Motion Detection is an important task for a vast number of computer vision applications. 

Goal: segment an image in a video stream into (moving) foreground and (static) background

Motion detection:

Motivation

- Motion Detection is an important task for a vast number of computer vision applications.
- Goal: segment an image in a video stream into (moving) foreground and (static) background

Shadows of moving objects:
- Shadows cast by moving objects are moving as well and are detected as foreground objects
- But: classifying those shadows as belonging to the foreground introduces problems:
  - object counting / connected component

The IHLS Background Model

The IHLS colour space

- Colours represented in terms of hue, luminance and saturation
- Assures, that
  - saturation of achromatic colours is always low
  - saturation is independend of brightness function

Saturation weighted hue statistics

- Hue information instable for weakly saturated colours
- Represent hue as Cartesian coordinates vector
- Weight vector by corresponding saturation
- Use Euclidean distance to compare chrominance vectors

Background model

- Mean luminance: \( \mu_y \) 
- Luminance’s standard deviation: \( \sigma_y \)
- Mean Euclidean distance: \( \sigma_D \)

Foreground check

- Observed pixel (luminance \( y_o \), saturation \( s_o \), hue vector \( \mathbf{h}_o \)) is classified as foreground if
  \[ \frac{|y_o - \mu_y|}{\sigma_y} > \alpha\sigma_D \quad \lor \quad \| \mathbf{h}_o - \mathbf{h}_b \| > \alpha\sigma_D \]

Shadow check (conducted on all foreground pixels)

- Pixel is darker
  \[ y_o < \mu_y \land |y_o - \mu_y| < \beta\sigma_y \]
- Colour is desaturated
  \[ s_o - S_{\text{inv}} < \tau_s \]
- Hue is similar
  \[ \| \mathbf{h}_o - \mathbf{h}_b \| < \tau_h \] where \( \mathbf{h}_b = \| \mathbf{h}_b \| \) reclassify as shadow

Experiments & Results

Methodology

- Competitors
  - State of the art algorithms
    - RGB background model + shadow check in HSV
    - RGB background model + shadow check in c1c2c3
    - RGB background model + shadow check in NRGB
    - Background modelling and shadow check in NRGB
- Performance metrics
  - Detection rate
  - False alarm rate
- In-depth evaluation
  - All parameters for each algorithm varied within the valid limits
  - Comparison via receiver operating characteristics (ROC curves)
- Test Sequences
  - 3 Sequences:
    - Stairway
      - Atrumatic scene
      - 31 groundtruth frames
    - Books
      - Colourful scene
      - 25 groundtruth frames
    - PETS2001
      - Standard scene for visual surveillance algorithms
      - 30 ground truth frames

Receiver Operating Characteristics

- Stairway
- Books
- PETS2001

Segmentation Results

- Ground truth:
- The proposed approach:
  - RGB+HSV
  - RGB+NRGB
  - NRGB+NRGB

Conclusions:

- Application of the advantageous IHLS colour space and saturation weighted hue statistics to visual surveillance
- In-depth evaluation of the developed algorithm and comparison to state of the art methods
- Evaluation has proven that the proposed approach is a meaningful way for motion detection and shadow suppression
- Algorithm satisfies real-time constraints (PAL-resolution, >25 frames per second)
- Published at IEEE Intl. Conf. on Signal and Image Processing (ICSIPO6, India) and EI. Letters on Comp. Vision and Image Analysis (ELClVA vol. 6 no. 3)

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