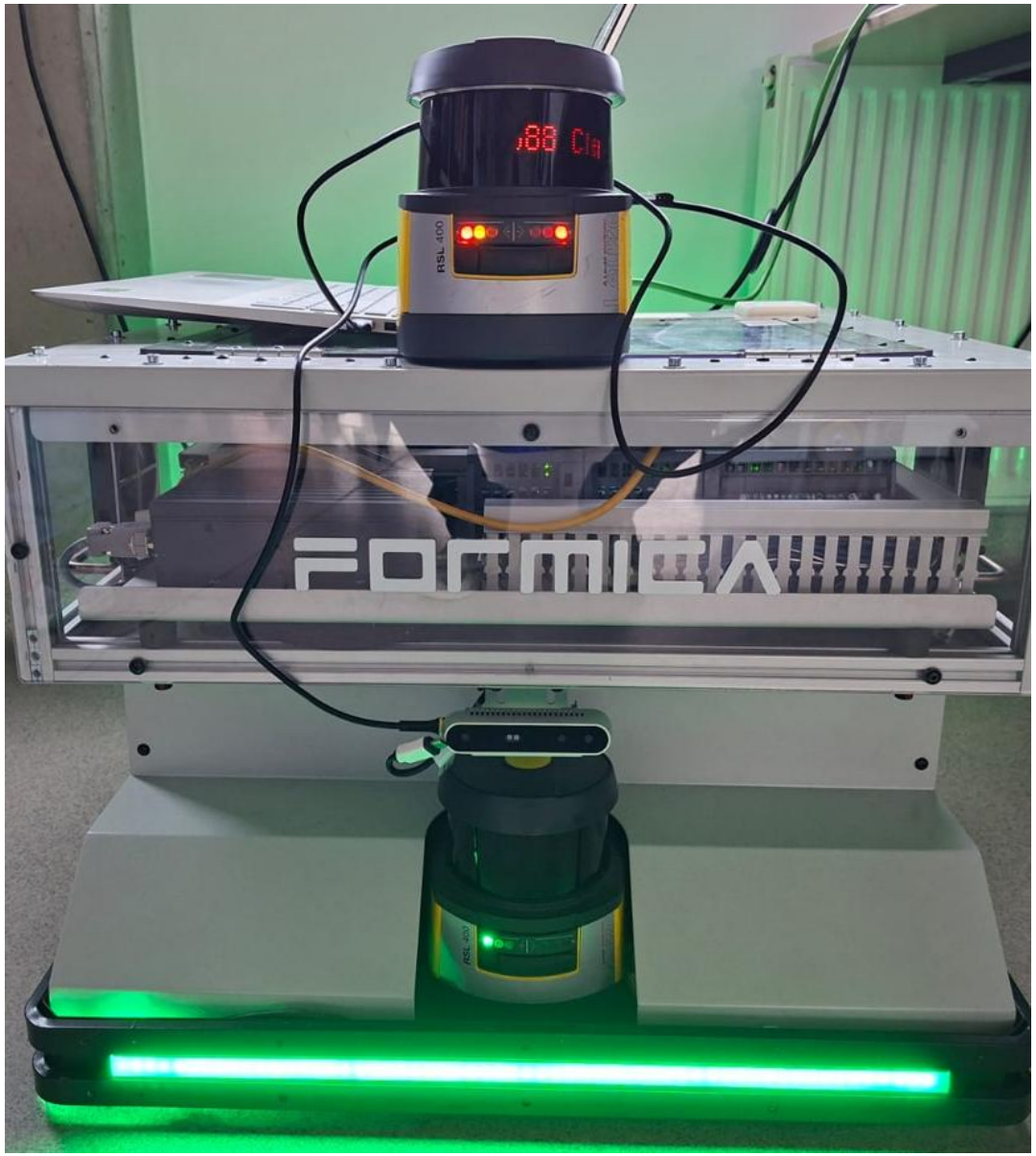
Lightweight Model for Collision Avoidance of AGVs in Crowded Environments

