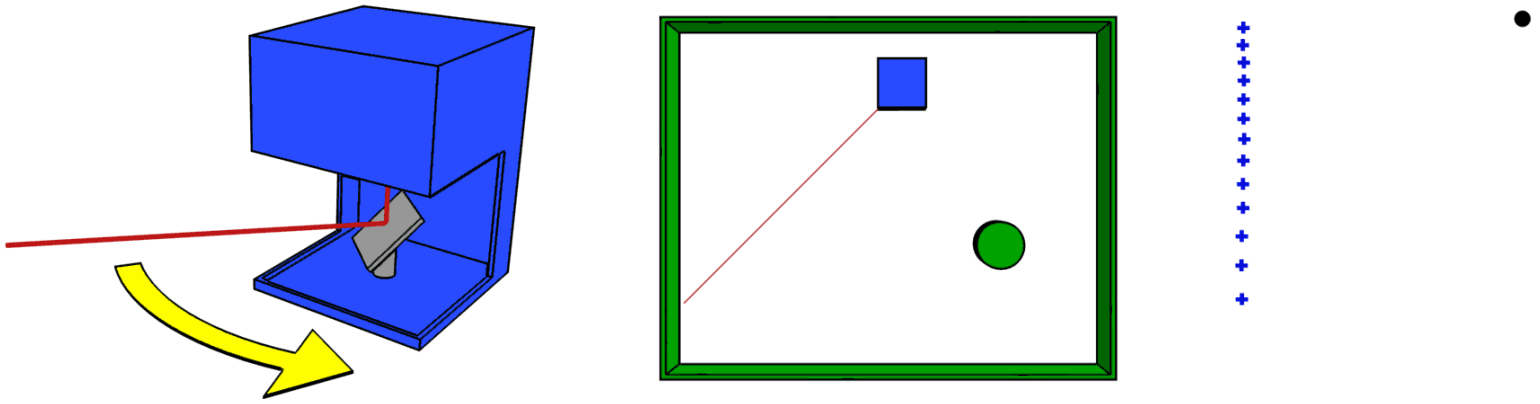
LIDAR

Group activity

- **LIDAR (light + radar)**: Calculate object distance by firing a laser and measuring the time it takes to return
  - Like radar but with a smaller wavelength of light



LIDAR

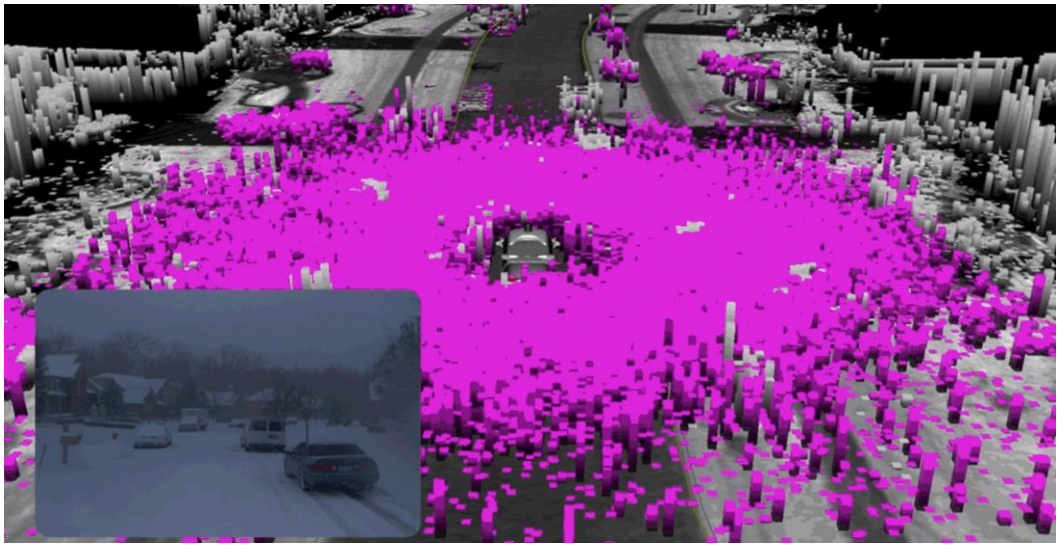


Animation created by Mike1024

LIDAR Limitations

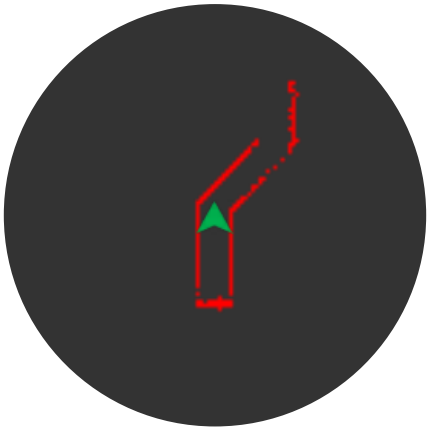
Group activity

- Accuracy varies based on material
- Subject to noise and null values
- Poor performance in snow



RACECAR-MN LIDAR

- YDLIDAR X4 (2D)
  - $100 (cheap for LIDAR)
  - Max range: 10 m
  - Between 6 to 12 hz
- 720 samples returned as an array of floats
  - 0^{th} entry = directly in front of the car
  - Ordered clockwise



Lidar Module

- Retrieves the LIDAR scan
- Public interface
  - `get_samples()`
  - `get_num_samples()`

Display Module

- Displays data and images to the screen
  - Simulation: Creates a window on your computer
  - RACECAR: Creates a window on the mini-monitor
- Public interface
  - `show_color_image()`
  - `show_depth_image()`
  - **`show_lidar()`**

Examples

Group activity

```
# Example 1
scan = rc.lidar.get_samples()
foo = scan[450]

# Example 2
scan = rc.lidar.get_samples()
scan = (scan - 0.01) % 100000
bar = np.argmin(scan) * 360 / rc.lidar.get_num_samples()

# Example 3
scan = rc.lidar.get_samples()
baz = [e for e in scan[170:191] if e > 0.0]
qux = sum(baz) / len(baz)
```

Examples

Group activity

```
# Example 1
scan = rc.lidar.get_samples()
foo = scan[450]

# Example 2
scan = rc.lidar.get_samples()
scan = (scan - 0.01) % 100000
bar = np.argmin(scan) * 360 / rc.lidar.get_num_samples()

# Example 3
scan = rc.lidar.get_samples()
baz = [e for e in scan[170:191] if e > 0.0]
qux = sum(baz) / len(baz)
```

when would this cause an error?

Lab 5 Objectives

- **Jupyter Notebook**: Write helper functions to measure average distance and find the closest point in a scan
- **Lab 5A**: Safety stop (revisited)
- **Lab 5B**: Wall following
- Revisit Phase 1 challenge