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Towards Highly Automated Driving in a Parking Garage: General Object Localization and Tracking Using An Environment-Embedded Camera System

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Motivation

- Detect **generic** objects along the **path of an autonomously driving car** to raise a warning to avoid a collision
- Lack of GPS information and non-sufficient on-board vehicle sensors

→ Indoor positioning and environment perception based on multiple surveillance cameras

- Detection of arbitrary objects (e.g., other vehicles, small / tall humans, bicycles, or animals)

Proposed System

- Extending the purpose of surveillance cameras already installed in the majority of parking garages.
- Recognizes objects and their position inside the coordinate system of a parking garage.
- Based on **synchronized multiple** grayscale cameras mounted on high tripods with **shared field of view** connected by a **local area network**

A typical scenario captured by 2 surveillance cameras

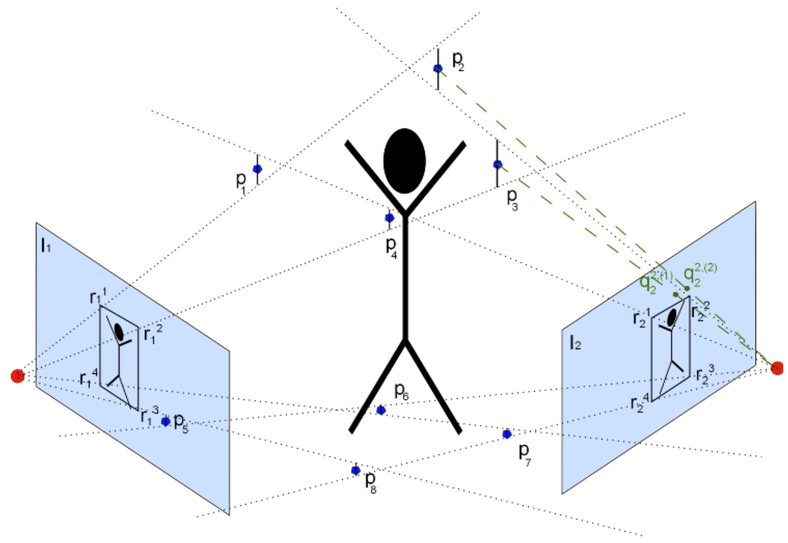
Foreground Segmentation

- Each camera is analyzed separately
- Only minor image regions contain objects of interest:

→ A model of the **static background** by the use of an exponentially smoothed mean-image.

- Segmentation of moving image regions
- Minimization of false segmentation caused by **shadows** with normalized cross-correlation (**NCC**)
- Calculating clusters (8-neighborhood) based on segmentation image into final regions of interest (ROI)
- Tracking of final ROIS with an Alpha-beta-filter

Image World Transform



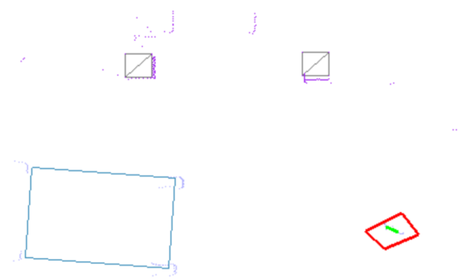
- Fusion of ROIs from several camera images with overlapping field of view

→ Marriage problem with symmetric distances: Matching by means of a distance measure

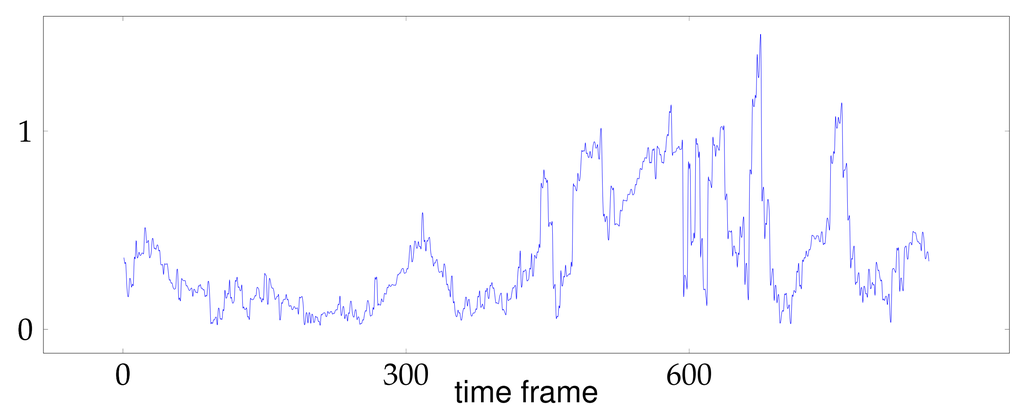
- Regarding of view rays from the respective camera center through all ROI corner points
- Intersection of these rays with those from other images

Experiments

- Two grayscale cameras
- LIDAR reference system
- A CAD representation for the proposed system and LIDAR reference system
- Representative sequence of a pedestrian containing several difficult situations
- System's mean positioning error in this sequence is $0.37m$.



The deviation of the LIDAR and the camera-based hypothesis:



Conclusion and Outlook

- Sufficiently precise to locate an object for applications like collision warning
- Based on surveillance cameras that a majority of modern parking possess
- The effect of strong light sources and the decomposition of ROIs needs to be reduced
- Finer segmentation by use of an adaptive data structure replacing ROIs