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▶ **Lightweight Model for Collision Avoidance of AGVs in Crowded Environments**

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# OUTLINES

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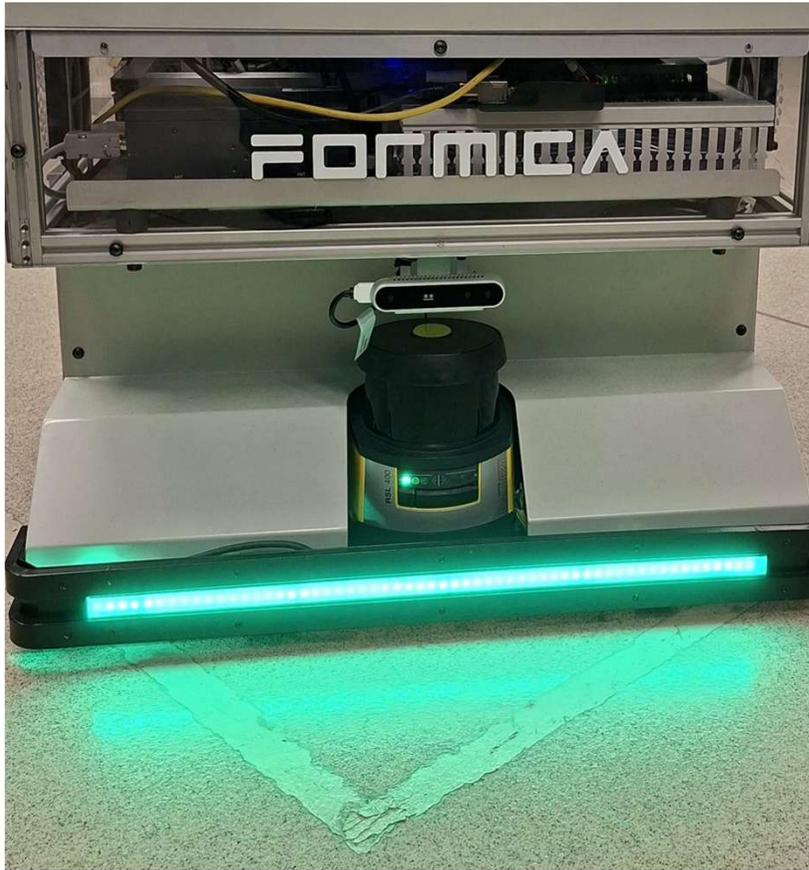
- Introduction
  - Problem definition
  - Methodology
  - Experimental Results
  - Limitations and Future Directions
  - Commercializatio
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# INTRODUCTION

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## 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.
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## Problem Statement

