Project Plan Presentation
LiDAR and Stereo Image Fusion for Autonomous Navigation
The Capstone Experience
Team Lockheed Martin Space

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Project Sponsor Overview

- Lockheed Martin is a Fortune 500 company employing over 100,000 people at over 60 locations
- Vast departments in Space, Aeronautics, Missile and Fire Control, and Rotary and Mission Systems
- Lockheed Martin Space advances vital technologies for future and current space endeavors
Project Functional Specifications

• Sense and communicate information about the surrounding lunar environment
• Facilitate messaging between IoT devices on the lunar surface
• Fuse together pointclouds and stereo-image data for accurate depth estimation and object detection on an embedded system
Screen Mockup: Pointclouds
Screen Mockup: Stereo-Disparity Mapping
Screen Mockup: Fusion Flowchart

Stereo Disparity Map → Disparity Map to Point Cloud → Point Cloud Data Format Unification → Averaging Values Between Point Clouds → Fused Point Cloud

LiDAR Point Cloud → Disparity Map to Point Cloud → Point Cloud Data Format Unification → Averaging Values Between Point Clouds → Fused Point Cloud
Screen Mockup: 3D YOLO Bounding Boxes
Project Technical Specifications

• Fuse pointclouds and stereovision data into a singular combined format
• Train 3D YOLO and Pointnet neural networks to process the data
  ▪ Models will be hot swappable
• Train PointDAN neural network to allow for domain-agnostic detections
• Create a ROS wrapper using Python/C++ to drive realtime sensors in testing the above networks
• Add messaging between system and IoT devices using MQTT and SmartSat™
Project System Architecture

Fusion

Jetson TX2

LiDAR

Cameras

Drivers

Processing

ROS (Robot Operating System)

Fusion

LiDAR-Stereo

Fusion

Neural

Network

Bounding

Boxes

Images

Cameras

Drivers

Stereovision
Project System Architecture

**MQTT Plugin**

Jetson TX2/Zynq UltraScale+

SmartSat™

MQTT Messaging API

Publish/Subscribe

MQTT Broker

IoT Device

MQTT Messaging API

Publish/Subscribe
Project System Components

• Hardware Platforms
  ▪ NVIDIA Jetson TX2 Developer Kit
  ▪ Xilinx Zync Ultrascale+
  ▪ Intel Realsense LiDAR Camera
  ▪ ImagingSource DMK 33GP031

• Software Platforms / Technologies
  ▪ ROS (Robot Operating System)
  ▪ Python
  ▪ NVIDIA Jetpack
  ▪ Kitti dataset
  ▪ MQTT
  ▪ VxWorks
  ▪ ONNX runtime
Project Risks

• Switching from prerecorded Lidar Data to sensor data
  ▪ Initially the team will have to use Kitti data for the models while the ROS wrapper is developed.
  ▪ ROS provides tools allowing sensor data to be easily read and integrated. The Kitti data format will be the same as the sensor allowing quick integration.

• Developing a system that fuses LiDAR and stereo data
  ▪ LiDAR and stereo data are typically different formats, respectively a pointcloud and a disparity map.
  ▪ The team will be converting the stereo disparity map into a pointcloud and combining them into a fused pointcloud

• Creating the neural network to process fused pointclouds
  ▪ Most neural networks for 3D image processing currently use either LiDAR or stereo data. The team must implement a model that is trained on the fused data from both.
  ▪ Since the team will be using fused pointclouds, a model trained on LiDAR pointclouds will work with the fused data.

• The model architecture must be size-efficient and be high performance
  ▪ The model will be deployed on an embedded system with memory and compute constraints
  ▪ The team will be benchmarking and testing the pretrained model to ensure performance, as well as utilizing integer quantization

• MQTT plugin must be compatible with multiple platforms
  ▪ The plugin is required to run on multiple different systems with different backends
  ▪ The team will test multiple MQTT APIs on all platforms to ensure that there is a suitable candidate
Questions?