MICHIGAN STATE UNIVERSITY

Alpha Presentation

LiDAR and Stereo Image Fusion for Autonomous Navigation

The Capstone Experience

Team Lockheed Martin Space

Matt Anikiej
Carlo Barths
Michael Dittman
Nathaniel Ferry
Dom Mazza

Department of Computer Science and Engineering
Michigan State University

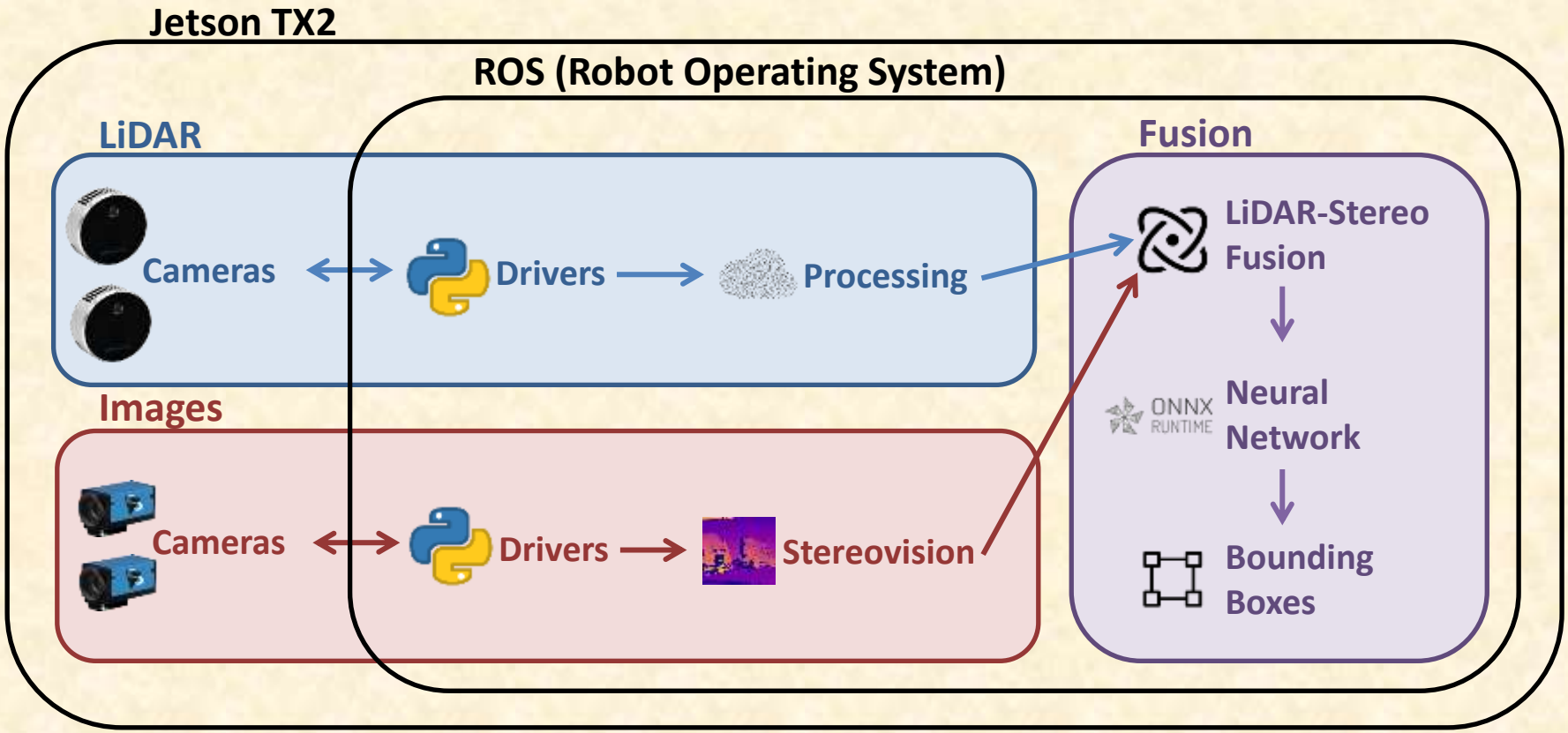
Fall 2022

From Students…
…to Professionals