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### **Camera-based:**

- Computational cost

### **Lidar-Based:**

- Lack of object Identification
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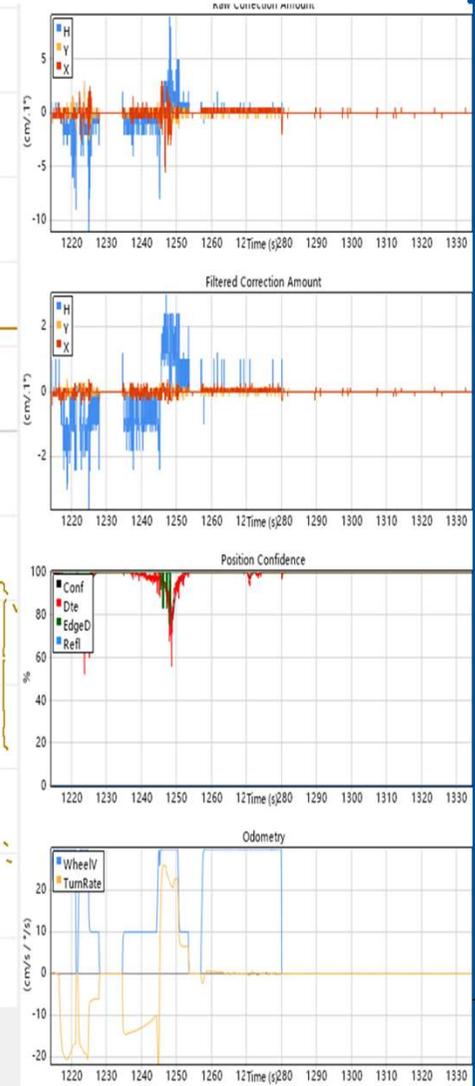
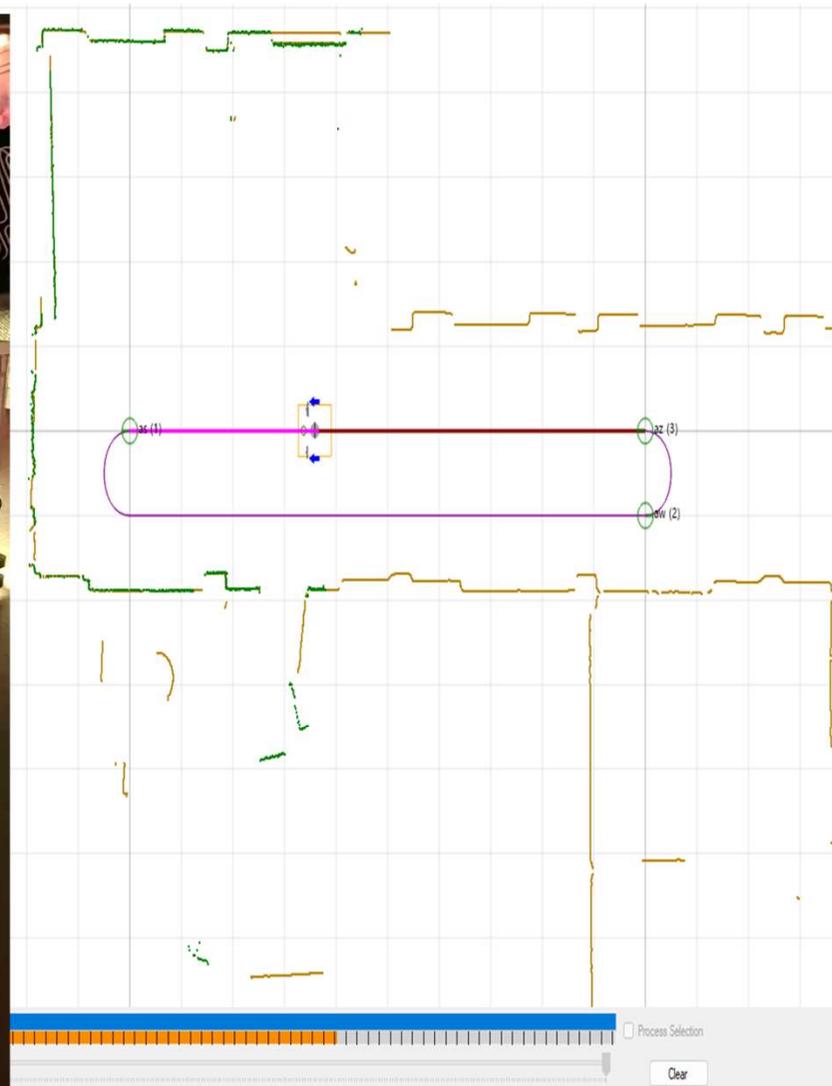
# Proposal Solutions



