Pedestrian Detection with SIMPL-Intersection, SEYOND's Traffic Management Lidar & AI System

A look into SIMPL-Intersection capabilities for pedestrian detection

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Introduction

In the field of Intelligent Transportation Systems (ITS), pedestrian safety and efficient traffic management are critical for modern cities.

As urban environments grow increasingly complex, demand rises for technology that can intelligently manage traffic signals while prioritizing pedestrian safety. SEYOND's SIMPL-Intersection represents a leap forward in this space, providing an advanced LiDAR-based detection and actuation solution tailored for urban intersections providing real-time data for monitoring pedestrian and vehicle movements with remarkable reliable accuracy.

This system dynamically adjusts traffic signal phases, extending or canceling pedestrian walk phases based on actual demand, improving both safety and traffic flow

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It also supplies cities with valuable insights into pedestrian behavior, empowering them to make data-driven decisions for safety improvements and infrastructure planning, all while respecting privacy.

This white paper explores how SIMPL-Intersection integrates seamlessly with existing infrastructure to enhance pedestrian safety, reduce traffic delays, and support smart city initiatives.

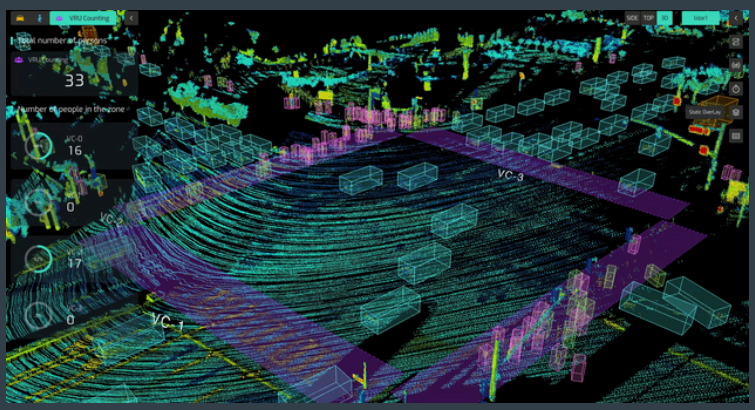
Pedestrian Detection: How It Works

SEYOND, a leader LiDAR manufacturer, combines LiDAR and artificial intelligence technologies to deliver precise, real-time detection of pedestrians and vulnerable road users.

By emitting rapid laser pulses and measuring their reflections, LiDAR systems produce point clouds, which are dense collections of points creating a 3D representation of the area. Two Falcon K LiDAR sensors (Nema TS2 compliant) are typically installed at each intersection for full coverage.

Seyond's traffic perception software processes data from multiple sensors, classifying road users and tracking their movements in real time.

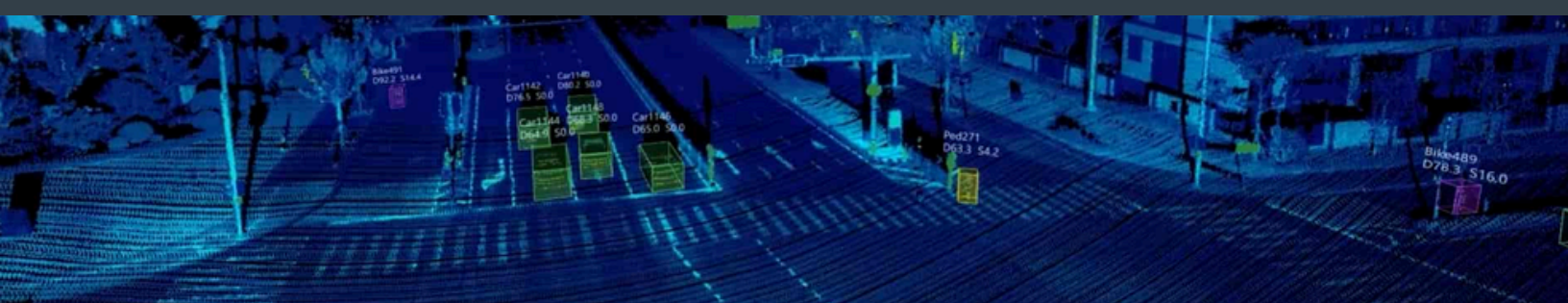
The system's accuracy allows for detailed counts, speeds and size tracking across detection zones.



