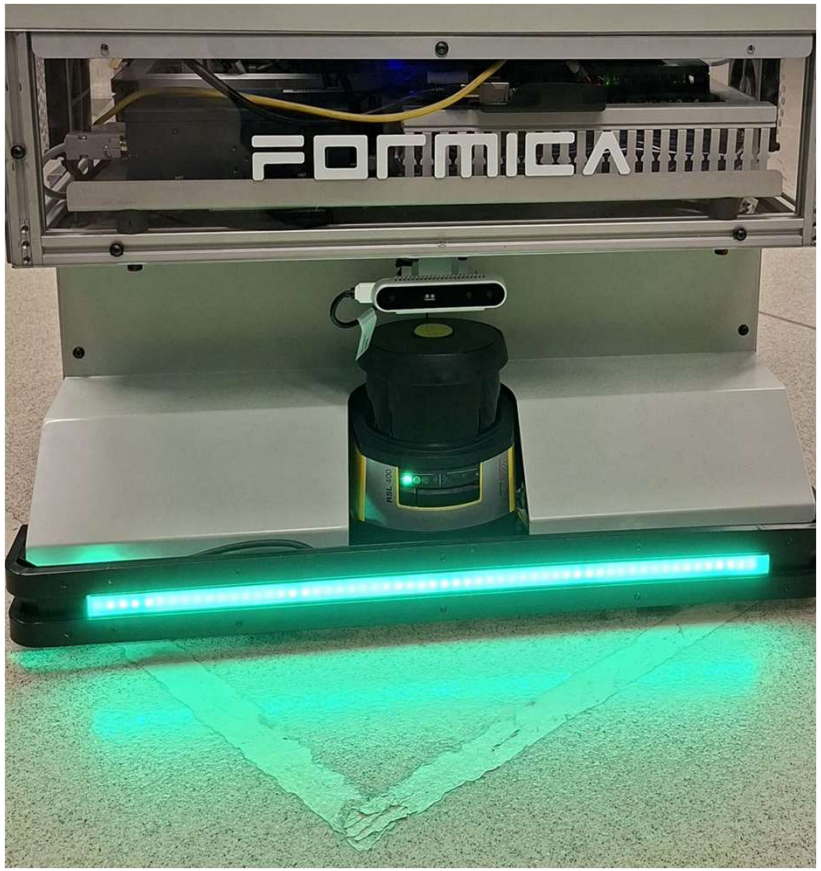
Lightweight Model for Collision Avoidance of AGVs in Crowded Environments

OUTLINES

- Introduction
- Problem definition
- Methodology
- Experimental Results
- Limitations and Future Directions
- Commercializatio

INTRODUCTION

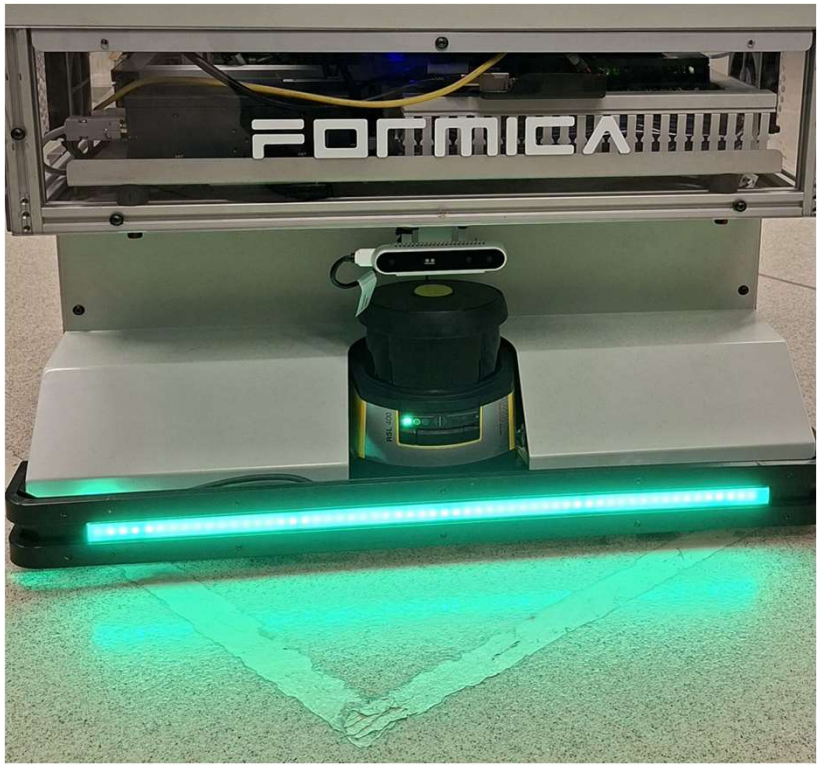
Automated Guided Vehicles (AGVs)