- **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

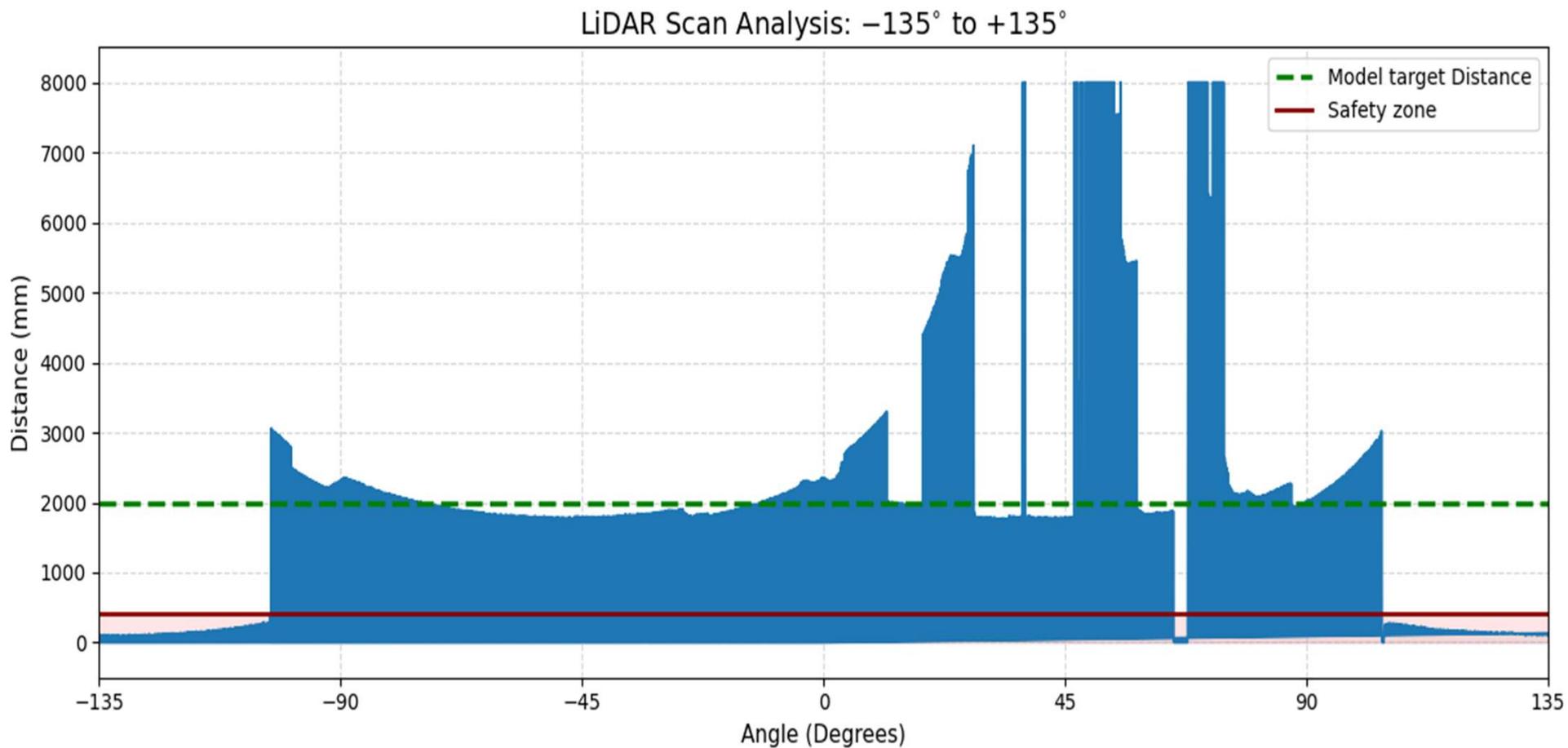


# AGV Real-Time Data Acquisition





# Lidar rsl 400 Data