AUTONOMOUS WHEELCHAIR NAVIGATION IN CROWDED SPACES & WHEELCHAIR FLEET MANAGEMENT

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CYBERWORKS ROBOTICS

MOTIVATION & OBJECTIVE

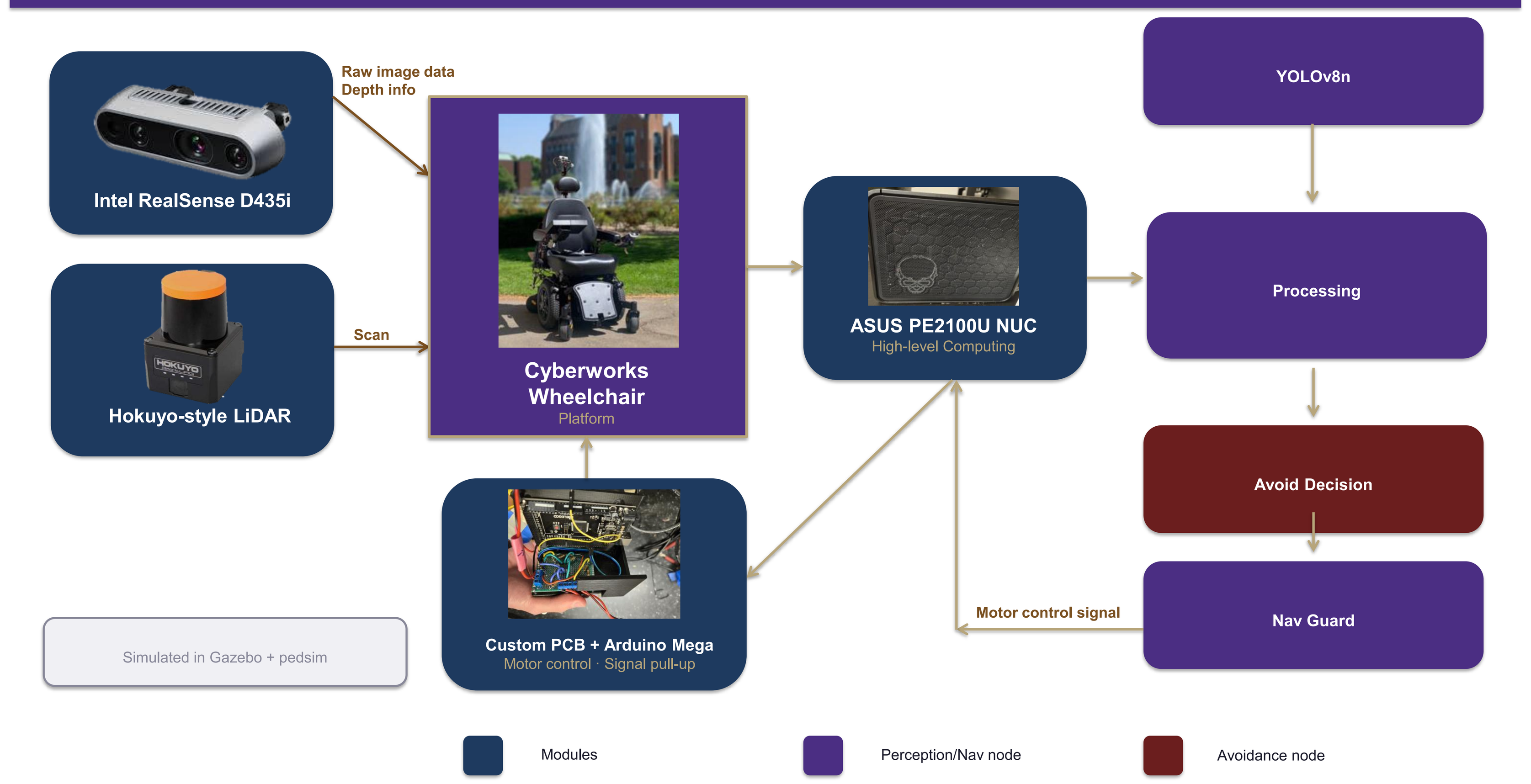
AI Vision

- Wheelchair users in crowded indoor spaces face safety risk navigating dense pedestrian flows
- Autonomous wheelchairs cannot detect crowds too wide to pass or dangerously close pedestrians
- Goal: Real-time crowd detection: binary WAIT / PROCEED, integrated with full autonomous ROS navigation stack