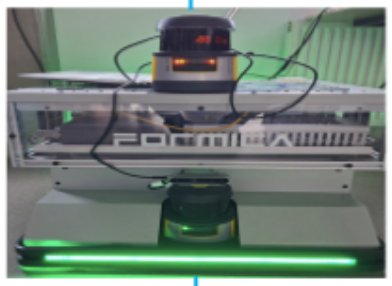
Data Collection Techniques

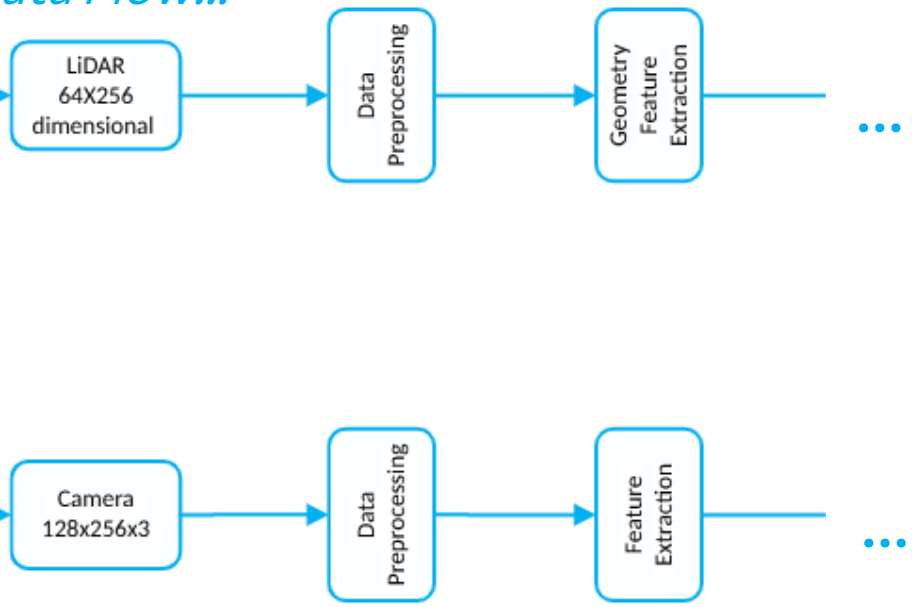


	Lidar RSL 400	**AGV camera images**
Data type	Numerical	RGB
Dimension	2D	3D
Parameters	- Distance - Angle - Start and stop Index - Warning field - Safety field - Index Interval - Timestamp - Scan number	High dimensional Visual Images

Data Preprocessing & Feature Extraction

LiDAR Data Flow...

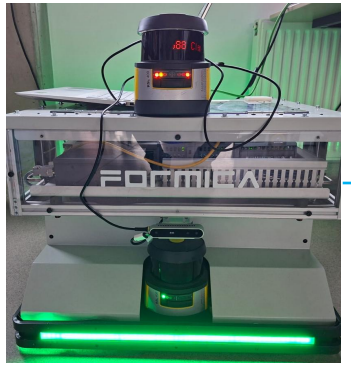




Camera Data Flow...

Data Preprocessing & Feature Extraction

***LiDAR** Data Flow...*



Captured Data → Data Validation → Sector Division

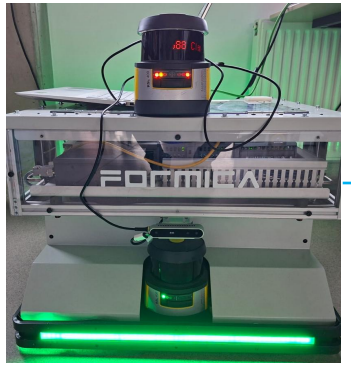
- **Right Sector**
  - Min Distance
  - Max Distance
  - Mean Distance
  - Closest Angle
- **Front Sector**
  - Min Distance
  - Max Distance
  - Mean Distance
  - Closest Angle
- **Left Sector**
  - Min Distance
  - Max Distance
  - Mean Distance
  - Closest Angle