Visualization



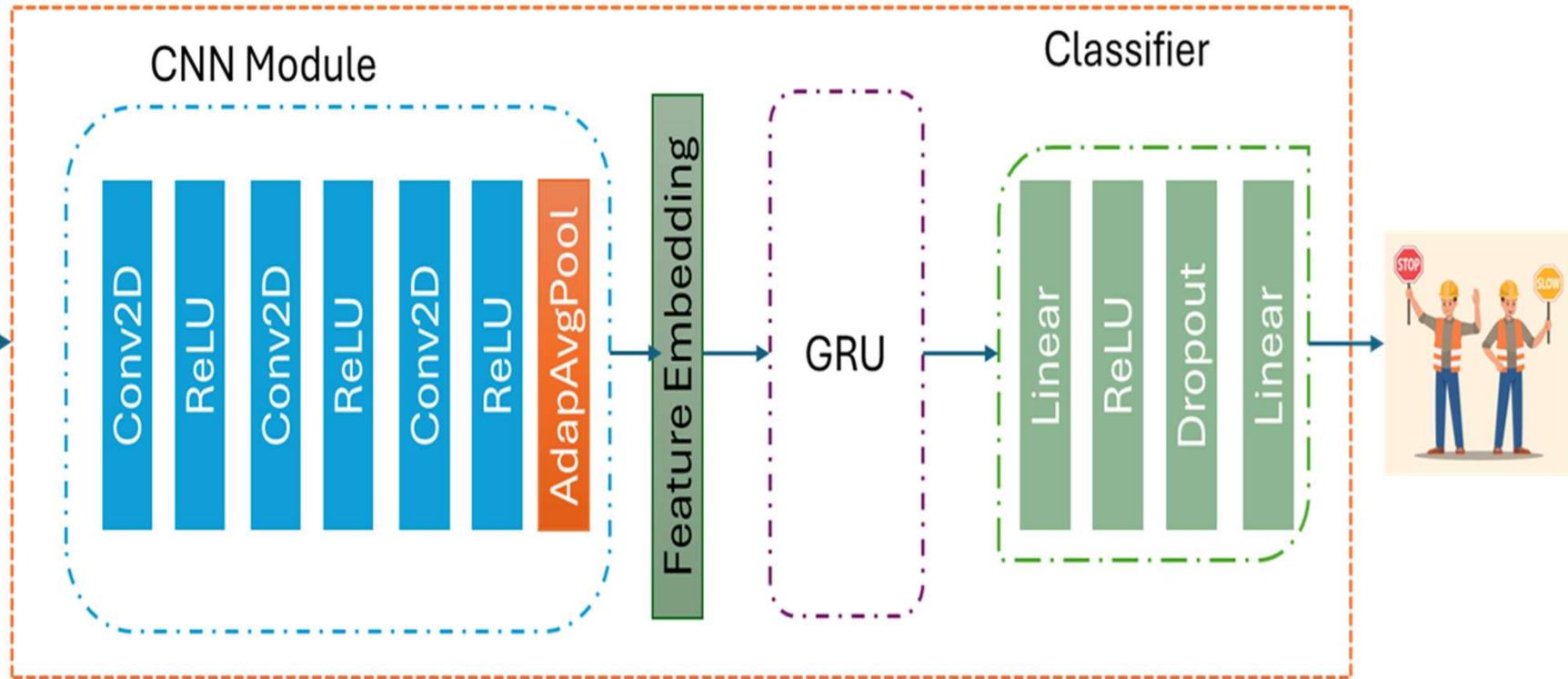


## Methodology - Preprocessing

	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





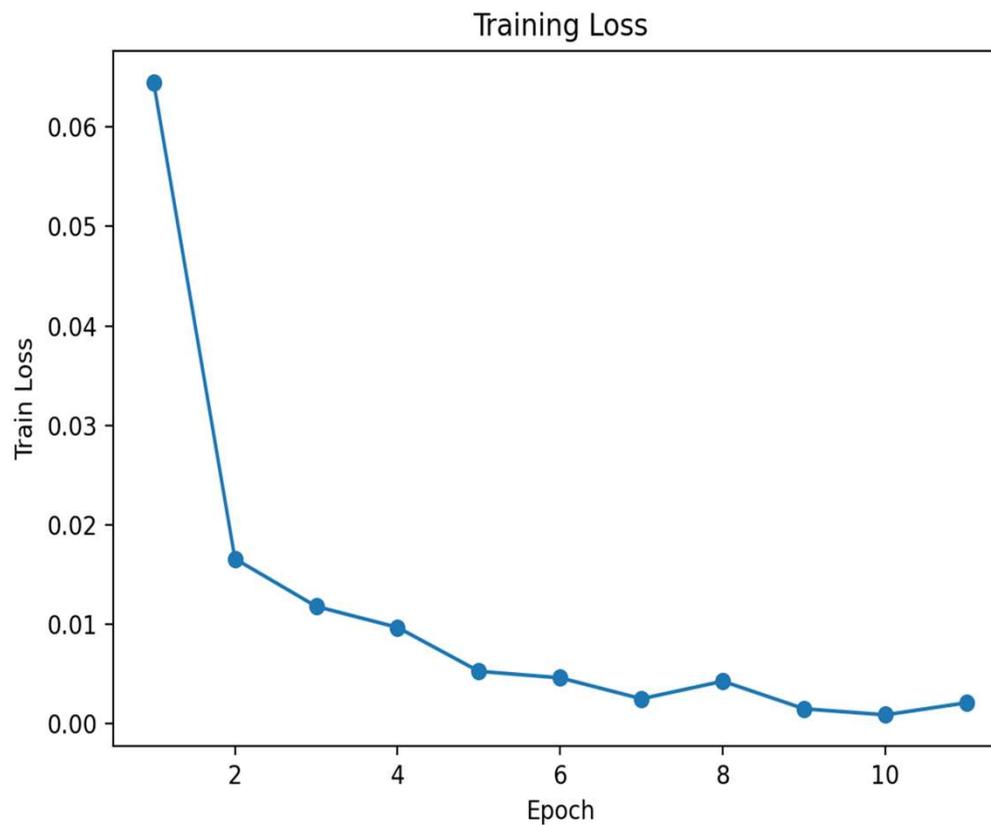
