

**MICHIGAN STATE**  

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**UNIVERSITY**

# Beta Presentation

LiDAR and Stereo Image Fusion for  
Autonomous Navigation

The Capstone Experience

Team Lockheed Martin Space

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Fall 2022



*From Students...  
...to Professionals*

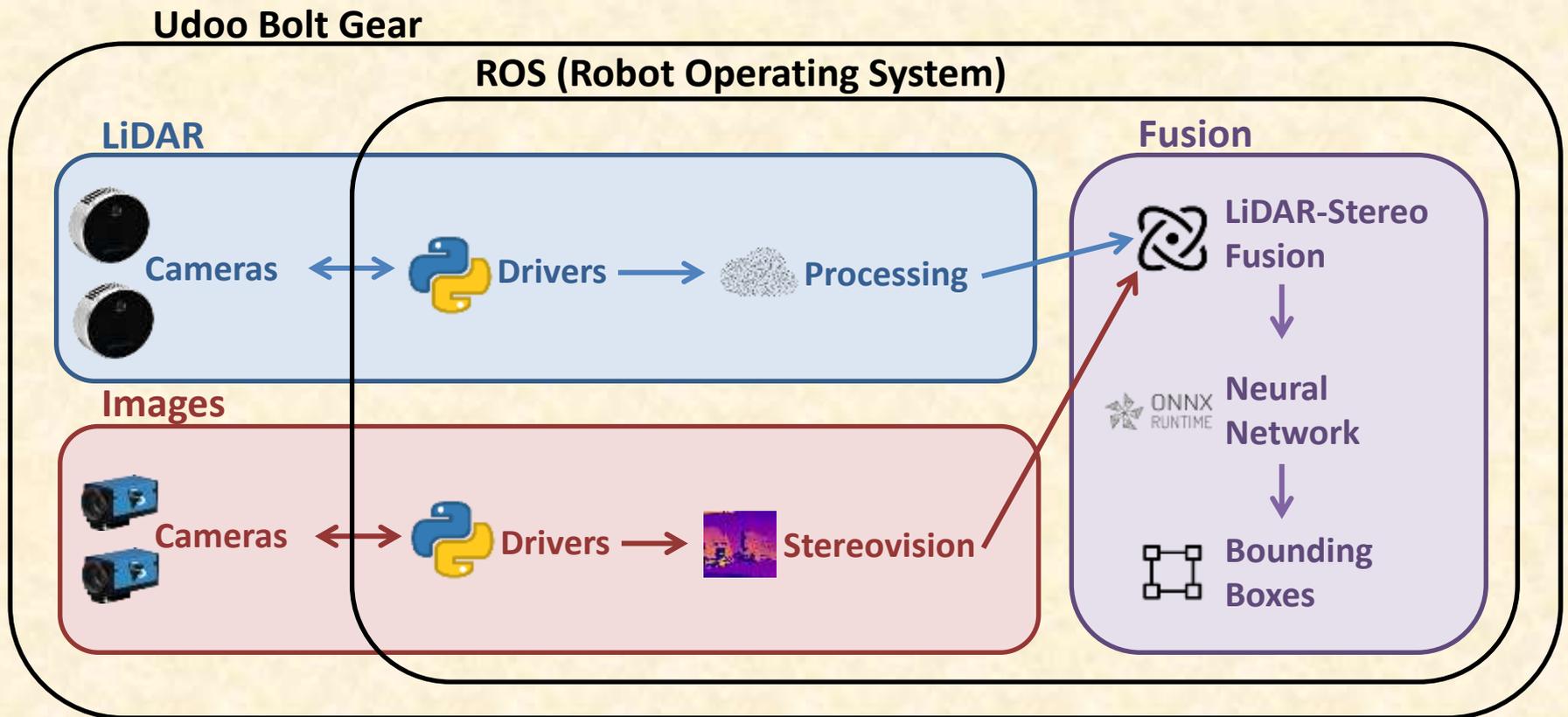
# Project Overview

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- Fuse LiDAR point clouds and stereo-imagery to generate a dense point cloud
- Utilization of a 3D neural network to detect on a dense point cloud
- Creation of a ROS wrapper to run the above systems on the UDOO Bolt Gear, with RealSense LiDAR/image sensors
- Setup MQTT Messaging to communicate between IoT devices



