Vehicle Cooperative Perception System

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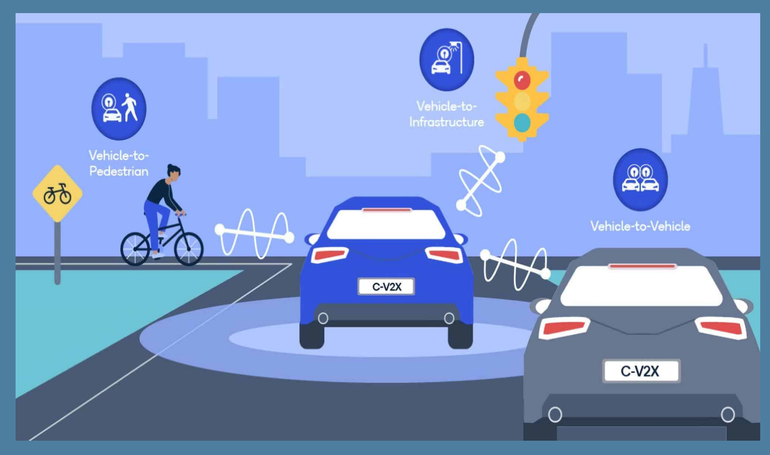


Problem Statements

- Driving on the road is the most dangerous activity we participate in daily with tens of thousands of fatalities occurring per year.
- Larger vehicles such as trucks have many blind spots where the driver's view of their surroundings is blocked, especially in complex traffic scenarios or adverse weather conditions.
- Traditional vehicle perception systems rely on low resolution sensors such as radar which don't give the full picture of the road. Vehicles also currently don't communicate hazards to each other.

Proposed Solutions

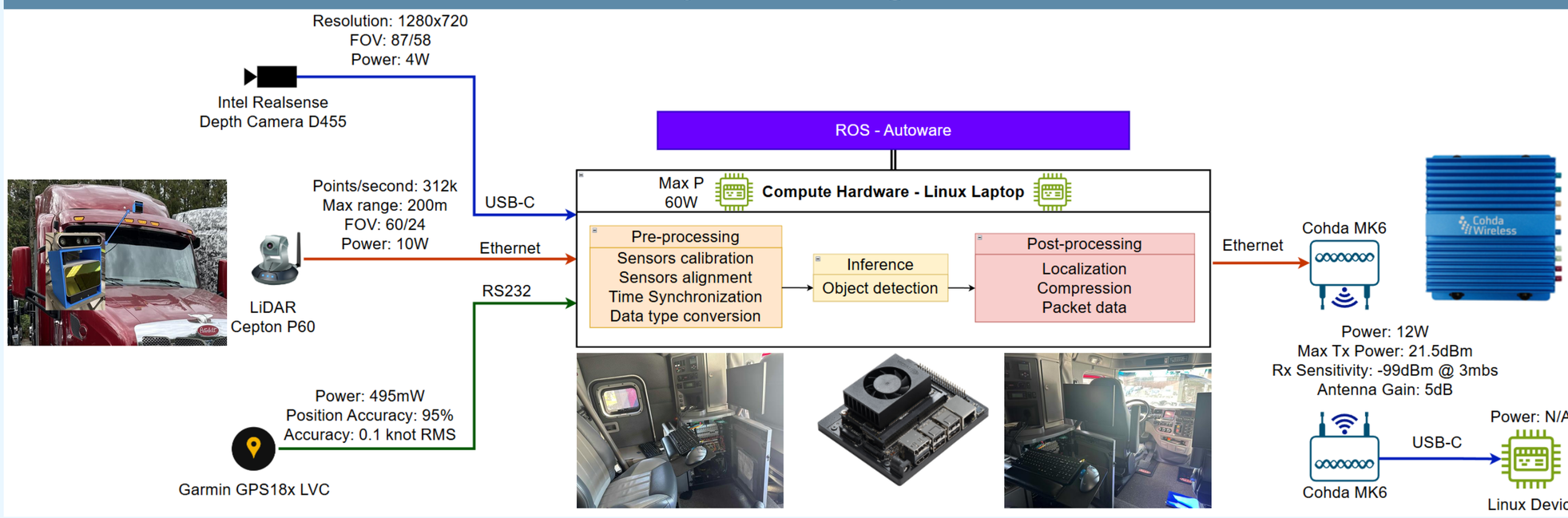
- **Integration of Edge Computing** – Analyzing the road in real-time: The system involves equipping each vehicle in a truck fleet with an array of sensors (including LiDAR, depth camera, GPS), a compute device, and a communication system.
- **Artificial Intelligence Models** - Data Fusion and Object Detection: Various AI models facilitate data fusion and object detection. These models analyze data from multiple sensors to perceive the environment accurately.
- **Communication System** - Real-time Information Exchange: Collaborative perception is enhanced through C-V2X communication, allowing vehicles to exchange critical information in real-time. This communication enables vehicles to share speed, location, heading information, and sensor data with nearby vehicles.
- **Energy Efficiency** - Maintains fuel economy: The system is designed with energy efficiency in mind. Energy consumption metrics are measured and optimized to ensure the system operates within acceptable limits.

