Video Summarization for Object Tracking in the Internet of Things

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Motivation

Building systems to monitor, trace and track objects is one of the fundamental issues in logistics.

- Video Surveillance
- RFID or GPS

Discovering important features in huge video content.

- Video Summarization
Problem
Since visual and RFID-based object tracking are used in IoT, is it possible to summarize the video on the item level?

- A, B & C: RFID-based object tracking system
- D & E: Video surveillance system
- G & F: Conveyor belt and object
Introduction

• Internet of Things
  – Item-level Object Identification
  – Positioning
  – Environmental Monitoring Applications
  – …….
Introduction

• Video Object Tracking
  – Object and Motion Detection
Introduction

• Video Summarization
  - extract an informative summary of video
Video Summarization for Object Tracking in the Internet of Things

The methodology (algorithmically)

• 1. Build the background with adjacent frames containing no objects in the screen.

• 2. Extract foreground areas (and connected components) from every frame.

• 3. Find valuable foreground areas (objects in the screen) using a clustering algorithm (K-means).

• 4. Stitch segments of frames to create a compact image as the summarization result.
Step 1: Background Estimation

• 1. Pick a group of frames containing no objects in the screen. IoT can easily acquire the time when objects are absent.

• 2. Build the background

\[ P(X_t) = \sum_{i=1}^{K} \omega_{b_i,b_m} \times \eta(X_t, \mu_{b_i,b_m}, \Sigma_{b_i,b_m}) \]
Inside Background Estimation

• The strategy to select frames is critical.

• Conventional GMM causes high computational cost due to the large number of selected frames.

• IoT can reduce this number.
Step 2: Foreground Extraction

1. Given the background, foreground areas can be established with pixels which cannot fit in.

2. Find the biggest connected component.
Step 3: Clustering Connected Components

1. It is necessary to keep important connected components (as well as to dump useless connected components). Hence, the K-means algorithm is used.
Step 4: Image Segments Stitching

1. When useful connected components are identified, the related parts of original frames can be extracted and stitched into a compact image as the summarization result.
Experimental Results

![Graph showing noise pixels of the conveyor belt for different frame sequences. The graph compares GMM and the proposed method.]
Conclusion

1. In IoT, it is possible to summarize the video on the item level.

2. Furthermore, IoT can improve the video summarization algorithms.
   - Lower computational cost
   - Higher summarization quality
Thank you!