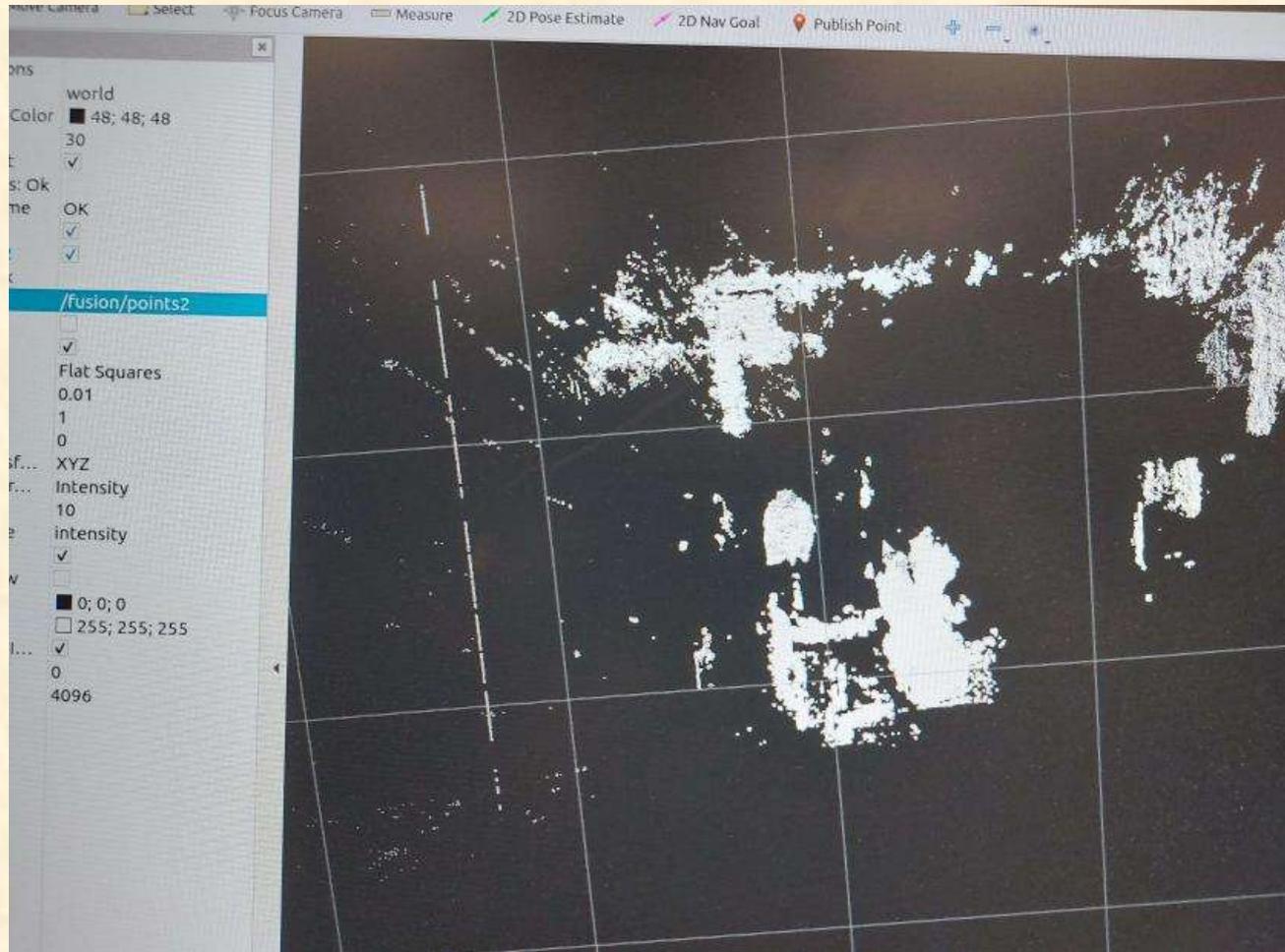
# System Architecture



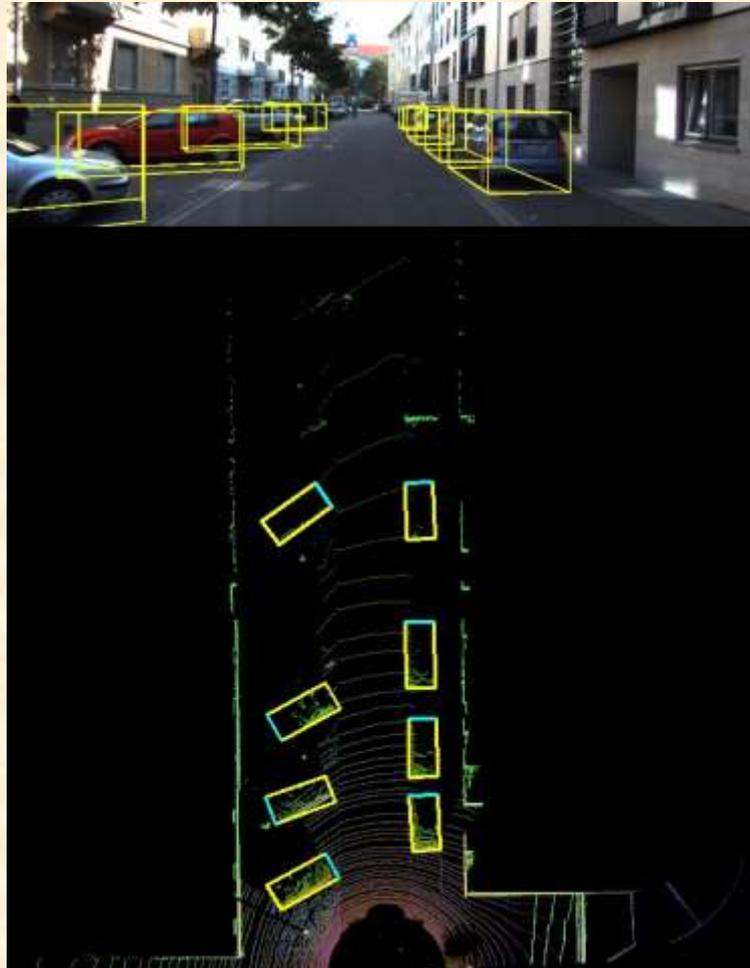
# UDOO Bolt Gear and RealSense LiDAR



# Fused Point Cloud



# YOLO3D Detections



# MQTT Messaging

```
2022-11-14T17:20:42.311657Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:42.311759Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.311886Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
2022-11-14T17:20:42.311981Z INFO [Mqtt-App] SendAndReceiveMessages: Received message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.312059Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 0 completed
2022-11-14T17:20:42.599311Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:42.599411Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.599437Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
2022-11-14T17:20:42.599479Z INFO [Mqtt-App] SendAndReceiveMessages: Received message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.599527Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 1 completed
2022-11-14T17:20:42.830741Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:42.830830Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.831329Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
2022-11-14T17:20:42.831811Z INFO [Mqtt-App] SendAndReceiveMessages: Received message: "Hello World! I am ready for development!"
2022-11-14T17:20:42.831905Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 2 completed
2022-11-14T17:20:43.066388Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:43.066488Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
2022-11-14T17:20:43.066514Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
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2022-11-14T17:20:43.066574Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 3 completed