- AGVs are driverless vehicles widely used to transport raw materials, components, or finished products in industrial settings such as factories and warehouses.

- AGVs enhance productivity, minimize operational time, improve workplace safety, reduce costs, and offer scalable solutions in Industrial Environments.

Problem Statement



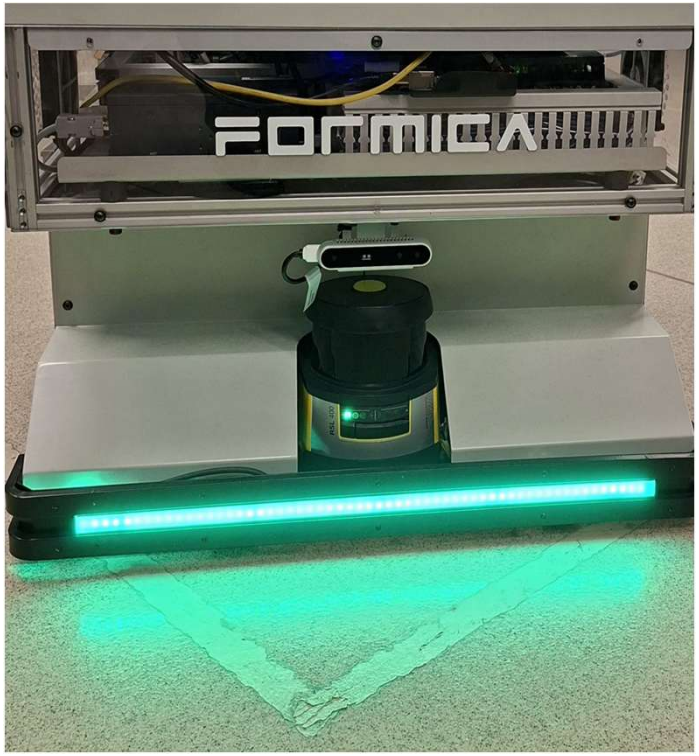
Camera-based:

- Computational cost

Lidar-Based:

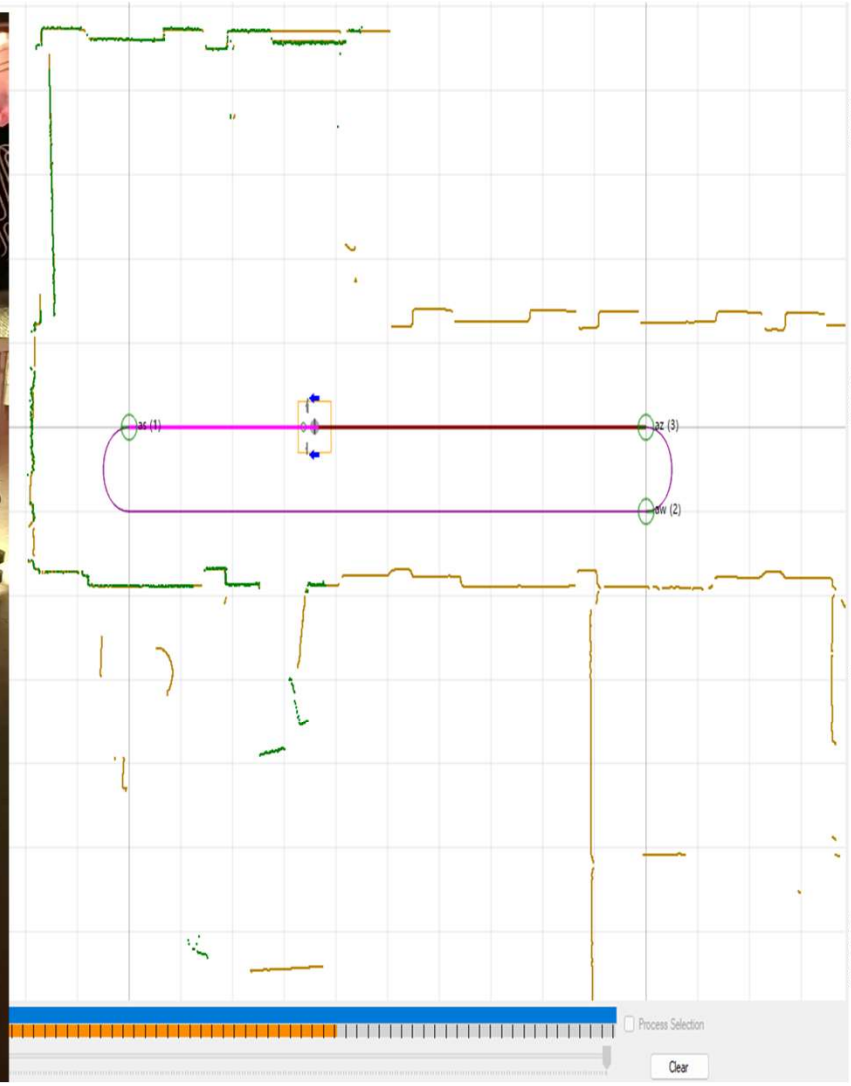
- Lack of object Identification

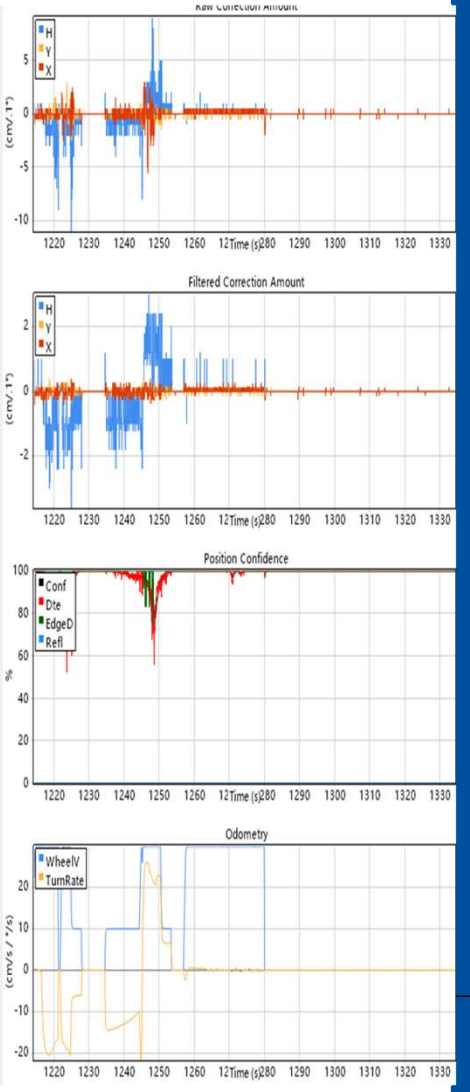
Proposal Solutions



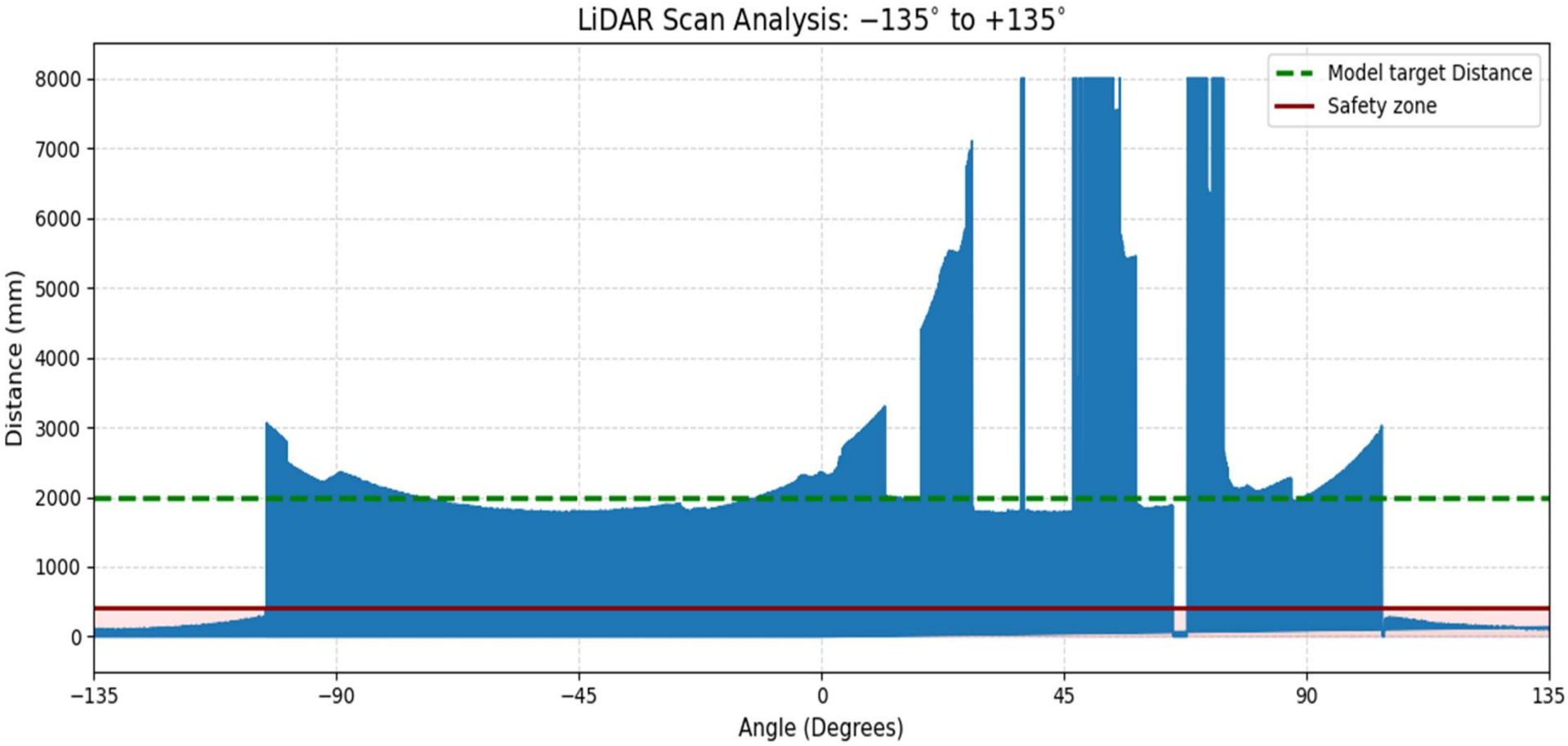
- **Goal:** classify **motion intent** of nearby objects (moving-toward / moving-away / lateral / static)
  - Trustworthy Lightweight Model for Object Detection
  - Behavior Forecasting
  - Rapid Trajectory Adaptation in dynamic Environments