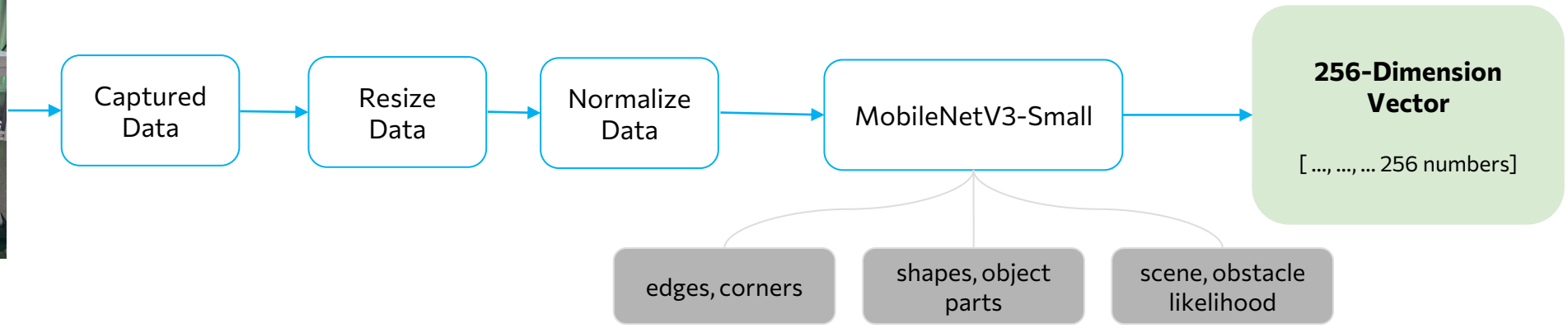
12-Dimensional Vector

[4 features x 3 sectors]