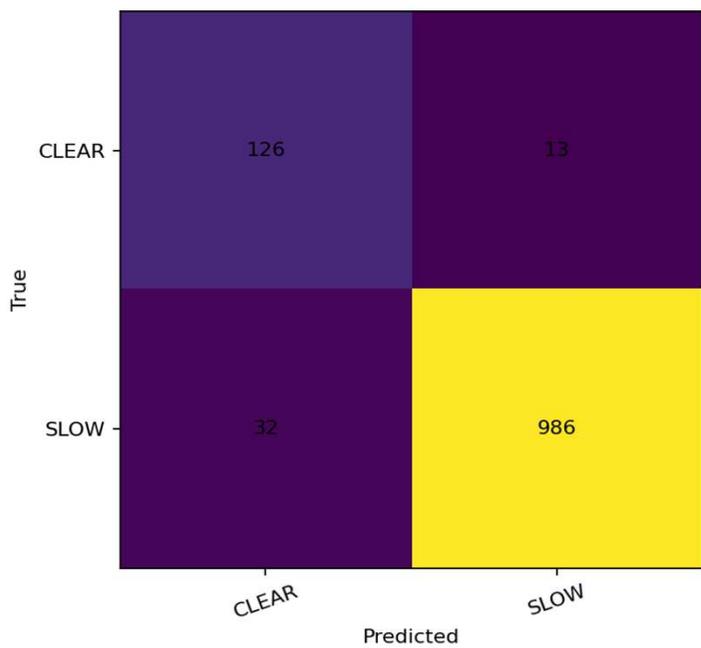
## Methodology - Decision Logic and Safety Actions

- 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)