Project Overview

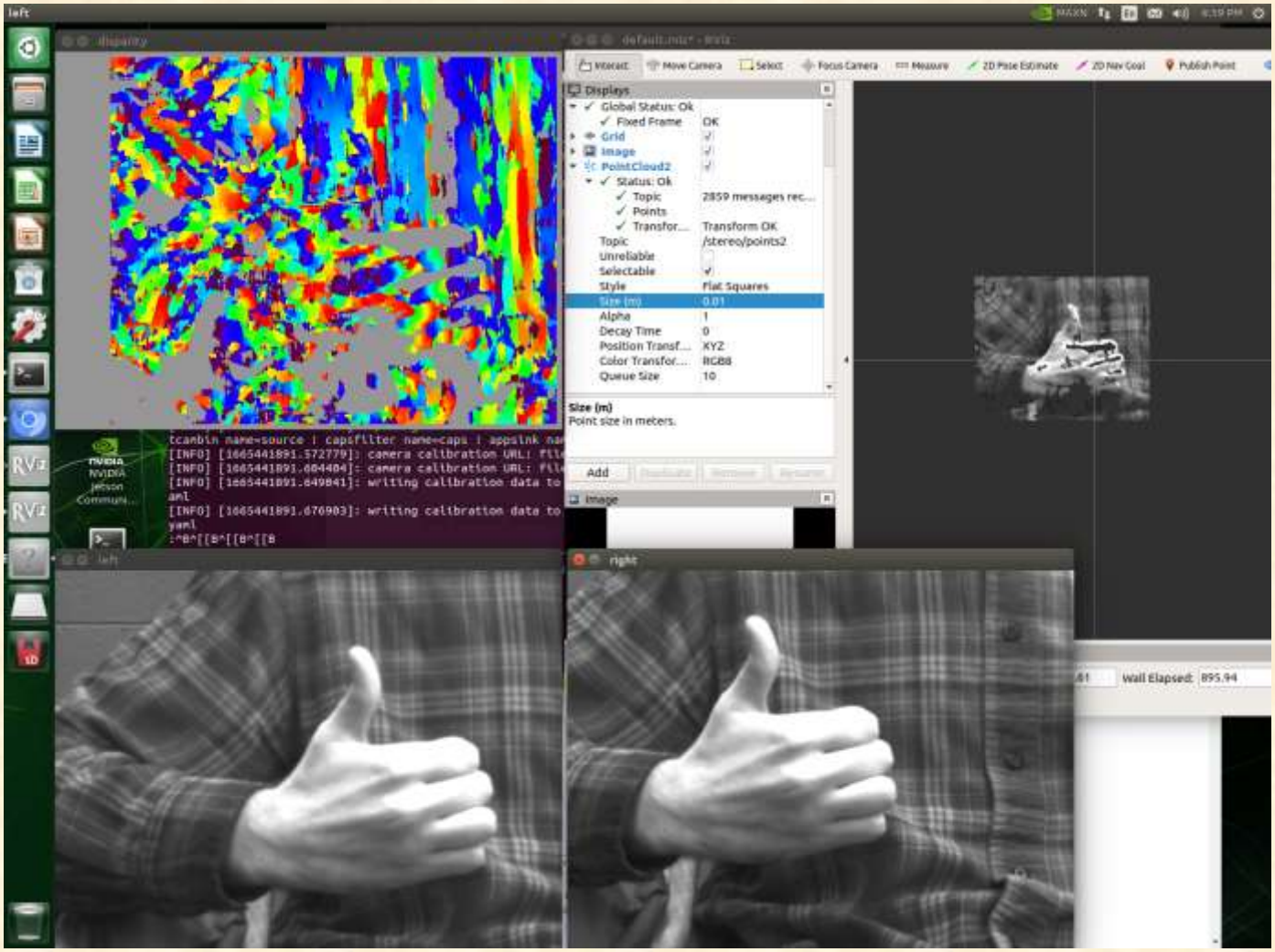
- Fuse LiDAR point clouds and stereo-imagery to generate a dense point cloud
- Utilization of multiple neural networks to detect on a dense point cloud
- Creation of a ROS wrapper to run the above systems on the Jetson TX2, with physical LiDAR and stereo camera components
- Setup MQTT Messaging to communicate between IoT devices

