**Spring 2022 - Final Group Project**

**Dataset Description**

**https://drive.google.com/drive/folders/1KOj2JToFH7r\_fF0BH2X8qWngw4rd6YSc? usp=sharing**

| **Dataset** | **robot** | **Sensors in Dataset** |
| --- | --- | --- |
| SkerkiD | AUV | Camera looking down |
| car\_IR\_RGB\_lidar | AGV/ Autonomous car | IR camera, Stereo RGB, 2 Lidars, IMU, GPS |
| LIDAR\_mapping\_bicycle\_ped estrian\_detection | AGV/ Autonomous car | 2 Lidars, IMU, GPS, CAN bus |
| uas\_infrared\_mosaic\_3dSFM | UAS | IR camera looking down |

Every dataset directory has an info.txt file with available topics for the provided rosbag. **1. SkerkiD:**

This dataset contains a number of overlapping images corresponding to an ancient shipwreck. AUV with camera and light source is used for collecting images in a survey pattern. Details of this dataset can be found in

Pizarro, O., & Singh, H. (2003). Toward large-area mosaicing for underwater scientific applications. *IEEE journal of oceanic engineering*, *28*(4), 651-672.

Also see the article in the April 1998 issue of National Geographic entitled High Tech Hunt for Roman Shipwrecks.

**2. car\_IR\_RGB\_lidar:**

In this dataset, Northeastern’s autonomous car(NUANCE) is driven manually along the streets of Newbury street in Boston. The dataset has stereo RGB cameras looking forward, IR camera looking forward, 2 Velodyne VLP-16 lidar mounted on top of the car, IMU, GPS. The main focus in this dataset was to collect camera data with at least one loop closures. The sensors like lidars, gps, imu in combination can serve as ground truth for visual slam algorithms.

The camera calibration for the RGB cameras are available in rosbag, IR camera calibration is provided in the info.txt file. The specs of the cameras, Lidar are also provided in the info.txt file.

**3. LIDAR\_mapping\_bicycle\_pedestrian\_detection:**

In this dataset, Northeastern’s autonomous car(NUANCE) is driven manually along the streets of Columbus avenue in Boston. The dataset has 2 Velodyne VLP-16 lidar mounted on top of the car, IMU, GPS along with the car's CAN bus data containing steering, brake, accelerator commands. It mainly focuses on lidar data of pedestrians, bicycles moving on the road. You can use the car's CAN data , GPS, IMU for augmentation.

The specs of the Lidar are also provided in the info.txt file.

**4. UAS\_Infrared\_mosaic\_3dSFM:**

In this dataset, InfraRed Camera facing down is mounted on the UAV. UAV is flown manually to record overlapping images covering most of the outdoor UAS arena in NEU Burlington campus.

The calibration data and specifications for the camera are provided in the info.txt in the dataset.

**Project Ideas**

**Image mosaicing:**

Relevant datasets : SkerkiD, UAS\_Infrared\_mosaic\_3dSFM

See the following paper on SkerkiD dataset

[1] Pizarro, O., & Singh, H. (2003). Toward large-area mosaicing for underwater scientific applications. *IEEE journal of oceanic engineering*, *28*(4), 651-672.

(a) Can we take these images and construct a large area panorama with them? A good reference for this dataset which explains some of the issues involved is the Pizarro paper referenced above.

The interesting idea here is to exploit the overlap not only along track but also side to side. You can use matlab and modify the example that we used for Lab #4 to accomplish this but look at the paper to see how we need to formulate the problem. You can also do this with OpenCV in python or any other code you find on Github

**3D Structure from Motion:**

Relevant datasets : SkerkiD, UAS\_Infrared\_mosaic\_3dSFM

When the above work [1] was done in 2003, computation resources were not as abundant as today. One other option is to compute a full 3D Structure From Motion algorithm that processes these images. This is somewhat more challenging but also provides us with a 3D navigation track for the robot. Essentially we switch from mosaicking (making a pretty picture) to Visual SLAM.

**Visual SLAM :**

Relevant datasets : SkerkiD, UAS\_Infrared\_mosaic\_3dSFM, car\_IR\_RGB\_lidar.

Can we develop a simple visual SLAM pipeline using image data from a moving vehicle. Here we estimate the pose as well as build the map.

You can refer to this blog post for a sample implementation on KITTI dataset and implement on the provided data mentioned above:

https://avisingh599.github.io/vision/monocular-vo/

You can use stereo RGB data for vSLAM pipeline. What is the advantage of using stereo? **Lane Detection:**

Relevant Datasets: https://github.com/commaai/comma2k19 , you can collect your own.

Follow the tutorials that we discussed in class. As we pointed out they were a little simple! Can you extend them for other kinds of data. Stick to traditional computer vision techniques rather than using neural nets for this lane detection task.

(a) Can you handle lane changes?

(b) Can you handle merges?

(c) Can you work with data at night?

(d) Can you use data on single lane roads (not highways)

Please realize that you have a fixed amount of time for this project. Pick a few segments and work on those as opposed to trying to do everything.

**Lidar Mapping:**

Relevant datasets : car\_IR\_RGB\_lidar, LIDAR\_mapping\_bicycle\_pedestrian\_detection

(a) Can we register point clouds from consecutive time steps and build the complete dense map? One of the common way to register point clouds is the iterative closest Point (ICP) algorithm: https://en.wikipedia.org/wiki/Iterative\_closest\_point.

Does ICP always work? Can we use other sensor data (GPS, IMU etc) to register point clouds better.

There are other ways to register point clouds like extracting 3D features, find correspondences and match similar to image stitching in Lab4.

(b) Another idea is to do Lidar odometry which is an extension to (a) where we estimate the pose of the robot . Check this paper out:http://www.roboticsproceedings.org/rss10/p07.pdf

**Lidar Object detection:**

Relevant datasets : car\_IR\_RGB\_lidar, LIDAR\_mapping\_bicycle\_pedestrian\_detection

Can we detect pedestrians, bicycles, cars, buildings etc from the point cloud data? This can be very useful to cluster points together and understand the semantics of the scene during autonomous driving.

Methods like clustering the voxels can also be used. Check out this thesis for reference https://coe.northeastern.edu/fieldrobotics/2017\_bicycle\_detection/RufoAntonio\_MastersThesis.p df