Generalized Background Subtraction Based on Hybrid Inference by Belief Propagation and Bayesian Filtering

Suha Kwak    Taegyu Lim    Woonhyun Nam    Bohyung Han    Joon Hee Han

Department of Computer Science and Engineering, POSTECH, Korea

**Problem**
- **Generalized background subtraction:** background subtraction for videos captured by a moving camera
- **Our method**
  - Probabilistic inference for motion models, which is insensitive to noises and occlusions
  - **Nonparametric belief propagation (NBP)** [1]
  - Reliable appearance estimation by prediction via motion and update with current observations
  - **Sequential Bayesian filtering**

**Initial Pixel-Labeling**
- **Motion segmentation**
  - Optical flow + epipolar const.

**Appearance Prediction via Motion**
- **Mixture of predictions**
  - Given a backward motion \( \tilde{v}_i \), appearance prediction for the \( i \)-th block at time \( t \) is given by

\[
p(\hat{H}(\tilde{v}_i) | \tilde{v}_i, M_{i-1}, J_{i-1}) = \sum_{k=1}^{N} p_k(\hat{H}(\tilde{v}_i) | M_{i-1}, J_{i-1})
\]

- **Appearance prediction via motion**
  - Mixture weights = expected responsibilities considering the motion models

\[
p(\hat{H}(\tilde{v}_i) | M_{i-1}, J_{i-1}) = \int p(\hat{H}(\tilde{v}_i) | v_{i-1}, M_{i-1}, J_{i-1}) \cdot p(v_{i-1} | M_{i-1}, J_{i-1}) \, dv_{i-1}
\]

**Experiments**
- **Hopkins–car1**
- **Hopkins–people2**
- **Skating**
- **Cycle**