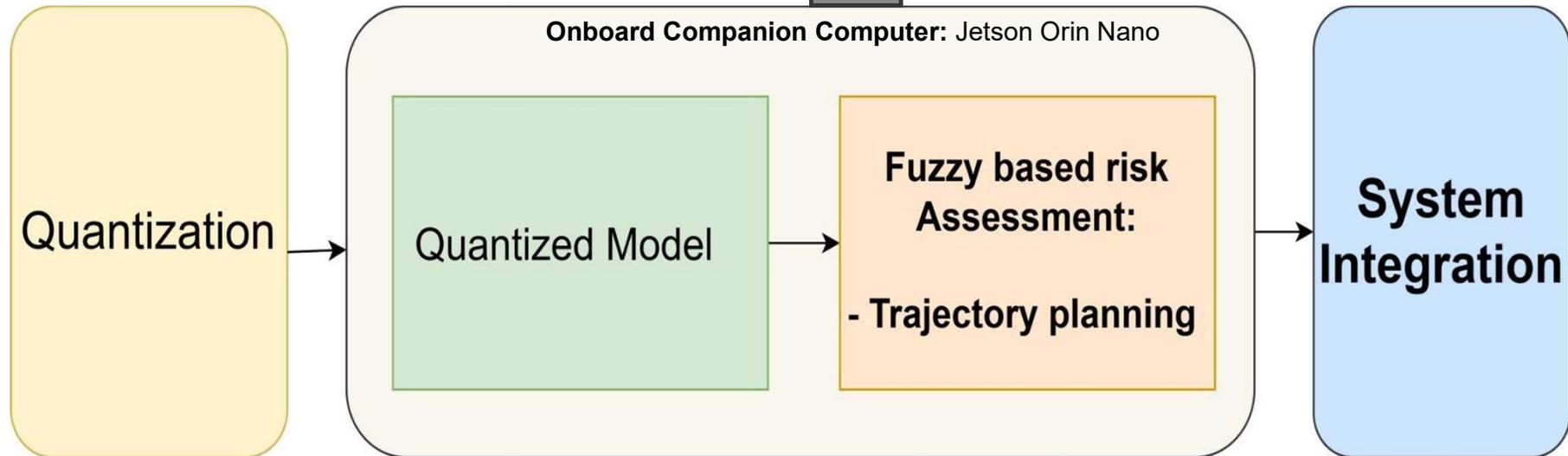




## Limitations and Future direction

**Limitation:** Leuse LiDAR 400 data

**Future Direction:**





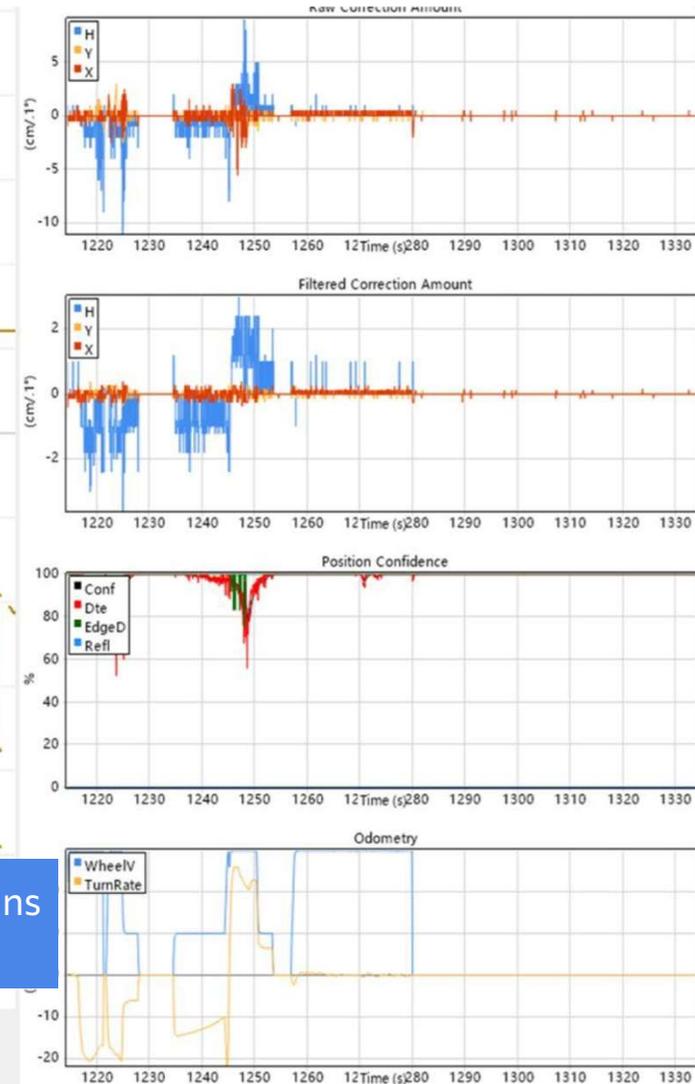
# Commercialization

## 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

## Lightweight AGV Collision Avoidance & Trajectory Intelligence



### Lightweight Perception & Object Identification



- Edge AI Processing
- Real-Time Object Detection
- Low-Power AGV Hardware



### Frequent Objects That Intercept AGV Trajectory-Level Reporting

- Humans, Forklifts, Other AGVs, Pallets
- Identification of Repeated Interception Zones



### AGV Control & Operator Interface

- Route Optimization for Future Trajectory



### Commercial Value

- Reduced Collisions
- Improved AGV Safety Compliance
- Lower Hardware Costs Without Modifying the Existing AGV System Architecture
- Higher Fleet Efficiency