Hardware

Sensors:
- Intel Realsense Camera D455
- Garmin GPS18x LVC
- Cepton LiDAR P60
- Ouster LiDAR OS2 (ordering)

FS.COM 1G Industrial Switch
Nvidia Jetson Xavier
Legion Pro 7 Laptop
Cohda Wireless MK6 (x2)

System Design

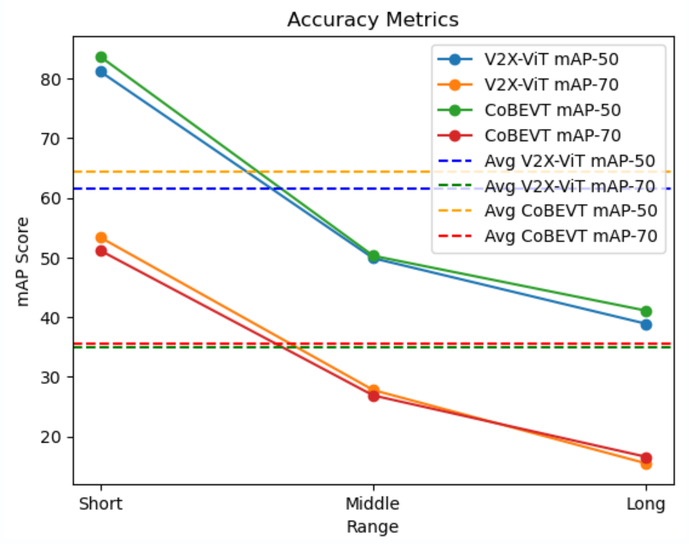


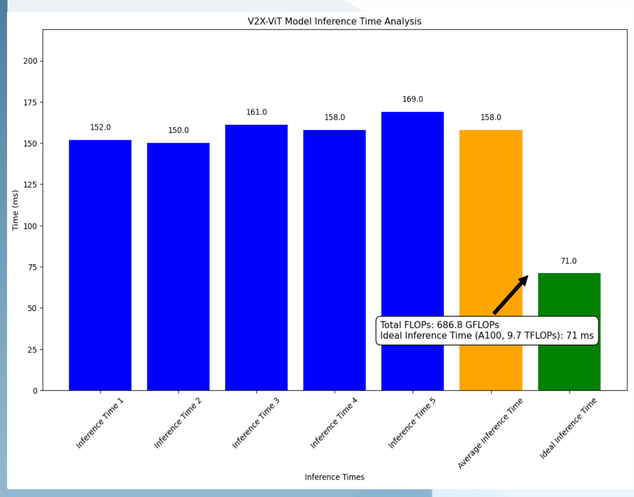
AI Models

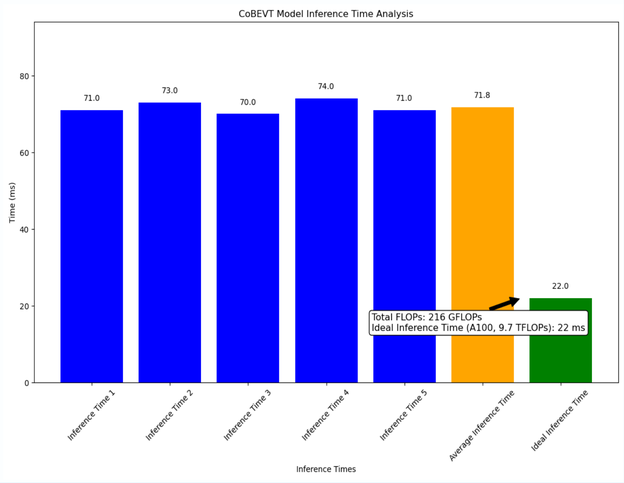
YOLOv8 (Cameras):
- **Total FLOPs**: 78.9 GFLOPs
- **Inference time:** 11ms
- Power consumption: 2.0W

