FFI Resultatkonferens
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Background

~40,000 fatalities worldwide / year
WP1 Data Collection
## WP2 Cyclist Braking Behavior

<table>
<thead>
<tr>
<th>Bike Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain bike (N=8)</td>
<td></td>
</tr>
<tr>
<td>Racer bike (N=1)</td>
<td>Thin tyres, backstyre, saddle higher than handlebar.</td>
</tr>
<tr>
<td>City bike (N=6)</td>
<td>Saddle and handlebar at approximately same height, often more than 7 gears, seldom foot brake.</td>
</tr>
<tr>
<td>Electric bike (N=6)</td>
<td></td>
</tr>
<tr>
<td>Comfort bike (N=11)</td>
<td>often footbrake, seldom more than 7 gears, handlebar higher than saddle.</td>
</tr>
</tbody>
</table>
WP2 Braking Results

- The average stopping distance is almost the same for different bicycle types
- There is a large variance in stopping distance between cyclists using one or two brakes
- The personality, reflected by cyclist type, is an important underlying factor affecting the stopping distance
WP3 Improved detector

- Classifier that detects pedestrians and person riding on bicycle
- Classification based separator that separates pedestrians and bicyclists
- Classifier that detects bicycle wheels
- Tracker that combines pedestrian measurements and bicycle wheel measurements
WP3 Detections
WP3 Detections
WP3 Tracking
WP4 Ellipse extraction

- A bicycle can be modeled in a state-space that facilitates analyzing the cyclist behavior [1].
- Fitting Ellipses to the bicycle wheels defines most of the state space parameters.

\[ x = (\psi, X_c, Z_c, \dot{\psi}, v_x, v_z, \delta, \theta, Y_c, S)^T \]

WP4 Solution

- We proposed a method to **detect cyclists** and fit **ellipses** to bicycle wheels “in-the-wild”.

WP4 Visualization
WP4 Visualization
WP5 Cyclist Intention Detection

Use DNN to

- Gesture recognition → Intention interpretation → Action prediction

<table>
<thead>
<tr>
<th>Left arm raised</th>
<th>Right arm raised</th>
<th>Looking back</th>
<th>Looking sideways</th>
<th>Waiting (at stop sign or zebra crossing)</th>
<th>Stops pedaling</th>
<th>No action</th>
<th>Foot down</th>
<th>Foot up</th>
<th>Cyclist leaning</th>
<th>Cyclist slowing down</th>
<th>Cyclist standing up</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>5</td>
<td>21</td>
<td>26</td>
<td>7</td>
<td>2</td>
<td>98</td>
<td>30</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
We tackle the “in-the-wild” scenario

Varying weather; cyclist pose, scale, and appearance; location; and time of the day

Examples of a cyclist gesturing account for a very small subset of typical data used for ADAS/AD

We utilize a human keypoint detector (PoseNet) pre-trained on a large human keypoint detection dataset

We use a simple Multivariate Normal Classifier (MVN) on top of the keypoints, trained on examples mined from Autoliv-data
Another cue is whether the cyclist is looking at the car.

Using the same data, we train a simple MVN classifier utilizing features from a ResNet18 pre-trained on ImageNet.

PoseNet seems unable to capture whether the face is turned towards us.

Instead we rely on features extracted from a ResNet18.
WP7 So where did we end up?
Real Life Benefits Estimation

- **AEB – cyclist**
  - M1 vehicle & opponent is a cyclist
  - 5 km/h <= own driving speed <= 40 km/h & cyclist speed <= 30 km/h
  - no visual obstruction
  - no ice and snow on road & no poor road condition
  - no unstable vehicle condition & fine weather
  - Addressing crossing and longitudinal cyclist accidents

- **22% reduction in number of fatalities** (GIDAS)

- **Improved cyclist detection (WP3)** - optimistic estimation ~17%
  - Wider FOV
  - Better classification of the cyclist and pedestrian
  - Resulting in better speed and braking prediction

- **Cyclist braking capabilities (WP2)** ~10%
  - Understand the capabilities of the cyclist in terms of evasive action (braking) can be considered to improve the threat assessment
  - Understanding the braking capabilities of different type of bicycles

- **Cyclist turning prediction (WP4)** ~10%

- **Cyclist intention detection (WP5)** ~15%
  - Intention and interaction models of cyclist can improve tracking of objects in a critical situation

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Thank you for listening!