LiDAR and Camera Sensor Data Fusion for Human Detection

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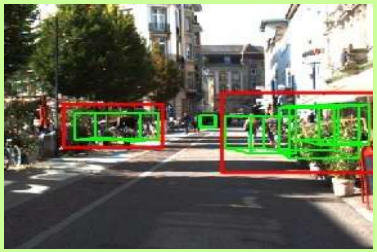


The fundamental objective of this project is to develop and validate a multi-modal human detection system that enhances autonomous vehicle perception by combining LiDAR and camera sensor data from the Waymo Open Dataset. Our system addresses critical safety challenges in autonomous driving by leveraging complementary sensor strengths - LiDAR's precise depth perception and spatial awareness alongside cameras' rich visual context and semantic understanding. The architecture features real-time sensor fusion with adaptive weighting mechanisms, dynamically adjusting to environmental conditions while maintaining processing times under 100ms.

Project Objective:

Key Motivations:

Safety Enhancement: Current **single-sensor systems** have critical blind spots. Need for redundancy in safety-critical decisions

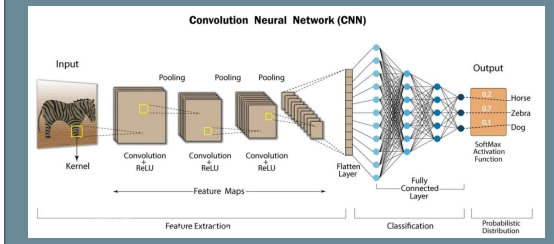
Technical Innovation: Develop novel sensor fusion architecture. Optimize for **resource-constrained** deployment.

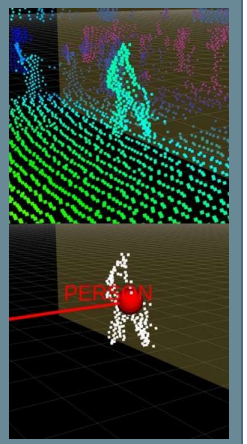
Industry Relevance: Address **real-world** autonomous driving challenges. Provide benchmarkable results using public dataset.

Data Flow

Data Collection

Data





Examples of better images

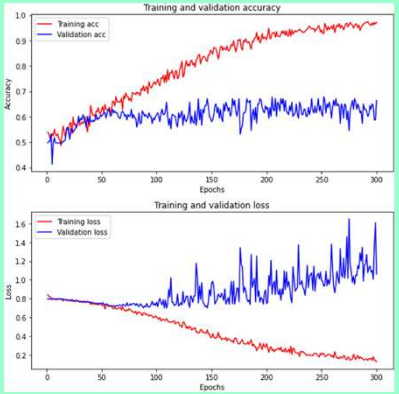
Disclaimer: Our neural network is comprised of a combination of MVX-net and EfficentB0 architectures

Potential Challenges and Limitations

Some problems/challenges that this project encounters are

1. Synchronization challenges between LiDAR and camera data:
This stems from the idea that matching these different data representations requires complex transformations

2. Various causes of data loss in a LiDAR-camera fusion system:
This comes from random errors occurring in epochs that are unpredictable. Such errors will get marked as “lost” and the model will move forward.



Project Timeline

Planning:
Our project aims to enhance pedestrian detection in autonomous driving scenarios by developing an optimized CNN architecture trained on Waymo datasets, incorporating comprehensive data analysis and advanced training strategies to improve detection accuracy across diverse real-world conditions.

Data Preprocessing:
Gather and preprocess the Waymo Open Dataset, focusing on LiDAR and camera sensor data. Filter, label, and augment data to cover diverse real-world scenarios for robust training. Develop initial scripts for preprocessing steps, including noise reduction for LiDAR and image normalization for camera data.

Model Architecture Design + Dev:
Design a Convolutional Neural Network (CNN) optimized for multi-modal sensor fusion. Experiment with different fusion methods to combine LiDAR and camera data. Implement the adaptive weighting mechanism to dynamically adjust sensor contributions based on environmental conditions. Develop the real-time processing pipeline to ensure processing times remain under 100ms.

Testing and Adjustments:
Perform optimization techniques, such as model pruning or quantization, to reduce computational load without sacrificing accuracy. Make final adjustments based on validation results, ensuring the system meets all real-time processing and accuracy goals. Prepare the model for deployment, ensuring compatibility with target hardware and software environments.