2022-11-14T17:20:43.351033Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:43.351128Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
2022-11-14T17:20:43.351152Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
2022-11-14T17:20:43.351171Z INFO [Mqtt-App] SendAndReceiveMessages: Received message: "Hello World! I am ready for development!"
2022-11-14T17:20:43.351185Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 4 completed
2022-11-14T17:20:43.586475Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
2022-11-14T17:20:43.586559Z INFO [Mqtt-App] SendAndReceiveMessages: Sent message: "Hello World! I am ready for development!"
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2022-11-14T17:20:43.821656Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.sender: Successfully sent message: Hello World! I am ready for development!
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2022-11-14T17:20:44.100087Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 7 completed
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2022-11-14T17:20:44.333389Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 8 completed
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2022-11-14T17:20:44.568537Z INFO [Mqtt-App] MQTT-Mech: Mechanism mqtt.queue.receiver Successfully received message
2022-11-14T17:20:44.568579Z INFO [Mqtt-App] SendAndReceiveMessages: Received message: "Hello World! I am ready for development!"
2022-11-14T17:20:44.568606Z NOTICE [Mqtt-App] SendAndReceiveMessages: Cycle 9 completed
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# What's left to do?

- Neural Networks
  - Hotswapping of models
- Fusion
  - Provide option to fine-tune fusion parameters
- ROS Wrapper and UDOO Bolt
  - System Documentation
- MQTT
  - Port code to VxWorks and embedded boards
  - Develop unit tests with Google Test



# Questions?

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