PAN-Robots
Collaborative project
FP7-2012-NMP-ICT-FoF

Infrastructure Sensors

Deliverable No.		D5.6
Work Package No.	WP5	Key technology development
Task No.	5.6	Infrastructure sensors
Coordinator		Kay Fuerstenberg, SICK AG
Author(s)		Markus Boehning, SICK AG
Dissemination level		Restricted
Version No.		1.0
File Name		D5.6 Infrastructure sensors v1.0.docx
Issue date		2014-10-28
Project start date, duration		2012-11-01, 36 months

Executive summary

Current automated guided vehicles (AGV) deployed in modern warehouses are equipped with several safety laser scanners to monitor the environment and to ensure safe and accident-free operation with regard to humans and many other obstacles. However, for situations where objects are not in the field of view of the safety laser scanners, for example due to occlusions at intersection corners, safety can only be ensured by slowing down the traffic.

Currently, an AGV decelerates while approaching a blind spot to adapt the required braking distance. Having passed the blind spot, the AGV accelerates back to maximum velocity to continue its mission. This ensures that the AGV can avoid a collision even with objects suddenly entering the monitored safety areas.

While this approach ensures safe operation even at blind spots and other critical warehouse black spots, it is inherently inefficient regarding mission time, energy consumption and mechanical wear of the AGV, as illustrated in Figure 1.

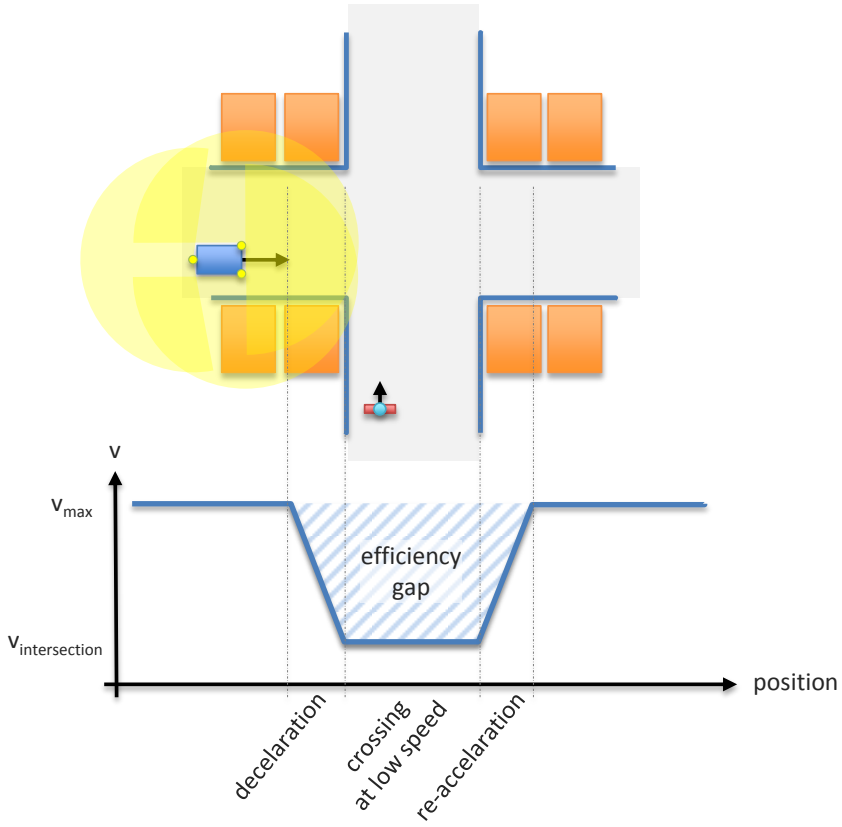

Figure 1: The AGV (blue) decelerates when approaching an intersection

The PAN-Robots **technical objective 8** [1] is to eliminate this inefficiency by an infrastructure-based cooperative environment perception system using a dedicated infrastructure laser scanner system to monitor a blind spot and to communicate the absence of other objects ("intersection is free") to approaching AGVs via the control center. In case the monitored black spot is not free of other objects, these objects are detected, tracked, classified and communicated to the control center for global live view integration.

The development of the PAN-Robots infrastructure-based cooperative environment perception system covers the choice of suitable hardware components as well the development of the software modules for sensor data preprocessing and, subsequently, reliable object detection, tracking and classification.

As a first step of development, the communication interfaces and the specifications for data exchange with the control center had been tested and verified with simulated data. Then a first test setup was installed in a testing environment at SICK in Hamburg, Germany to acquire first measurements. This setup was later transferred to and installed in the Coca-Cola Iberian Partners (CCIP) warehouse in Bilbao, Spain, during a measurement campaign in September 2014.

