In The Name of Allah

Digital Media Laboratory
Sharif University of Technology

Statistical Pattern Recognition

General Object Tracking by Detection

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http://ce.sharif.edu/courses/90-91/2/ce725-1/

Agenda

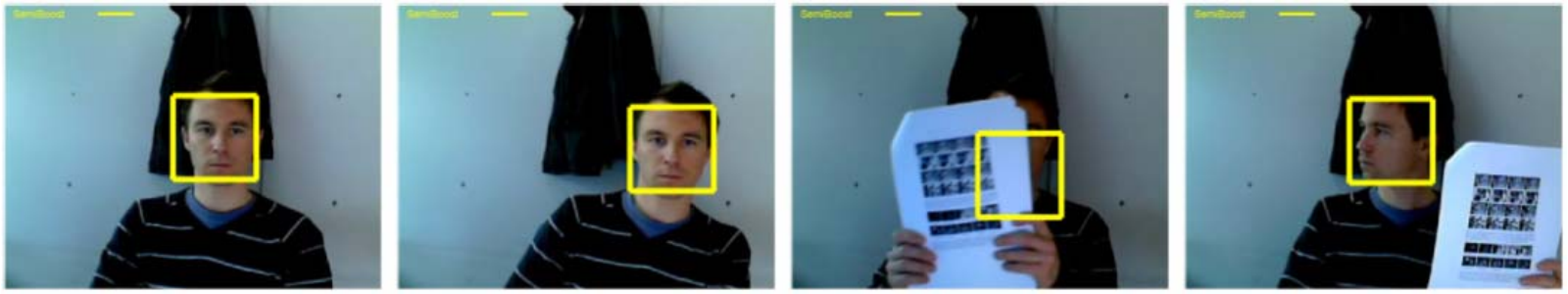
- Problem setup
- Tracking challenges
- Tracking by detection
- Generative model
- Discriminative model
  - Offline supervised tracking
  - Online supervised tracking
  - Online semi-supervised tracking

Problem setup

- **Tracking is the task of finding the object states from the observed image sequence.**
- **By object states we mean position, scale, velocity and other parameters characterizing the object.**
- **In our case:**
  - **The object position is selected in the first image**
  - **The tracker must detect the object position in upcoming image sequence**

Tracking challenges

- **The task is challenging because of:**
  - **Complicated object appearance changes which are difficult to model,**
  - **Background clutter which makes it difficult to distinguish the object from the background,**
  - **Complex non-linear dynamics, which makes it hard to predict the object state,**
  - **Occlusion which causes the observation to be noisy and incomplete.**



Tracking challenges

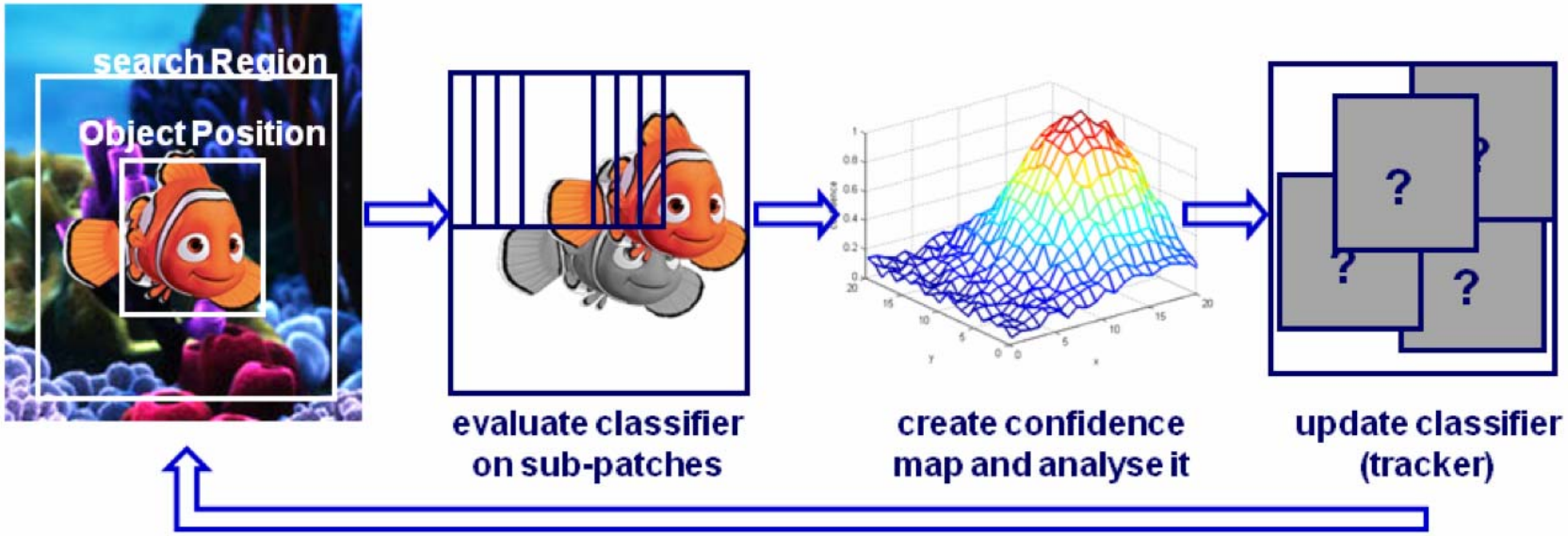
- **Drifting problem:**
  - Each time we make an update to our tracker an error might be introduced.
  - If errors accumulate over time then it may result in tracking failures.

