University Defence Research Collaboration (UDRC)
Signal Processing in a Networked Battlespace

Context-driven Behaviour Monitoring and Anomaly Detection

E_WP4 Researchers: Rolf Baxter, Puneet Chhabra,
James Hopgood, Neil Robertson, Andrew Wallace

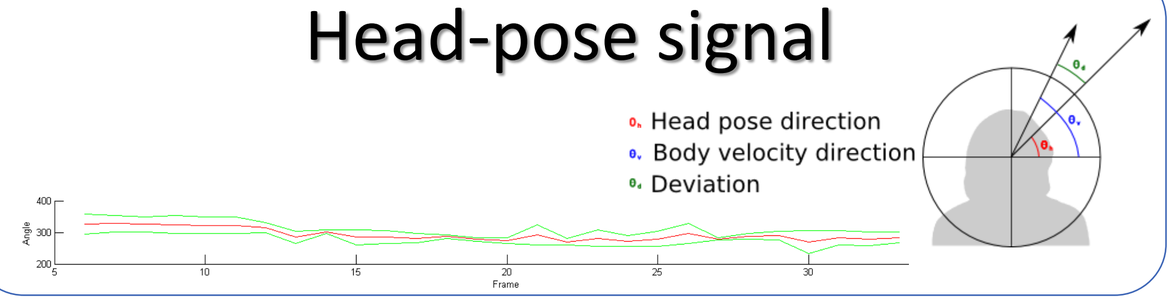
Abstract

We focus specifically on the problems of using electro-optic (video, IR, LiDAR) and audible data to monitor behaviour and detect anomalies. Building on recent work in audio-video tracking, we propose to use audio-video features to detect anomalies that are visually indistinguishable from normal behaviour. In combination with spatial, temporal, and social context models, we will show that subtle anomalies can be detected, and that tracking can be improved by feeding back behaviour inference to low-level tracking algorithms.

Background

- Subtle anomalies are difficult to detect due to a low signal to noise ratio.
- By building better models of normality this ratio can be improved.
- We are currently investigating ‘intentional priors’ as a means of making better behaviour predictions.
- Intuitively, people tend to look where they are going and we have been pursuing head-pose as an informative intentional prior for person behaviour tracking.
- Using head-pose we can make better motion predictions.
- This theory generalises: Consider a vehicle indicating, contextual information facilitates better predictions.

Head-pose signal



Research objectives

- Use temporal, spatial and social context to build better models of behaviour normality.
- To integrate different contextual behaviour models into a unified anomaly detection algorithm.
- To close the loop between contextual behaviour modelling and tracking, using predictions about future behaviour to improve tracking and detect anomalies.

Experiments

Head-pose behaviour

- Analysis of pedestrian behaviour to validate the hypothesis that people look where they are going.

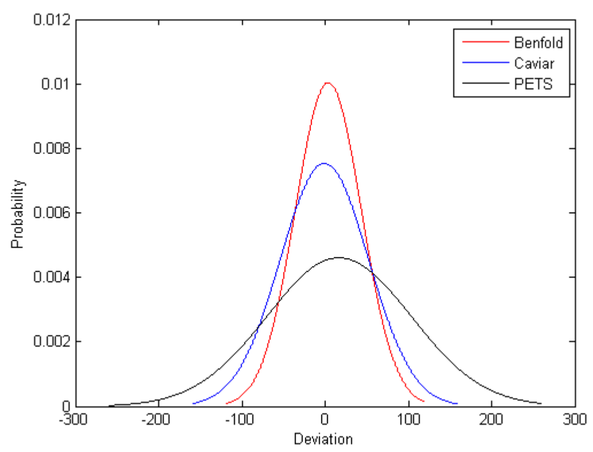
Intentional tracking

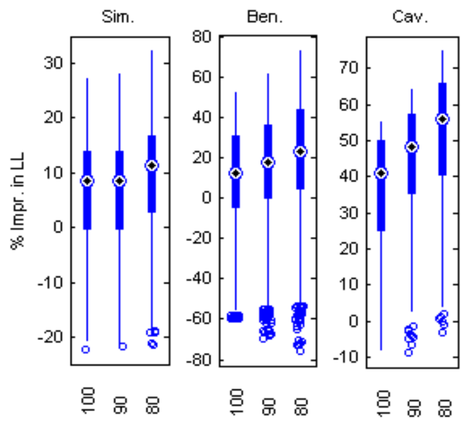
- Fusion of head-pose into the Kalman Filter (KF) prediction step.
- Comparison of tracking performance with and without head-pose information using public video datasets.

Anomaly detection

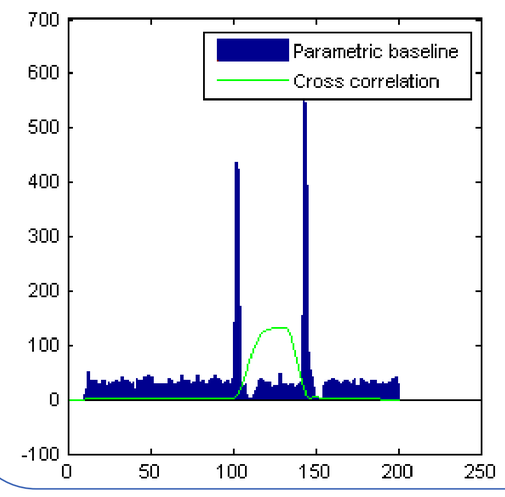
- Analysis of tracking error (measurement innovation) as an anomaly signal.
- Increases can be identified using cross-correlation and indicate that ‘something interesting’ (potential anomaly) is happening.

Results & Future Work





- **Above-left:** Pedestrian head-pose deviations for 3 video datasets. **Above-right:** Tracking improvement by our intentional tracker vs. a standard Kalman Filter at different detection rates.
- **Below:** Anomaly signal for somebody looking over their shoulder.



Future Work

- Develop algorithm for segmenting the anomaly signal.
- Addition of spatial and temporal context to allow better behaviour modelling.

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