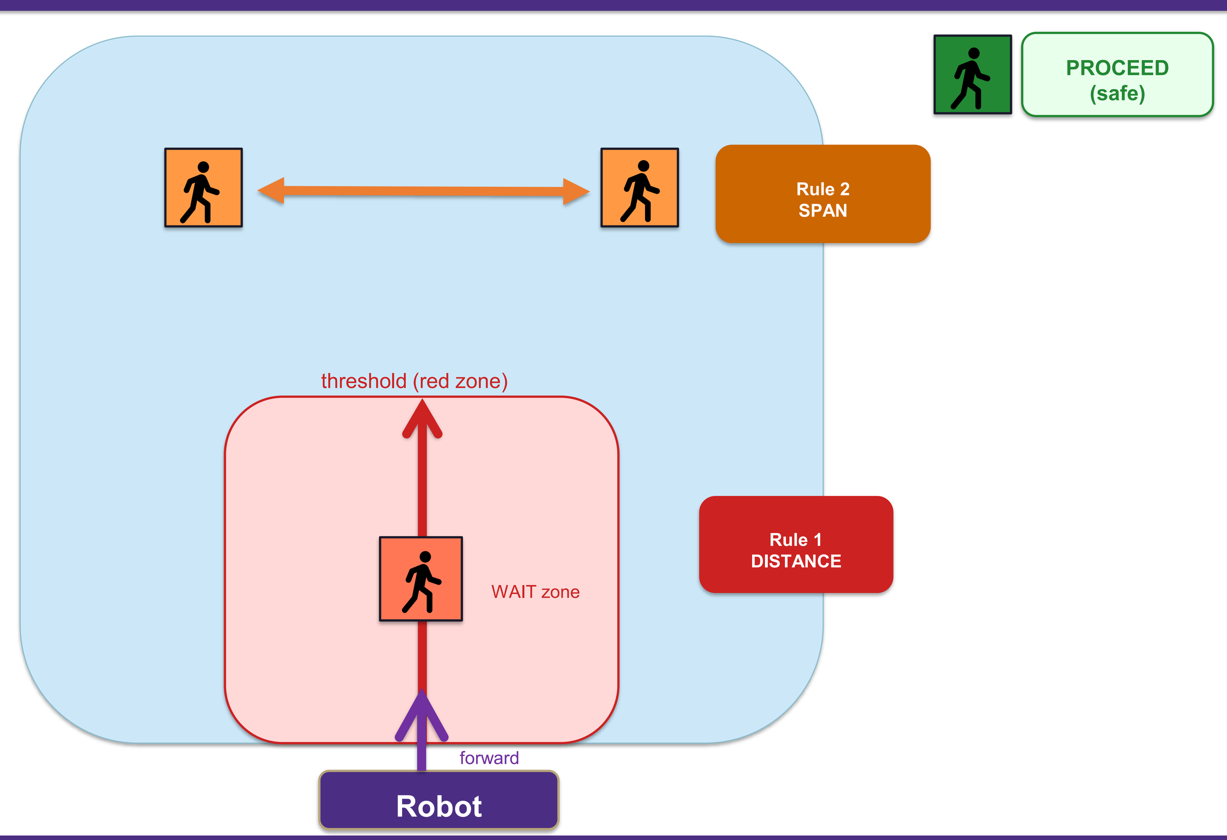
Fleet Management

- Fleet operators lack a unified interface to monitor and control fleets in real time
- Legacy WebSocket video causes high latency, and no shared map view exists for multi-robot fleet coordination
- Goal: Low-latency WebRTC video streaming + multi-robot map visualization, integrated into the existing Fleet UI

AI VISION - SYSTEM PLATFORM OVERVIEW



AI VISION - AVOIDANCE DECISION LOGIC



AI VISION - SYSTEM REQUIREMENTS

Perception
- Detection ≥ 10 Hz from RGB-D
- 3D position in robot frame
- Lateral cluster span

Navigation
- Gate move_base cmd_vel
- gmapping SLAM

Avoidance
- WAIT: span
- WAIT: nearest
- dropout hold-off

Deployment
- CPU-only — no GPU needed
- ROS Noetic · Python 3
- Pipeline latency: < 2 ms