V2X-ViT (LiDAR + Cameras):
- **Total FLOPs:** 686.8 GFLOPs
- **Inference time:** 158ms
- Power consumption: 17.7W

CoBEVT (LiDAR + Cameras):
- **Total FLOPs:** 216 GFLOPs
- **Inference time:** 72ms
- Power consumption: 5.6W

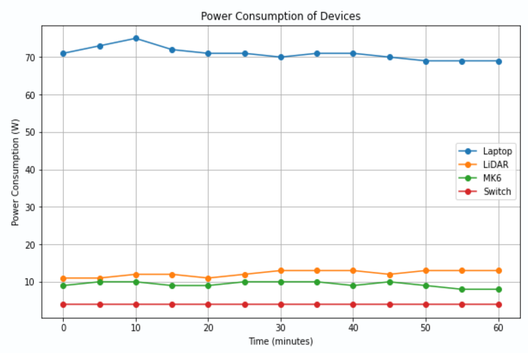


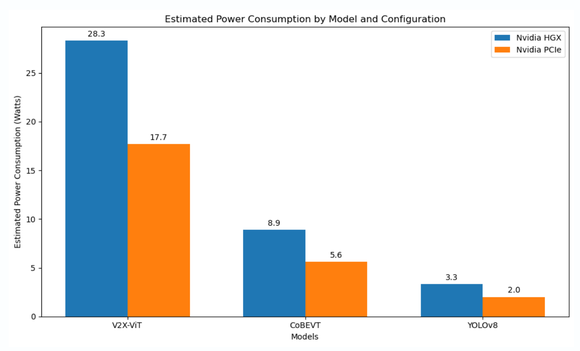




Power Consumption

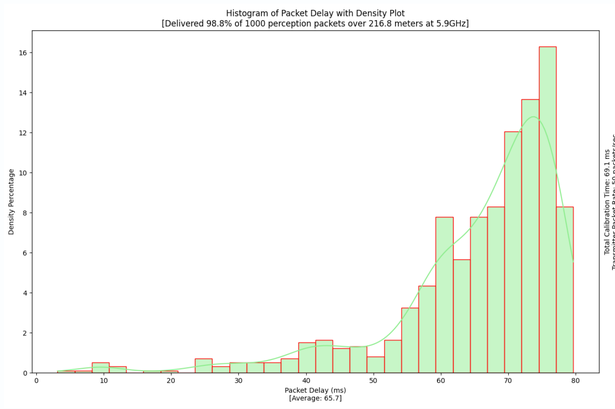
Note: Currently, the system operates on a laptop, resulting in suboptimal power consumption. Switching to an Nvidia Jetson will reduce the computing device's power consumption to below 30W.

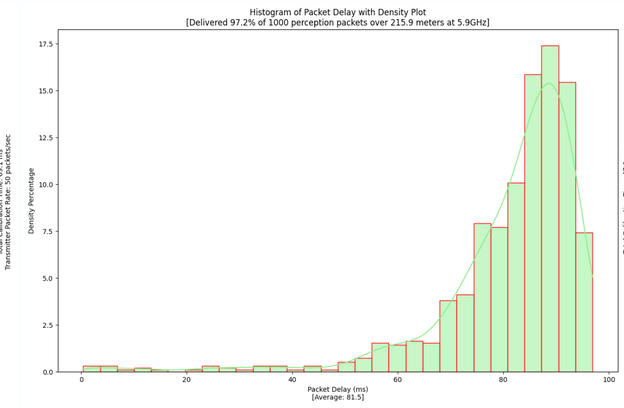




Communication System

Note: Perception data from the compute device is encoded and sent to the one MK6 (software defined radio) to transmit at **5.9GHz**. Then, at the other MK6 the data is decoded, and network metrics are logged. The graphs below show these metrics. Python/Bash scripts facilitate MK6-computer interaction.





References & Acknowledgements

- IoT Automotive News. "Qualcomm C-V2X Communication Technology Now Deployed on Virginia Roadways."
- Bhaskar Ramasubramanian's cluster
- Synnove Svendsen (AI Models)

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