AGV Real-Time Data Acquisition





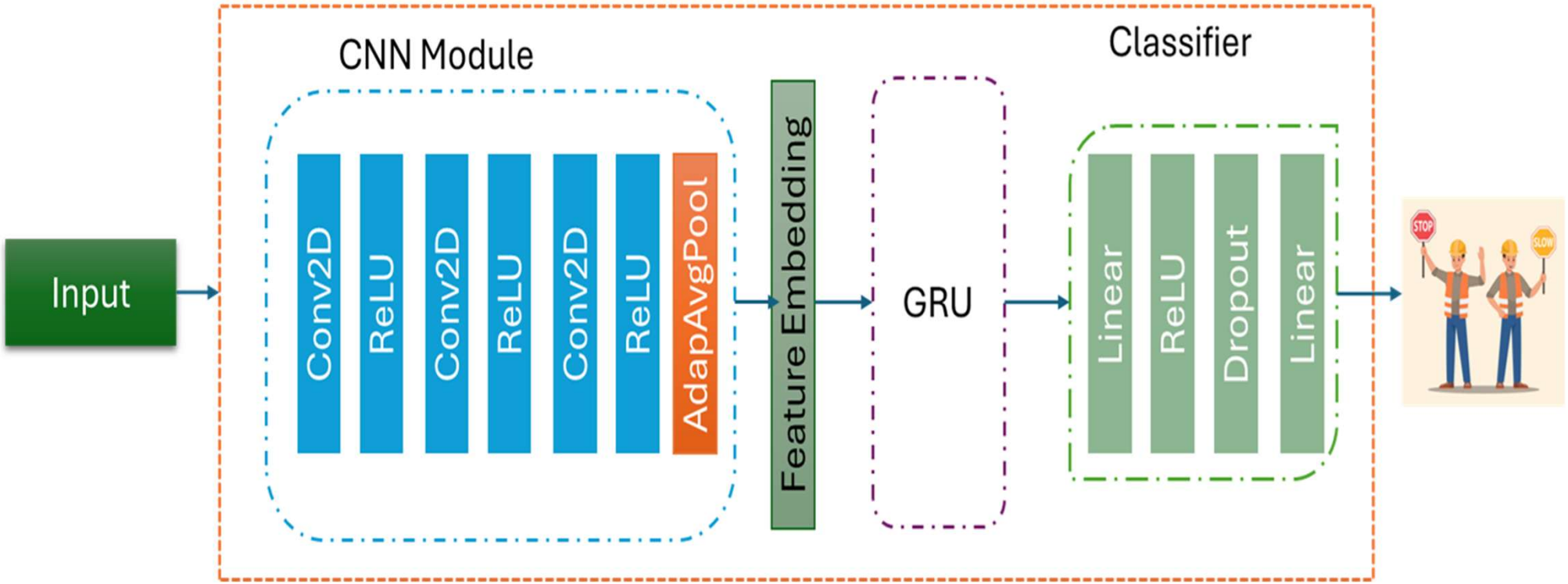
Lidar rsl 400 Data Visualization



Methodology - Preprocessing

	Split	Total	Clear	Clear (%)	Slow	Slow (%)
	Train	4,618	1,014	22%	3,604	78%
	Test	1,157	139	12%	1,018	88%
Bootstrapping	Train	23,090	5,004	22%	18,086	78%
SMOTE	Train	36,172	18,086	50%	18,086	50%