AI VISION - SOFTWARE PIPELINE

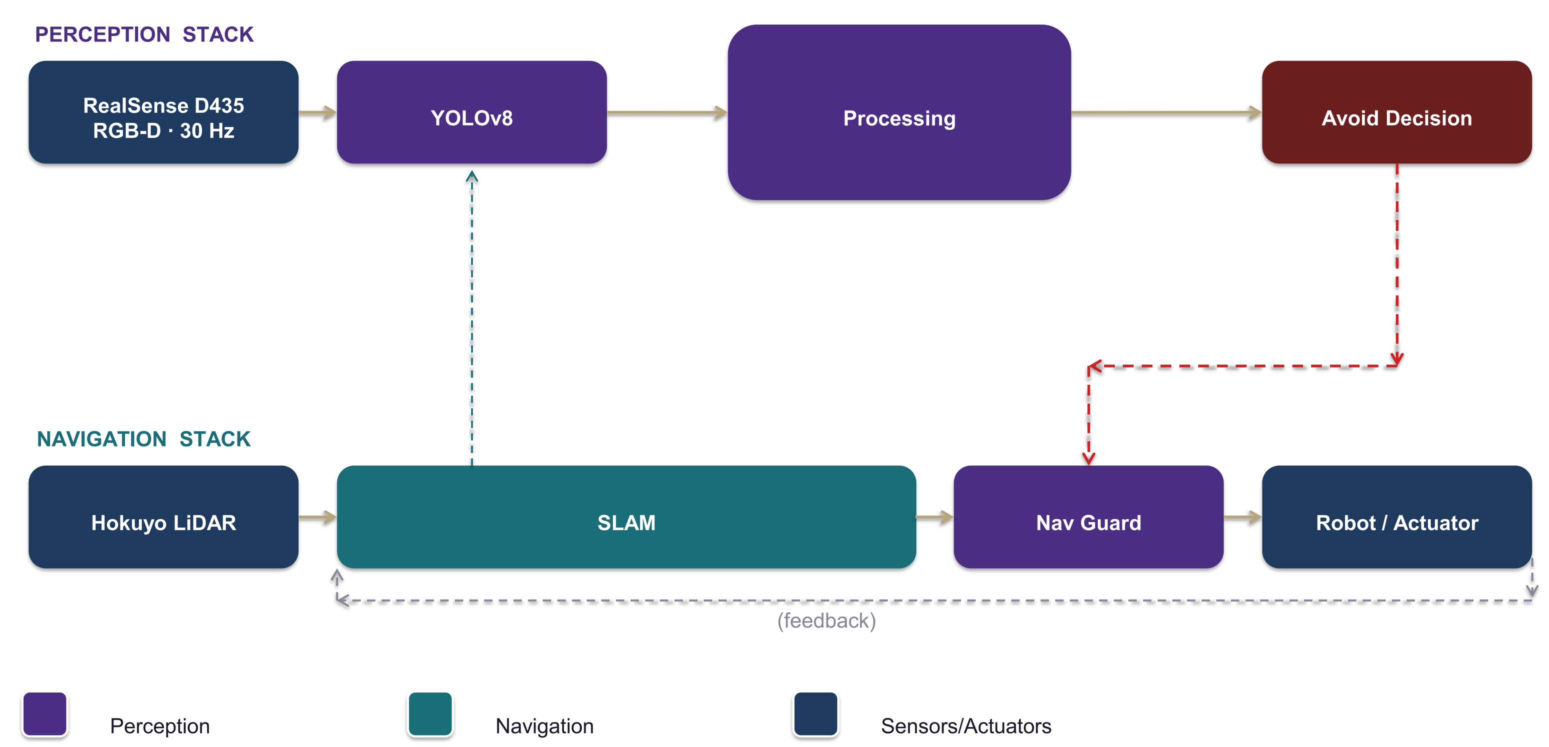