Cities can easily define virtual detection zones for vulnerable road users (VRUs), allowing monitoring of crosswalks, mid-block crossings, and pedestrian behavior. Key detection capabilities include:

- Identifying Pedestrian Silhouettes: Recognizes pedestrian-specific shapes up to 50m beyond the stop bar, even if partially obscured.
- Tracking Pedestrian Movement: Continuously updates to track pedestrian movement across intersections or within specific zones.
- Detecting All Road Users: Achieves 99% accuracy in vehicle detection and counts, with detection up to 150m beyond the stop bar.

This robust solution ensures reliable performance in diverse weather and lighting conditions, with an accuracy rate of 82% in high-density crosswalks and 100% in average traffic conditions.



Extending Walk Phases

SIMPL-Intersection's unique capabilities extend beyond basic pedestrian detection; it actively monitors pedestrian behavior and can adapt intersection signaling to support safer, more inclusive crossings.

1. Real-Time Pedestrian Behavior Monitoring

When a pedestrian is detected within the virtual detection zone placed over the crosswalks, SIMPL-Intersection's perception software immediately begins analyzing movement speed, trajectory, and behavior. Here's how it works:

- Speed and Trajectory Analysis: The system continuously tracks pace and direction in real-time, recognizing slower moving individuals (e.g. elderly or mobility impaired pedestrians).

- Behavior Prediction: By assessing current movement and past data patterns, SIMPL-Intersection can predict if a pedestrian might need additional crossing time. This is especially critical for people with slower speeds, such as children, seniors, or individuals with physical disabilities.

2. Communication with TLCs for Adaptive Timing

Once the system detects that a pedestrian is crossing slowly or requires more time, it automatically communicates with the intersection's traffic light controller to extend the pedestrian walk phase. This dynamic adjustment is crucial for ensuring pedestrian safety, as it allows the system to adapt to real-time needs rather than relying on preset signal timings.

- Extended Walk Time: SIMPL-Intersection can extend pedestrian walk phases as needed, allowing ample time for safe passage based on real-time pedestrian behavior.

- Flexible and Scalable Adjustments: The timing can be adapted not only based on individual pedestrian needs but also to account for high pedestrian traffic, such as during peak hours or events. This capability is particularly advantageous for high-traffic urban intersections.

3. Prioritizing Vulnerable Road Users

In line with Vision Zero initiatives and city goals to reduce pedestrian fatalities, SIMPL-Intersection places a focus on vulnerable road users. This includes those who may be less visible to drivers or may need more time to cross, enhancing safety in the following ways:

- Enhanced Accessibility: Adaptive walk times support inclusivity, ensuring that people of all abilities have the time needed to cross. This can be life-changing for individuals with mobility impairments who might otherwise feel rushed or unsafe.

- Reduced Intersection Conflicts: By holding signals for pedestrians who are still crossing, SIMPL-Intersection minimizes situations where vehicles turn or enter intersections with pedestrians still in the crosswalk, minimizing potential risks.

Cancelling Walk Phases

In modern urban environments, where balancing pedestrian and vehicle needs is paramount, SEYOND's SIMPL-Intersection takes a proactive role in improving traffic flow and reducing unnecessary delays.

1. Dynamic Signal Control for Optimized Traffic Flow

Through its advanced LiDAR and AI-based perception system, SIMPL-Intersection detects when no pedestrians are present and dynamically signals the traffic light controller to cancel or skip the pedestrian walk phase. This capability enhances traffic efficiency by adapting to real-time conditions and optimizing signal timing, creating a more seamless flow for vehicles without compromising pedestrian safety when required. This results in a smoother traffic flow, particularly in high-traffic areas, reducing both travel times and fuel consumption associated with idling vehicles.

- Absence Detection: Using high-resolution LiDAR data and AI-driven perception software, SIMPL-Intersection continuously scans crosswalks and VRU detection zones. When no pedestrians are detected waiting to cross, the system recognizes this and communicates with the traffic light controller to adjust the signal timing.