Model Architecture - 2D CNN + GRU

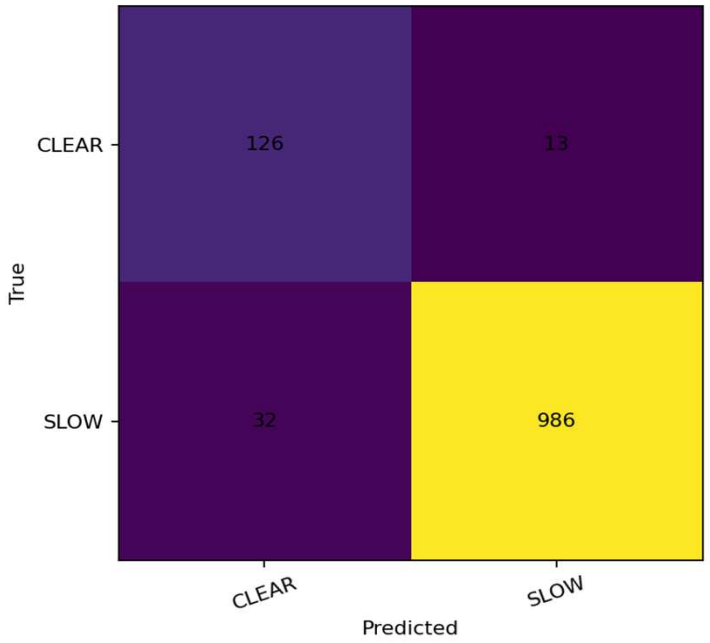


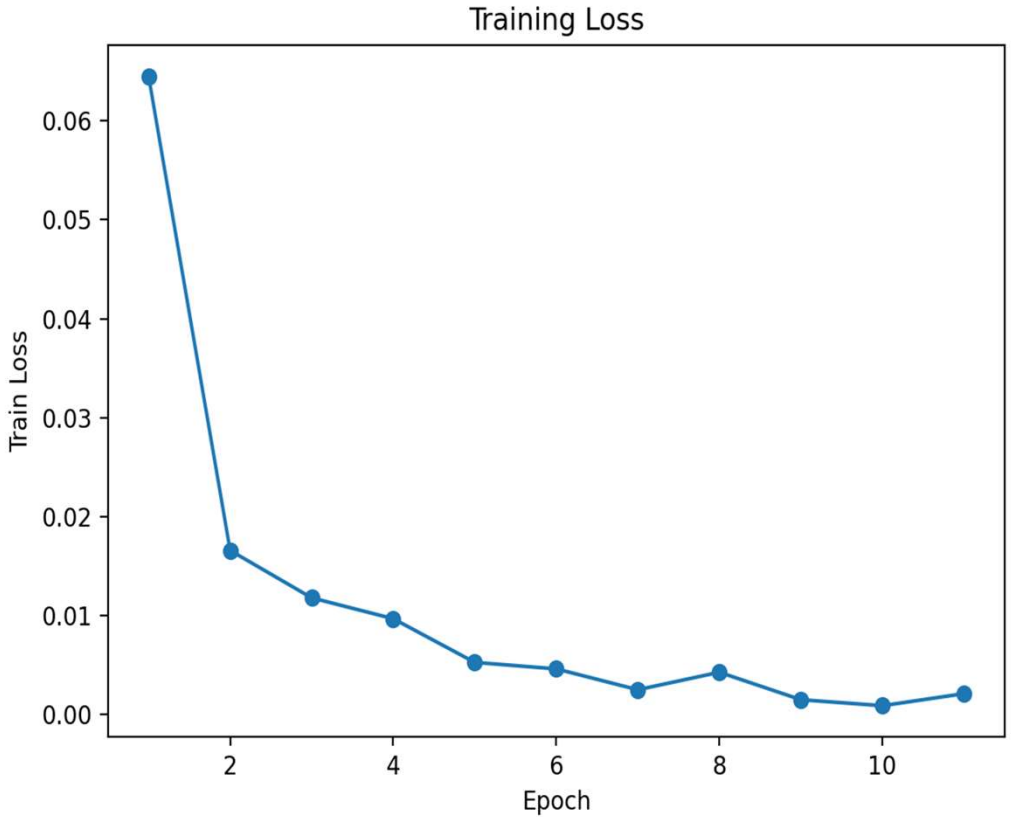
Methodology - Decision Logic and Safety Actions

- Inputs are transformed into **linguistic risk categories** (*low, medium, high*).
- A **fuzzy inference mechanism** combines these inputs to compute a **continuous risk score** between 0 and 1.
- This risk score directly governs the autonomous system's behavior:

Risk Level	Action	Control Meaning
< 0.35	Continue	Normal operation
0.35 - 0.65	Slow	Preventive deceleration
> 0.65	Stop	Emergency avoidance

Experimental Results (CNN–GRU Perception + Fuzzy Risk Actions)