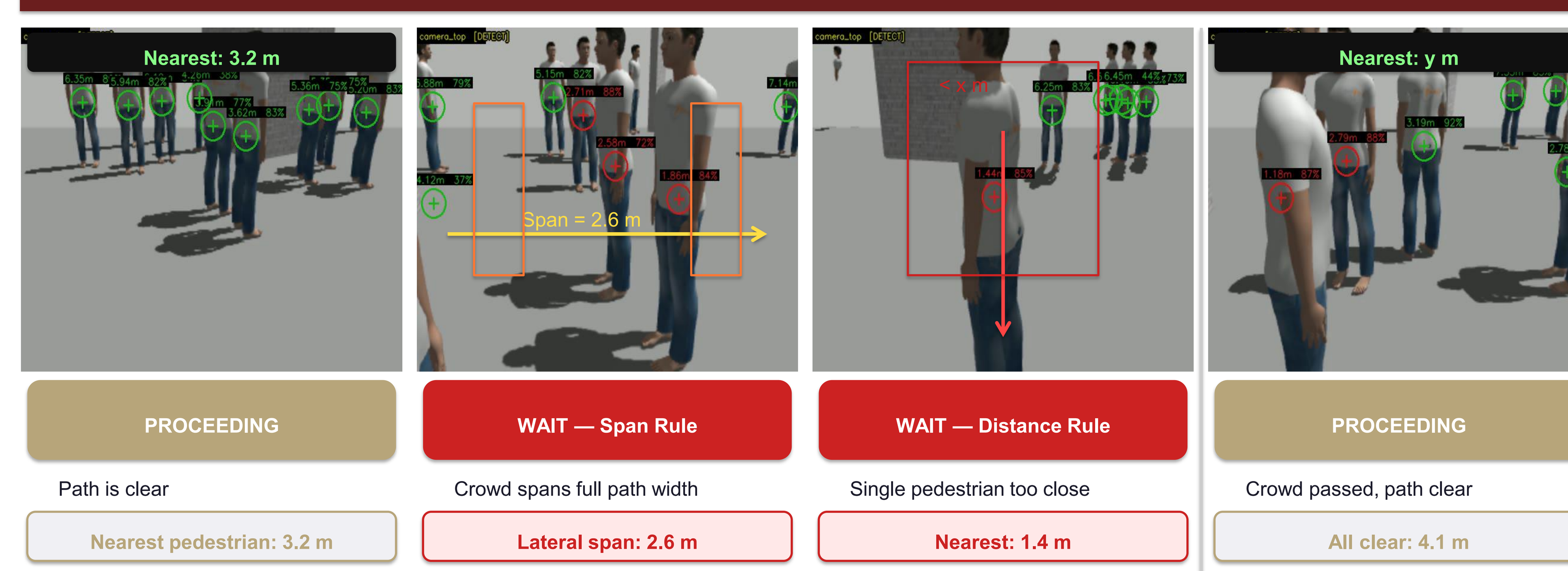