- Continuous Monitoring: Even during low-traffic times, such as late at night or early mornings, SIMPL-Intersection ensures accurate pedestrian detection. This allows the system to skip the pedestrian phase when unnecessary while remaining ready to activate it should a pedestrian approach.

2. Balancing Pedestrian and Vehicle Needs

SEYOND's SIMPL approach balances the dynamic needs of both pedestrians and vehicles, ensuring that traffic signals are responsive to real-time conditions. This balance supports city goals for both safety and efficiency, without prioritizing one type of road user over the other.

- Prioritizing Responsiveness: SIMPL-Intersection's ability to selectively cancel or activate the pedestrian phase based on real-time conditions allows it to respond quickly to changing traffic patterns and demands, optimizes signal timing to improve traffic flow and pedestrian access.

- Flexibility Across Varied Traffic Conditions: During periods with low pedestrian activity, SIMPL-Intersection's adaptive control becomes especially valuable, while in high-pedestrian areas or times, the system remains fully capable of prioritizing pedestrian safety by extending walk times or reactivating walk phases when needed.

3. Supporting Smarter, Sustainable Urban Mobility

By dynamically managing pedestrian signals and optimizing traffic flow, SIMPL-Intersection contributes to smarter, more sustainable urban mobility. This approach reduces vehicle congestion, lowers emissions and aligns with cities' goals for efficient, safe, and adaptive infrastructure.

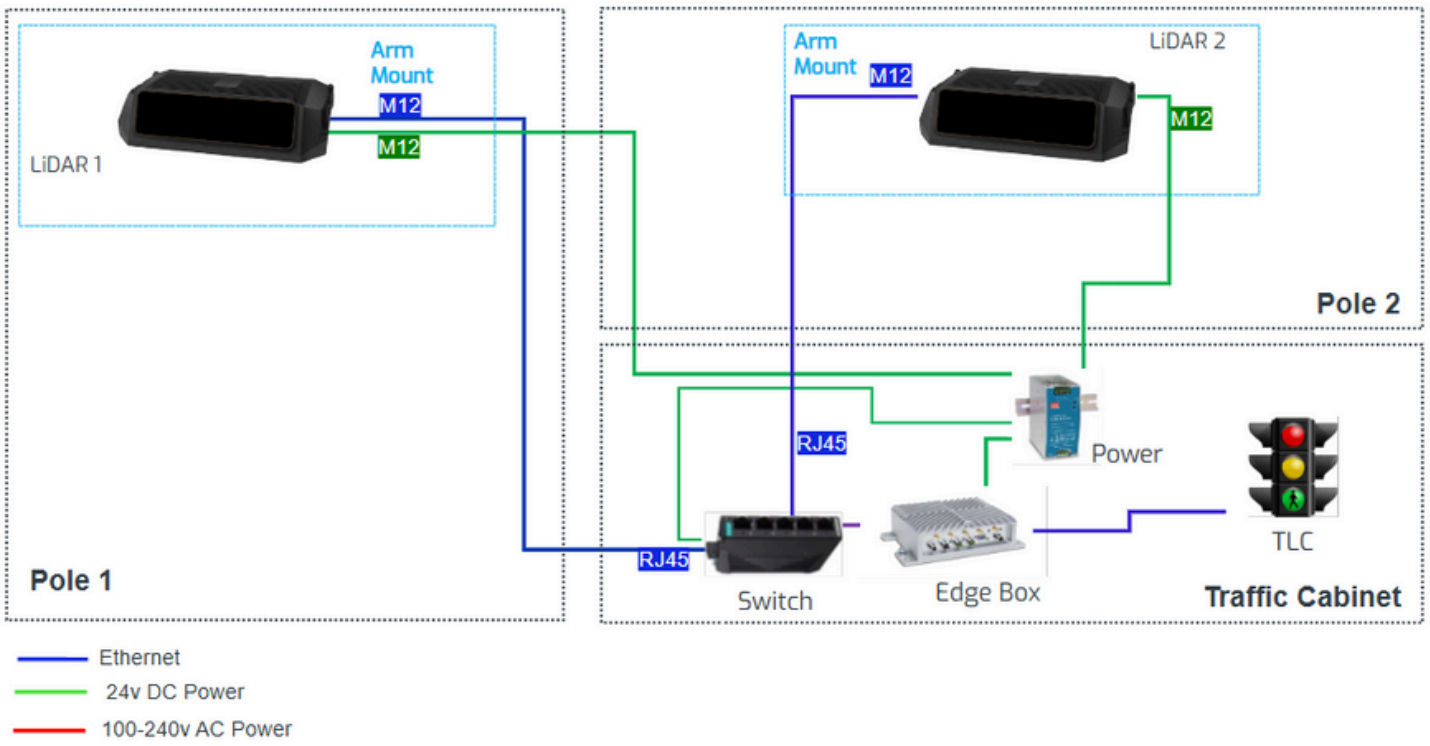
- Environmental Benefits: Reducing vehicle idle time by canceling unnecessary walk phases decreases fuel consumption and emissions, supporting urban sustainability efforts.

