Automatic Classification, Counting and Modelling of Non-Motorized Traffic

… with Video Analytics

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Why bother?

- Pedestrian and Bicycle **volumes** are **key performance figures** for evaluating measures
- Problem: Currently **few available data** of non-motorized traffic
- Non-motorized traffic is **hard to measure** automatically

- **Video analytics has potential …**
  - can cover large areas
  - rich data to classify objects
  - relatively easy installation and setup

… but there remain Big Challenges

- Environmental Conditions

- Dense / Complex Scenarios

Contents: 3 Video Analytics Approaches:

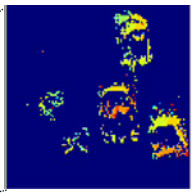
1 **Embedded Visual 3D Sensor** for Real-Time Classification and Counting

2 Automatic Pedestrian **Path Modeling** based on **Individual People Tracks**

3 Automatic Pedestrian **Path Modeling** based on **Optical Flow**

Embedded Visual 3D Sensor

Stereo Sensor



far
near

3D-raw Data

Control Video for annotation

Class	Sample	Correctly classified	Classification rate [%]
Riding cyclist	*N* = 82	82	100
Pedestrian	*N* = 26	24	92

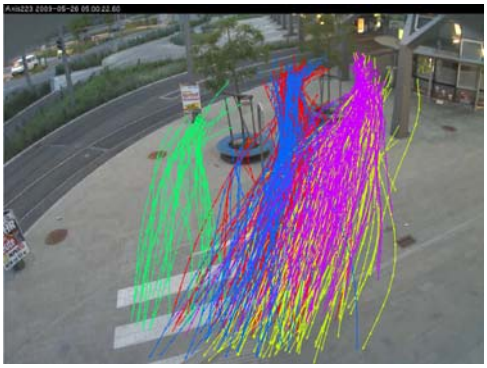
- **Pending: Long-term test data collection**
- **Weather-Proof prototype for real-time processing ready by end of 2009**

Vision-Based People Tracking

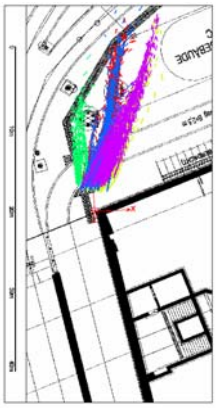
- Individual People Tracks are based on **Pedestrian Detectors**
- Pedestrian Detectors classify **rectangular windows** into pedestrian/non-pedestrian class
- Requires 10000s of training examples!
- **Breaks down for dense scenarios** due to occlusions

Clustering Trajectories into Groups

- Our approach can cope with **broken trajectories**
- Our approach can **automatically select the number of clusters**

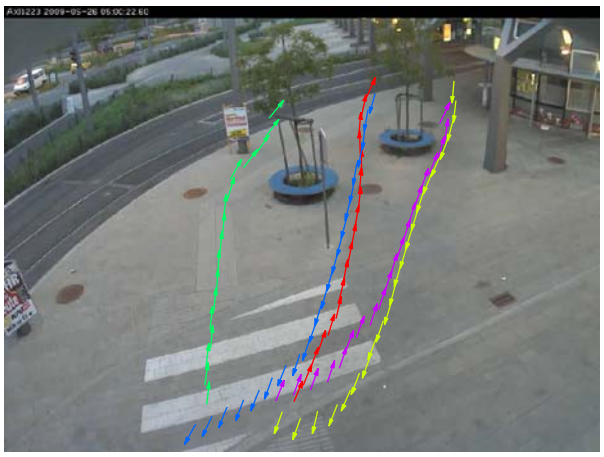


Trajectories of 1 day **automatically** clustered into **5 major groups**



Visualization of ground plane (after camera calibration)

Modeling Paths as Mean Trajectories



Our group works on 3 Video Analytics Approaches:

1 **Embedded Visual 3D Sensor** for Real-Time Classification and Counting

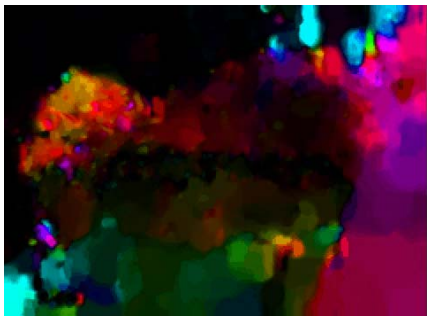
2 Automatic Pedestrian Path Modeling based on **Individual People Tracks**