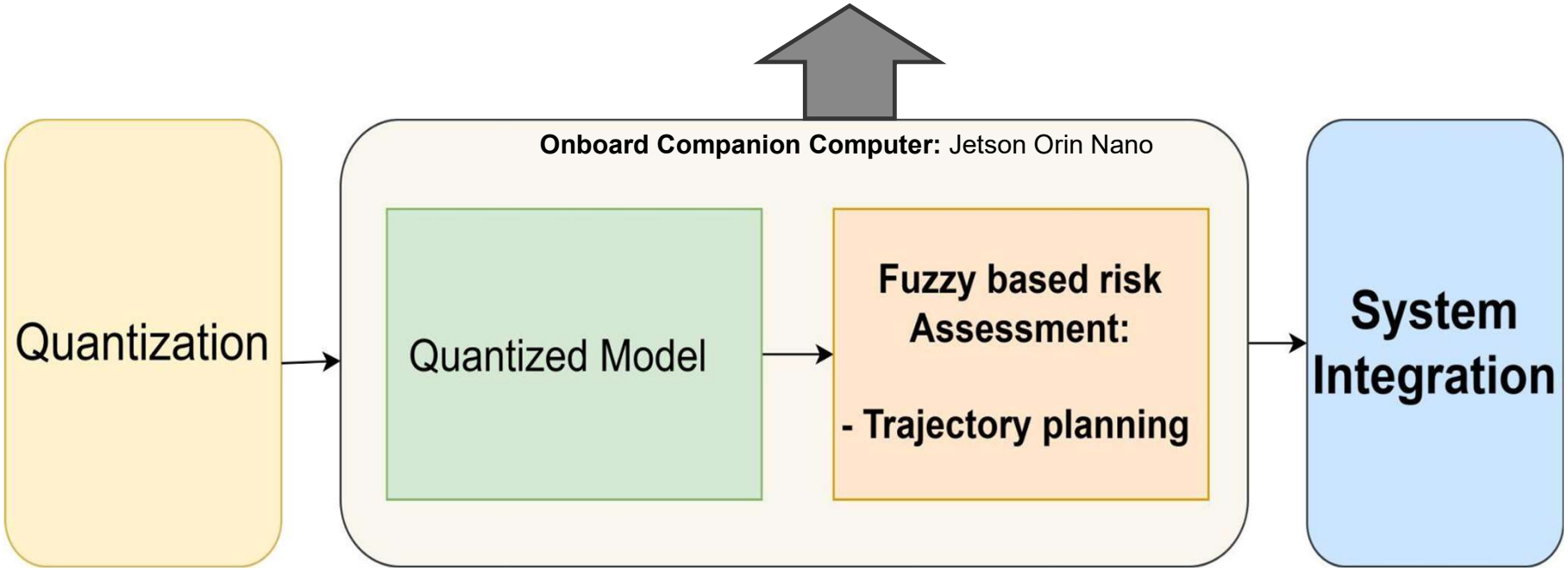




Limitations and Future direction

Limitation: Leuse LiDAR 400 data

Future Direction:



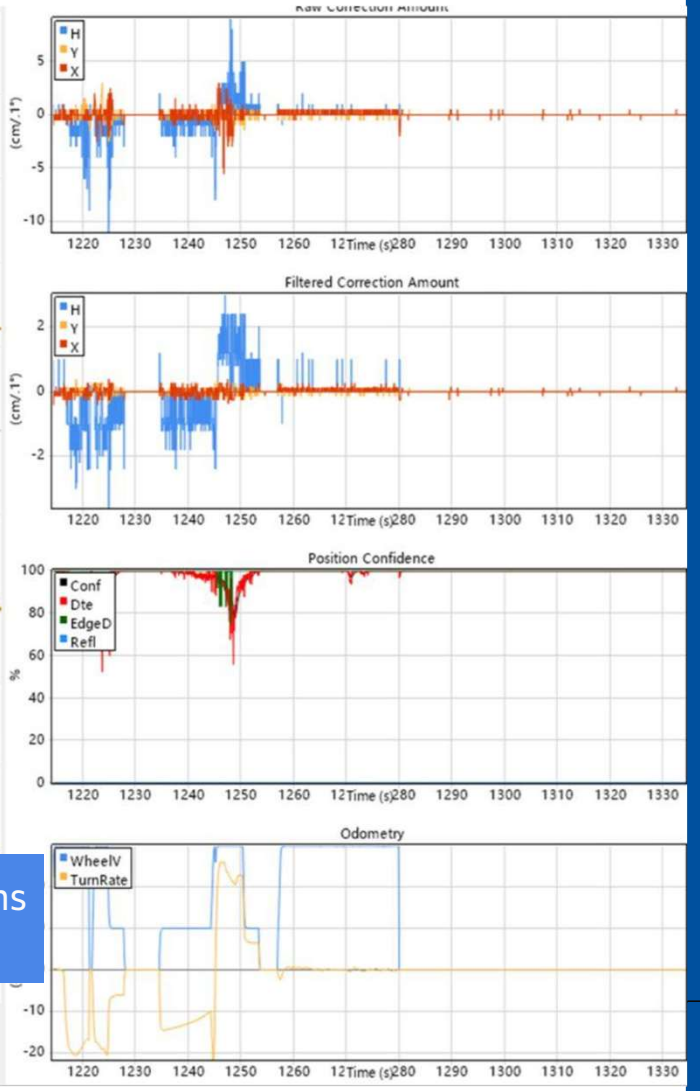
Commercialization

Collision Avoidance with Object classification in crowded Environment:

- In real-time.
- Without affecting AGV's efficiency.

Why this matters:

- Object Identification for Frequent AGV Trajectory-Level Interceptions
- Enhancement of the future trajectory planning



Commercialization