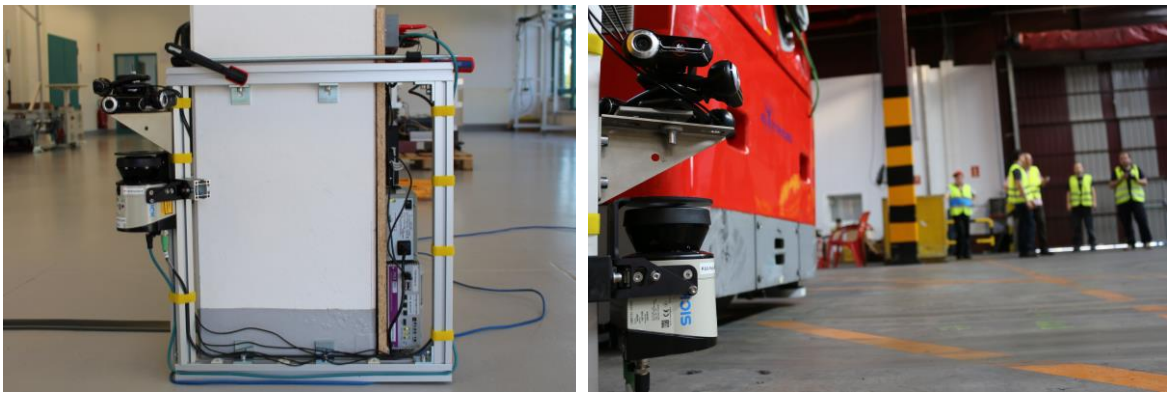

Figure 2: Infrastructure installation at SICK in Hamburg (left) and at CCIP in Bilbao (right)

During this measurement campaign, approximately 200 hours/2.7 Terabytes of raw sensor measurement data was recorded. The recorded data was then post-processed and the algorithms for data segmentation, object detection, tracking and classification were developed and tailored to the needs of warehouse environments.

The system reliably detects, tracks and classifies objects and thus correctly decides between the absence and presence of other objects in the monitored blind spot, all exemplified in Figure 3.

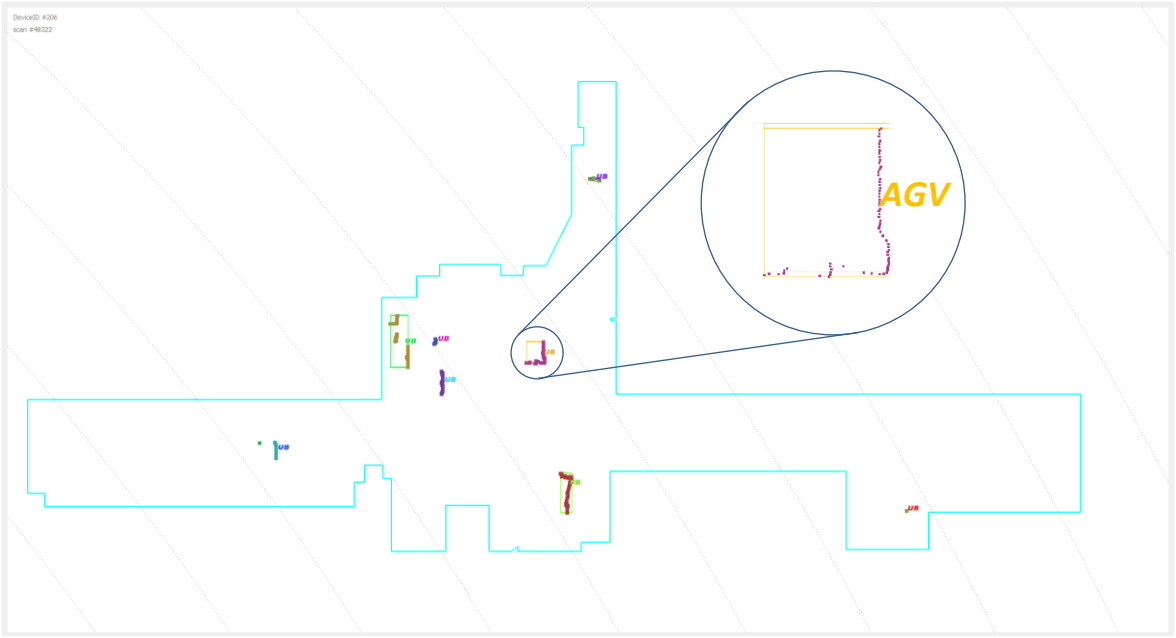

Figure 3: Classified objects with object boxes