interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Real time monocular camera based pedestrian recognition for object based fusion & confirmation

Mirko Meuter, Delphi Electronics & Safety

interactIVe Final Event

20th-21st November 2013

Contents

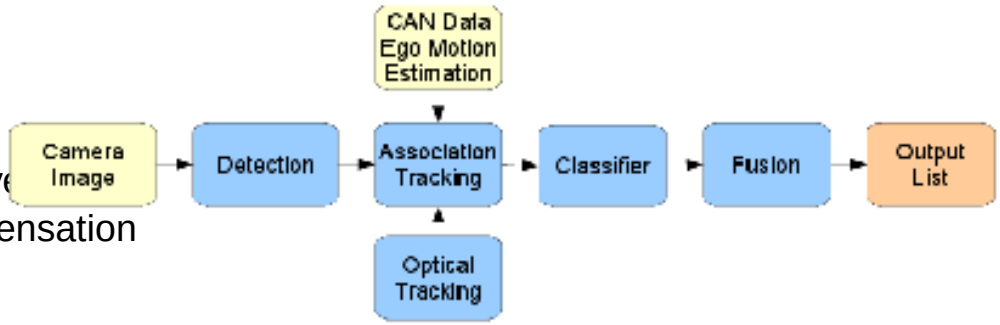
- Pedestrian detection and recognition task and challenges
- System overview
- Method
  - Detection
  - Tracking
  - Classification
  - Fusion
- Evaluation results
- Lessons learned and future work

Pedestrian detection module | Task description

- Task
  - Identify pedestrians in video images
    (experimental module, part of Perception advanced research)
- Challenges
  - Real-time capable for limited hardware resources
  - Monocular sensor
  - Moving vehicle
  - Low false alarm rates required
  - Must work under challenging environmental, weather and lighting conditions
  - Large variation in each class
- Many of these aspects are not considered in the scientific literature regarding pedestrian recognition
  - Find suitable perception methods as input for advanced fusion systems

Pedestrian detection module | System overview

- Detector
  - Provides pedestrian candidates: position, size
  - Mean-Shift clusters candidates with similar size and position
- Tracker
  - Estimates target position and ve
  - Can data for ego motion compensation
  - Fusion with optical tracking
- Classifier
  - Strong classifier rejects false track hypothesis
- Time-fusion
  - Filters fluctuations in Classification results over time



Pedestrian detection module | Approach

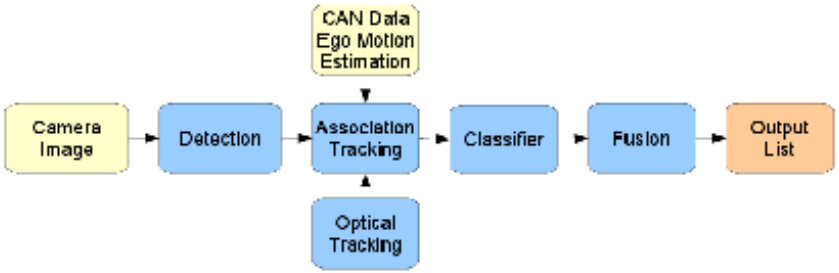
- Processing the image at every reasonable position and scale (Sliding window approach)
  - Efficient cascaded structure (early rejection of areas without structure)
  - Detector creation from sample images
  - Appearance learning on automatically selected features
  - Provides position, scale and confidence estimates
- Processing time
  - 6ms – 9ms on PC
  - Real time capability on specialized embedded systems
  - Much faster compared to similar systems in literature

Detector raw results: **yellow BB** high conf.
grey BB low conf.

Pedestrian detection module | Results

Module chain

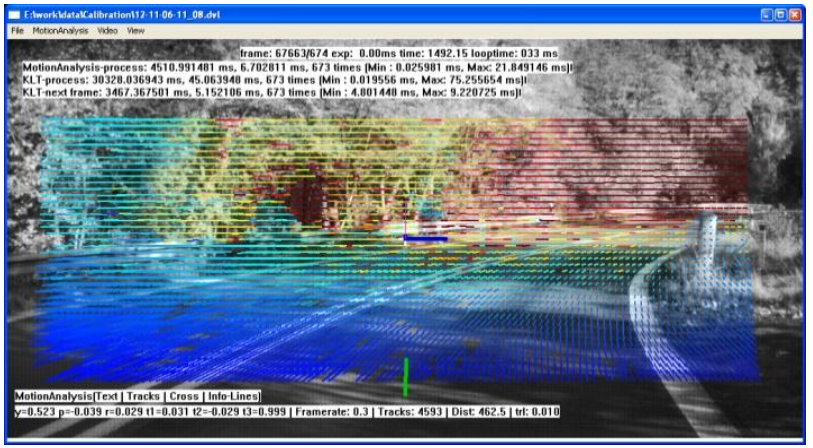
- Tracker
  - Bank of Extended Kalman filters
  - Estimates position & velocity
- Track based classifier
  - BOW to achieve shift and position tolerance
- Temporal fusion
  - Temporal delay neural network used to fuse detections and classifications
  - Low pass filter

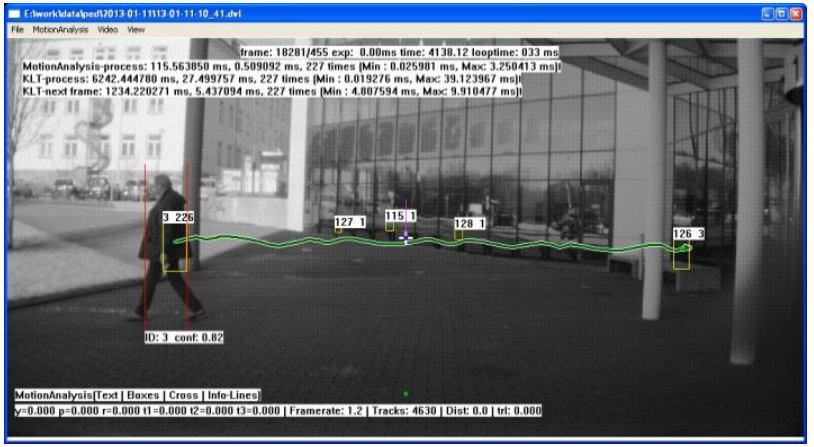


Pedestrian system performance (2/2)

Future work

- Use optical flow to improve pedestrian recognition
  - Ego motion and distance estimation
  - Ground plane estimation
  - Foreground background seperation
- Use optical tracking of pedestrians
- Refine detection bounding boxes
- Collect more training data





Lessons learned

- Reliable pedestrian detection requires a combination of multiple techniques and sensor fusion

Acknowledgments

- To the entire Interactive Perception team for cooperation

- To Volvo truck demonstrator team for their support for video and data logging

- Special thanks also to Daimler, Ford, ICCS, and Forwiss / University of Passau

Thank you.

Co-funded and supported
by the European Commission

Mirko Meuter
Advanced Engineering
Delphi Electronics & Safety
Delphiplatz 1, 42119 Wuppertal

DELPHI

SEVENTH FRAMEWORK
PROGRAMME