Anomaly Detection in Video

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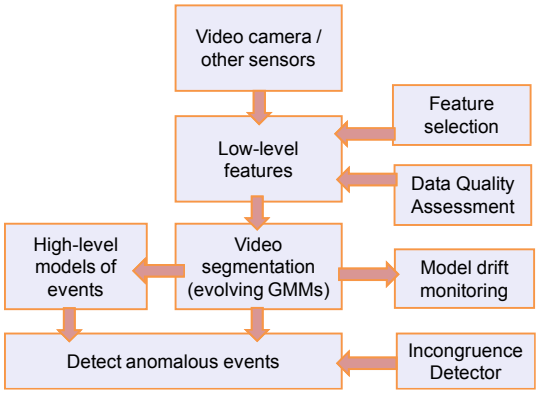
Problem

- **Aim:** Develop an accurate, data-driven anomaly detection method which is computationally efficient, can incorporate domain knowledge to detect anomalies in video.

Proposed System for Anomaly Detection

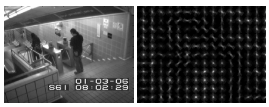


Anomalies: Examples which do not fit the model of normal behaviour (*outliers)*

Low-level feature extraction

- VIRAT dataset, Histogram of Oriented Gradient (HOG) features

- Technion Subway dataset, HOG



- Flower sequence, learn GMMs from L*a*b* colour space features

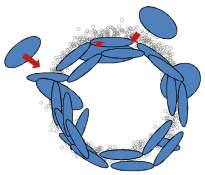
Incremental Learning

- **Main idea:** Adjust what has been learned according to new examples
- **Why?**
  - ➢ Update domain knowledge
  - ➢ Efficient Learning (computer memory, time)
- **How?**
  - ➢ Evolving statistical models (GMMs/HMMs)
    - Access to all data simultaneously not required
      - – Less memory
      - – Parallel processing

Algorithm Development

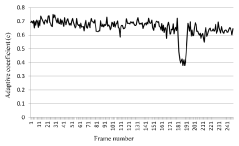
- **Step 1:** GMM concatenation

$$\theta_{encl} = \{ca_1, \ldots, ca_K, (1-c)a_1^{\prime(t)}, \ldots, (1-c)a_{K'}^{\prime(t)}, m_1, \ldots, m_K, m_1^{\prime(t)}, \ldots, m_{K'}^{\prime(t)}, C_1, \ldots, C_K, C_1^{\prime(t)}, \ldots, C_{K'}^{\prime(t)}\}$$



- **Step2:** Adaptive coefficient estimation for the evolving GMM

a. Detect change between frames X, Y by estimating Minkowski distance between colour histograms of frames *f(i;X), f(i;Y)*

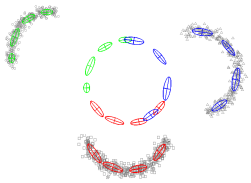


$$D(X,Y) = \left(\sum_i |f(i;X) - f(i;Y)|^p \right)^{1/p} \rightarrow L_1(t)$$

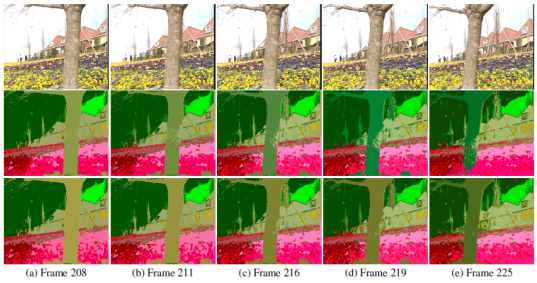
b. Estimate c as a linear function of $L_1(t)$

$$c = b_0 + b_1 L_1(t)$$

- **Step 3:** GMM merging Using EM algorithm



Experimental Results



Flower sequence http://media.xiph.org/
1: Original
2: Charron and Hicks, ICIP 2010
3: Our method

Future Work

- Focus on incremental learning of statistical models (GMMs) of video features
- Combine low-level statistical models of video features with high-level event models for anomaly detection
- Choose a suitable scenario and corresponding datasets, possibilities include:
  - ➢ existing publically available datasets
  - ➢ unusual behaviour detection in office environment (will need to generate in-house)
  - ➢ video streams from UAVs (in collaboration with Loughborough)