- Improved Driver Experience: Responsive signal control minimizes driver frustration from waiting at red lights unnecessarily, improving overall satisfaction and compliance with traffic signals.

SIMPL-Intersection System Topology

SIMPL-Intersection is designed for seamless integration into urban traffic management systems. Key components include:

- **LiDAR Sensors**: Typically, two LiDAR sensors are installed at a four-way intersection on opposing corners, mounted on the traffic light poles. Positioned 4 to 6 meters above the ground, each sensor captures data from two approaches and outputs an Ethernet cable. SIMPL-Intersection Kits provide mounting arms and all necessary hardware
- **Edge Processor**: The Ethernet cable connects to an edge processor located in the traffic light cabinet. Equipped with an NVIDIA GPU, this processor enables real-time data processing and analysis.
- **Traffic Light Controller**: The edge processor connects to the traffic light controller, usually via an Ethernet or serial cable. This setup allows the traffic light controller to make real-time decisions based on pedestrian data, supporting a responsive, intelligent traffic management system that prioritizes pedestrian safety and optimizes traffic flow.



Privacy and GDPR Compliance

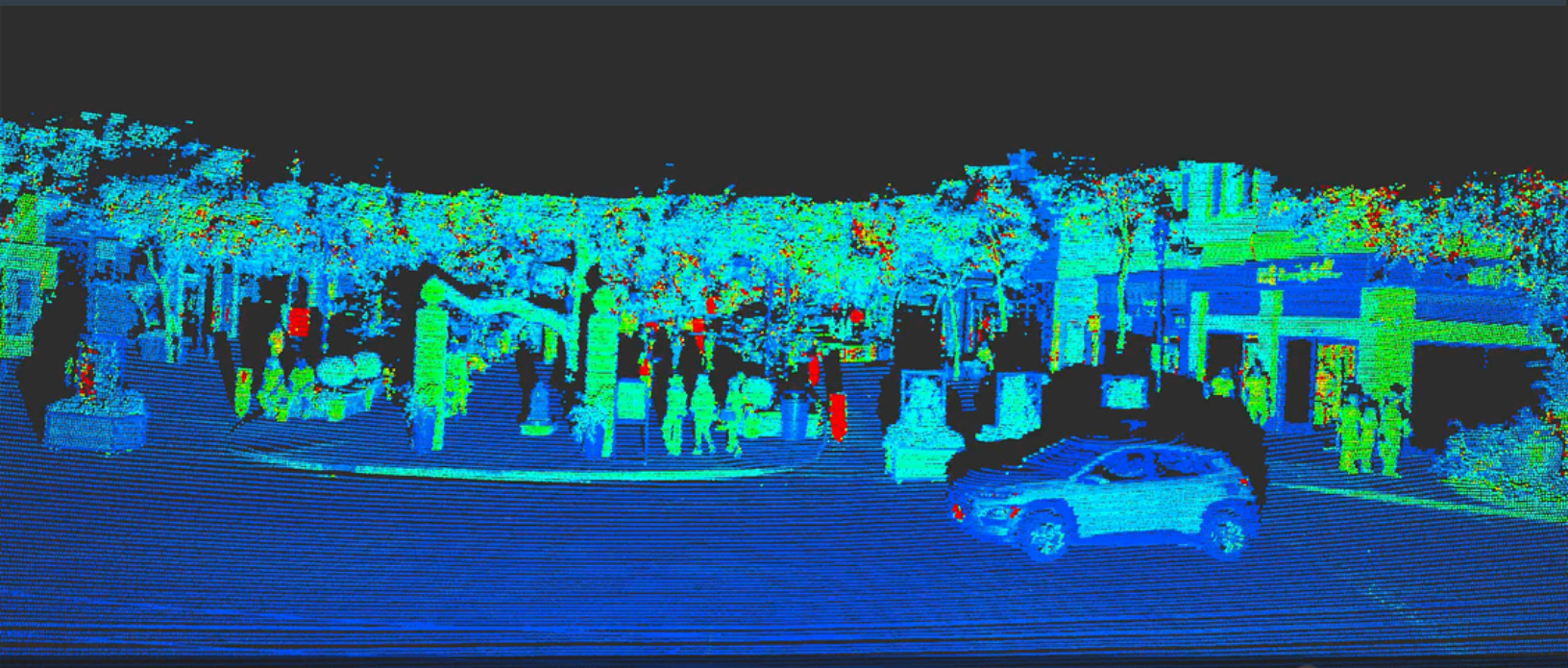
SIMPL-Intersection is designed with privacy and data protection at its core. The system is GDPR-compliant, emphasizing data privacy through anonymization, secure transmission, and minimal retention. Key privacy features include:

- **Data Anonymization**: The LiDAR system generates point clouds to represent pedestrians, vehicles, and other objects as sets of abstract data points without any identifying information. This representation allows for detailed analysis of movement and behavior while safeguarding individual privacy. No personal data is stored or processed, ensuring that individual privacy is always protected.

- **Secure Data Transmission**: Data is encrypted both at rest and during transmission between SIMPL-Intersection components, protecting it from unauthorized access or tampering.

- **Minimal Data Retention:** A key principle of SIMPL-Intersection's design is minimal data retention. Data is processed in real-time and discarded once immediate analytical requirements are met, reducing long-term data storage requirements.

SEYOND SIMPL's commitment to privacy ensures that cities can implement this advanced traffic management solution without compromising the privacy of individuals.



Conclusion

SEYOND's SIMPL-Intersection represents a transformative step forward in intersection safety and traffic efficiency. By combining advanced LiDAR technology with AI-powered perception software, SIMPL-Intersection delivers precise, real-time monitoring of pedestrians and other road users, allowing for adaptive traffic signal control that enhances safety and optimizes traffic flow. Its ability to dynamically adjust walk phases based on pedestrian presence, extend crossing times for individuals with mobility needs, and cancel unnecessary signals exemplifies a responsive approach to traffic management that meets the diverse needs of modern cities.

Beyond these immediate operational benefits, SIMPL-Intersection offers cities valuable insights into pedestrian behavior and intersection usage. These insights empower municipalities to make data-driven decisions for infrastructure improvements, targeted safety interventions, and policy adjustments. This data-centric approach, coupled with SEYOND's commitment to privacy and GDPR compliance, ensures that cities can implement these advancements responsibly, protecting individual privacy through data anonymization, secure transmission, and minimal retention practices.

As cities worldwide strive to create safer, smarter, and more inclusive urban environments, SIMPL-Intersection provides a scalable, privacy-conscious solution. It supports Vision Zero initiatives, promotes sustainable mobility, and demonstrates that technology can enhance public safety without compromising personal privacy.

With SIMPL-Intersection, SEYOND is helping shape the future of urban mobility, building intersections that prioritize the well-being of all road users and support the long-term vision of resilient, connected cities.

About Seyond

Seyond™ is a leading global provider of image-grade LiDAR technology, powering a safer, smarter and more mobile world across the automotive, intelligent transportation, traffic management, robotics and industrial automation sectors.
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