3 Automatic Pedestrian Path Modeling based on **Optical Flow**

Optical Flow

- Optical Flow models motion of pixels between consecutive frames

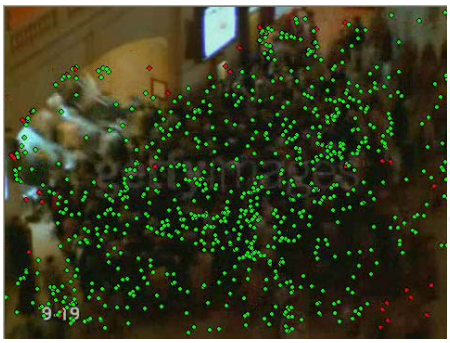
Crowded Video



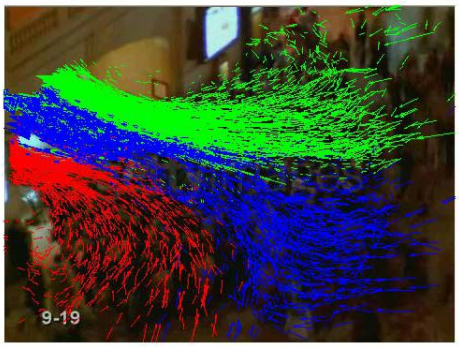
Optical Flow

Clustering of Particle Trajectories

- Crowd is modeled as a set of interacting particles



Particles moving in optical flow

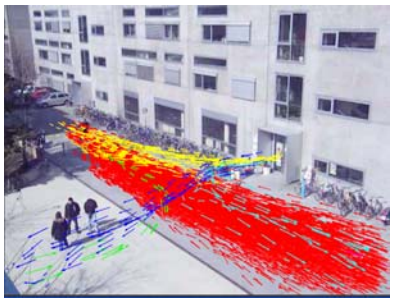


Particle trajectories **automatically clustered into 3 groups**

Clustering of Particle Trajectories (2)

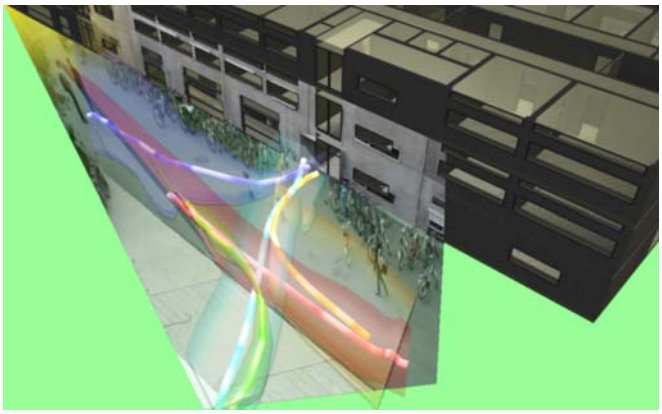
- Crowd is modeled a set of interacting particles

Crowded Video (Acting at University)



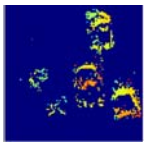
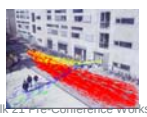
Particle Trajectories **automatically clustered into 5 groups**

Path models combined with 3D Model



In cooperation with Institute of Computer Graphics and Knowledge Visualization Group, Graz Technical University

Conclusion

Approach	Main Advantages	Open Issues
Émbedded 3D Sensor 	▪ **Real-Time** counting of **pedestrians and cyclists** ▪ Embedded Device ▪ Robust to weather conditions	▪ Works only good in **constrained field of view** (best with top view) ▪ **Umbrellas** still pose problems ▪ Modeling of long-term data
Individual Path Modeling 	▪ Pedestrian path modeling in **mixed scenarios** ▪ Robust against weather conditions	▪ Classifying **cyclists** (sometimes based on velocity) ▪ Porting tracking to a **smart camera**
Particle Path Modeling 	▪ Pedestrian path modeling in **dense crowds**	▪ Optical flow computing is still bottleneck ▪ Tackling Motion not from Pedestrians?