Fig 4. Left-to-right: sensor → YOLOv8n detection → 3D projection → clustering → avoid decision → nav_guard → robot.

AI VISION - AVOIDANCE SYSTEM IN ACTION



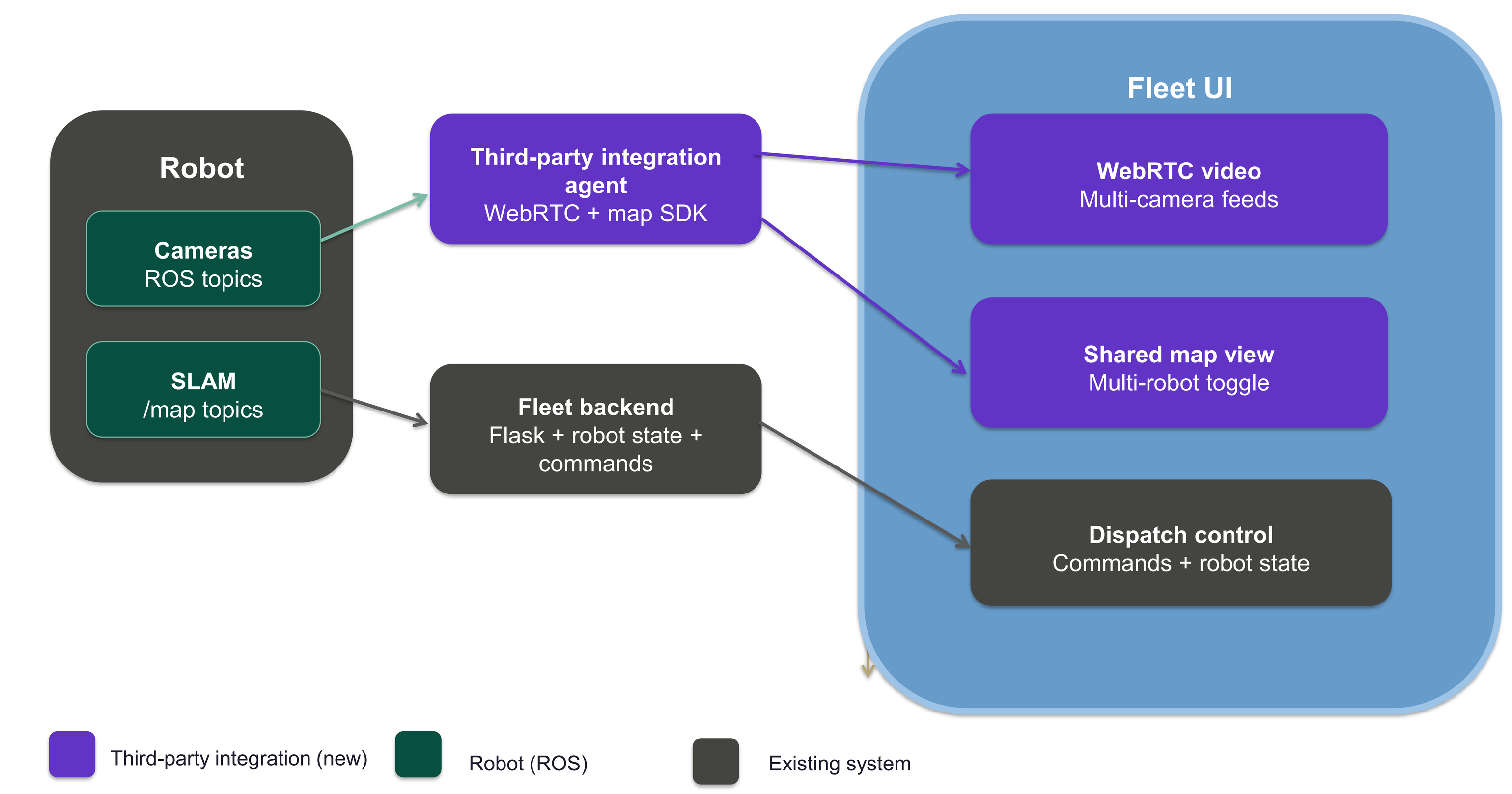
Note: camera images are embedded screenshots from a live ROS recording. All annotation overlays, text labels, and explanation boxes are editable native shapes.

AI VISION - KEY RESULTS

Metric	Value	Notes
Full loop time	3 min 12 s	6 waypoints W1→W6→W1 at 0.8 m/s
Goal success rate	92% (11/12)	120 sim-sec timeout per goal
Nav guard WAIT rate	7.7%	Robot stopped for pedestrians
YOLOv8n inference	REAL-TIME	OpenVINO
Pipeline latency	< 2 ms	Camera → WAIT/PROCEED decision
Span-rule events	5 438	30-min test · crowd width ≥ x m
Distance-rule events	5 905	30-min test · nearest ≤ x m
Simulation RTF	≈ 0.96	Near real-time · Gazebo + ROS Noetic

Table 1. Performance summary — 5-min navigation demo and 30-min avoidance stress test.

FLEET MANAGEMENT - SOFTWARE PIPELINE



FLEET MANAGEMENT – WEB PAGE

FUTURE WORK & CONCLUSION

Future Work

- Real NUC deployment for real-life dense crowd environments such as hospitals, airports, festivals, etc.
- 360° cameras · dynamic speed · risk score
- Hostile pedestrian identification and prevention maneuver
- Replace third-party agent's WebRTC with a self-hosted streaming solution to reduce third-party dependency and eliminate per-robot subscription costs
- Integrate the new fleet UI directly into the sponsor's existing web platform

Conclusion

- Realtime FPS on CPU · 50 + minutes of confirmed events in sim
- Autonomous nav + crowd avoidance — ready for HW
- Integrated Maps and WebRTC SDK for real-time map visualization and live video streaming
- Developed a new UI interface for fleet monitoring

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