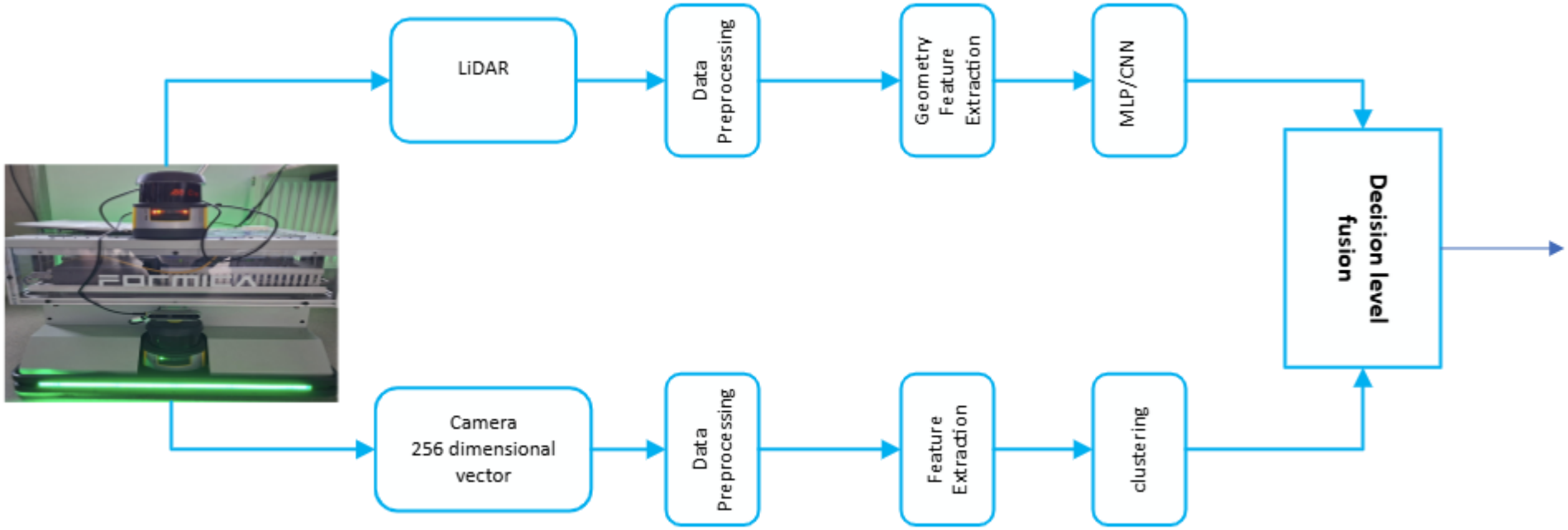
Data Preprocessing & Feature Extraction

***Camera** Data Flow...*



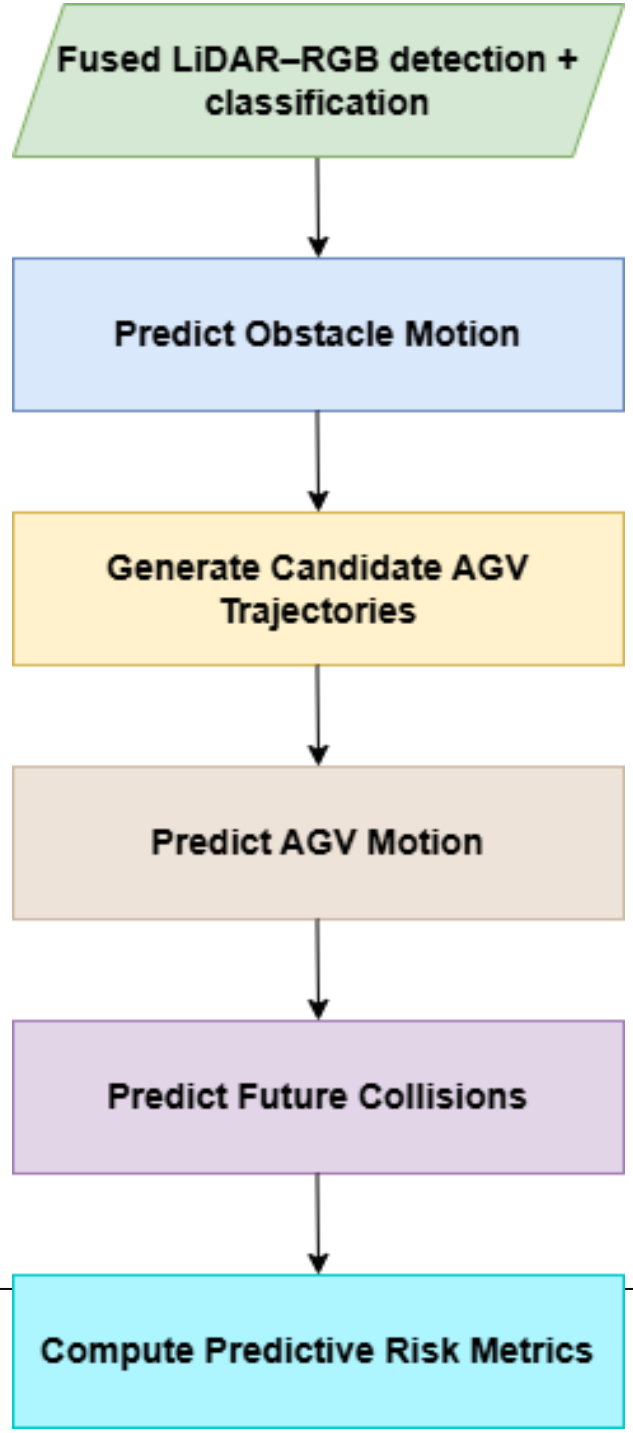


Object detection and classification

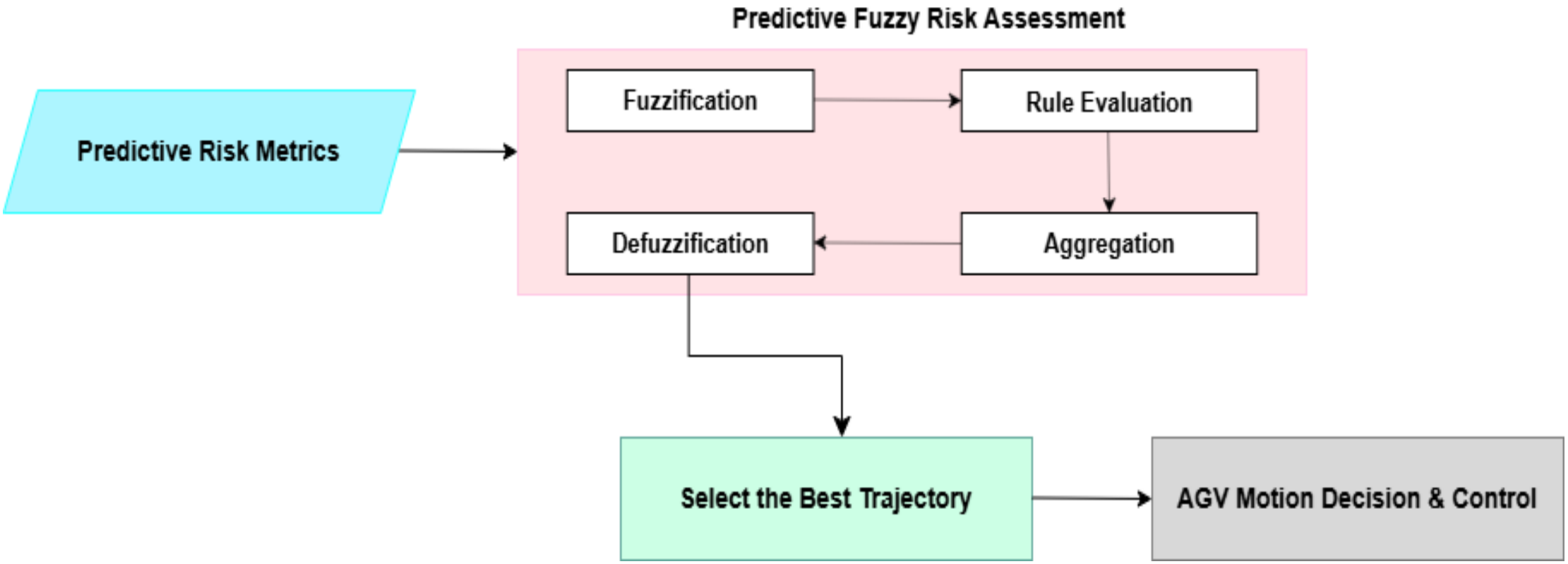


Predictive Collision Avoidance

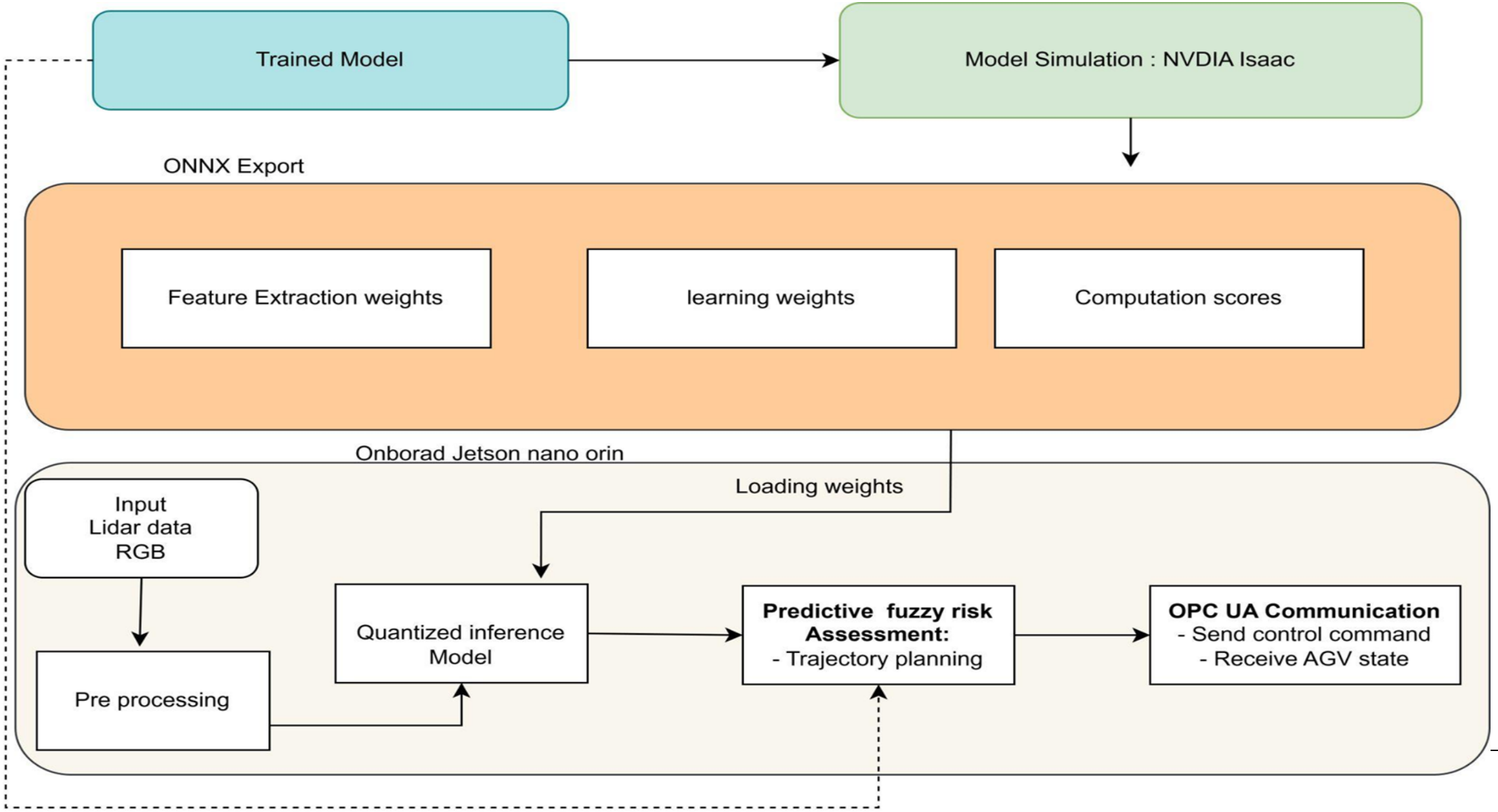
- **Avoid collisions before they happen** by predicting hazardous situations early, not only reacting when obstacles are already too close.
- **Use fused LiDAR–RGB perception** to achieve reliable situational awareness with accurate geometry and semantic understanding.
- **Predict the future motion** of both the AGV to evaluate safety and choose the safest trajectory in advance.



Risk Assessment



Onboard Model Deployment Techniques



System Integration and Communication

- The deployed model inference operates on an edge device (Jetson Nano Orin), with real-time sensor data processing, and communicates with the AGV through OPC UA.

- The **lightweight AI model inference** predicts:
  - obstacle risk,
  - time-to-collision,
  - recommended action (continue / slow / stop).

- These predictions are transmitted as safety variables via OPC UA, enabling Navitrol and the PLC control logic to react and adjust AGV motion.

- The Jetson edge computer runs the AI model and publishes safety outputs to the AGV's Navitrol, including Risk Level, Time to Collision, Speed Override, and Stop Command.
- Navitrol / AGV controller work as OPC UA clients and read/write PLC variables:

  Low risk → AGV follows the Navitrol route at normal speed.

  Higher risk → PLC applies Speed Override to slow the AGV.

  Stop Command = TRUE → PLC performs immediate emergency stop.

- LiDAR safety fields stay active as a separate hardware safety layer.
- Even if the AI model fails or OPC UA communication fails, the certified safety scanner can still stop the AGV.