System Architecture

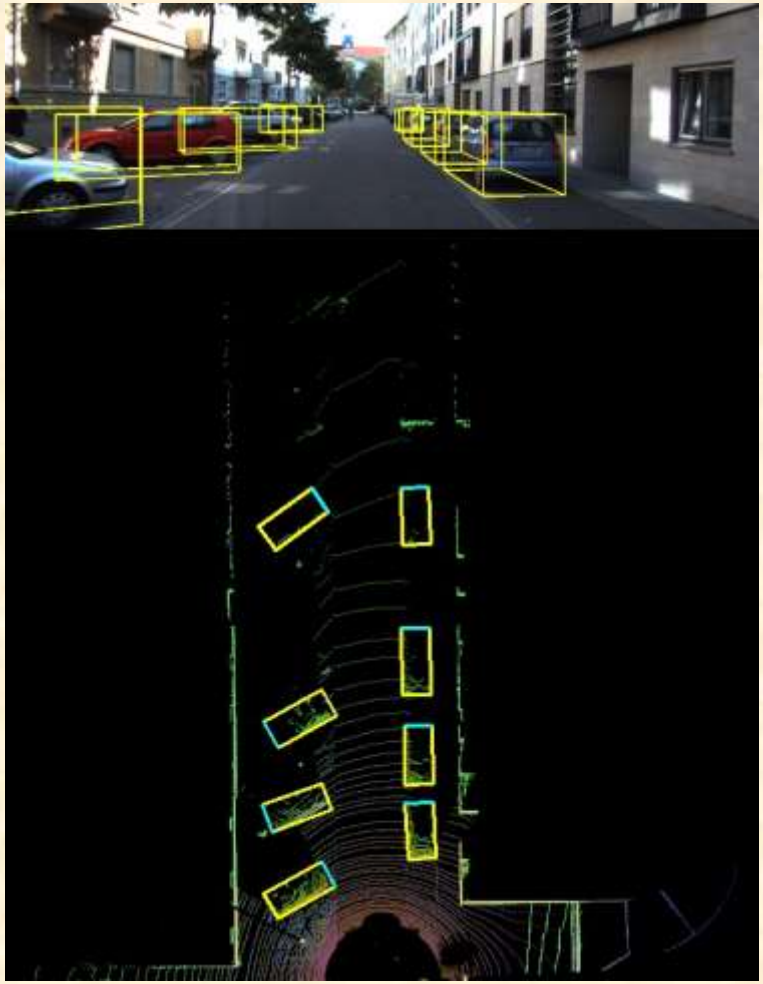


Jetson TX2, LiDAR, Mono Cameras

Stereo → Disparity Map → Point Cloud



YOLO3D Detections



MQTT Messaging

```
2022-10-11T01:46:30.374701Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.378187Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 0 completed
2022-10-11T01:46:30.378612Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.379026Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.379247Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 1 completed
2022-10-11T01:46:30.379447Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.379656Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.379815Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 2 completed
2022-10-11T01:46:30.380071Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.382293Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.382589Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 3 completed
2022-10-11T01:46:30.386890Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.387131Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.387179Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 4 completed
2022-10-11T01:46:30.394223Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394437Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394488Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 5 completed
2022-10-11T01:46:30.394561Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394649Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394689Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 6 completed
2022-10-11T01:46:30.394750Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394828Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.394869Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 7 completed
2022-10-11T01:46:30.395525Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.395644Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.395688Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 8 completed
2022-10-11T01:46:30.396064Z    INFO [HelloWorld] SendAndReceiveMessages: Sent message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.396550Z    INFO [HelloWorld] SendAndReceiveMessages: Received message: "Hello from CSE498 Team Lockheed Martin!"
2022-10-11T01:46:30.396636Z  NOTICE [HelloWorld] SendAndReceiveMessages: Cycle 9 completed
2022-10-11T01:46:30.407397Z  NOTICE [HelloWorld] LifecycleClient: Reporting exit status DEACTIVATED
2022-10-11T01:46:30.407532Z  NOTICE [HelloWorld] ORCA: HelloWorld stopped.
2022-10-11T01:46:30.407585Z  NOTICE [HelloWorld] ORCA: HelloWorld is exiting.
2022-10-11T01:46:30.408729Z    INFO [HelloWorld] ======================== LOG END ========================
dittmann@ubuntu:~/Documents/code_repo/smartsat_helloworld/HelloWorld$
```

What's left to do?

- Neural Networks
  - Train on fused-data
  - ONNX conversion testing
  - Optimize for TensorRT
  - Deploy on Jetson
- Fusion
  - Point cloud concatenation
- ROS Wrapper and Jetson
  - Hardware sync for LiDAR
  - Logging system overhaul
  - System sanity checks
  - Inference integration
- MQTT
  - Integrate MQTT with SmartSat™ SDK
  - Port code to VxWorks and embedded boards
  - Develop unit tests with Google Test

Questions?