Tracking by detection

- **Tracking by detection has the following steps:**
  1. **Calculate the region which is probable to find the object:**
     - It may be simply defined by enlarging the previous object region.
     - It also can be calculated based on motion models.
     - Size of search region affects the tracker performance.
  2. **Extract many sub patches from the search window.**
  3. **Create confidence map which measure the probability of being the target object for each patches.**
  4. **Select the most probable patches as target object**
     - To remove noisy prediction some smoothing step is required on the confiedence map.
  5. **Update the Tracker (if needed).**

Tracking by detection

- **Finding Nemo!**

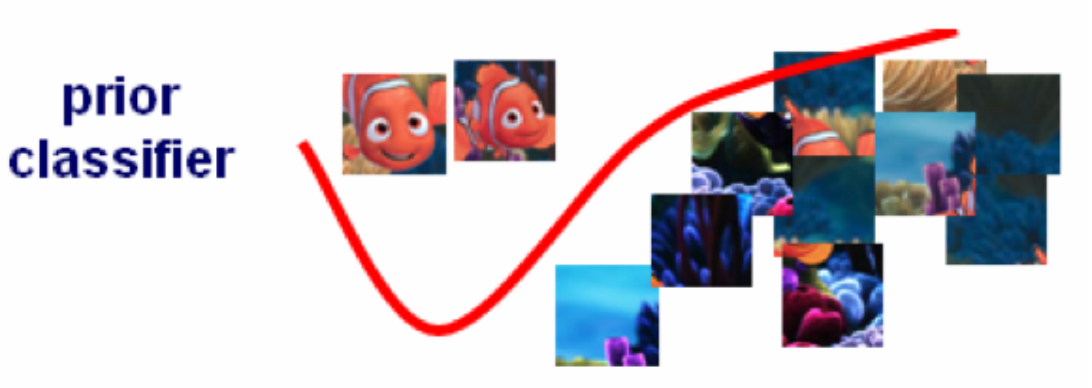


Generative model

- Tries to solve the problems by building a generative model to describe the visual appearance of the object.
- Finds the state which has the most similar object appearance to the model in a maximum-likelihood or maximum-a-posterior formulation.
- To accommodate appearance changes the object model is often updated online.
- Unfortunately, object appearance changes are highly nonlinear and difficult to model.
- An incorrect update of the object model may leads to the “drifting” problem.
- The main problem for generative trackers is that they rely on knowledge of the foreground only, completely ignoring the background, which is the main reason for the “drifting” problem.

Discriminative model

- **Discriminative trackers train a binary classifier to separate background and foreground patches.**
- **The positive patch with highest confidence selects as target object.**



Offline supervised tracking

- **The classifier train with target object in the first image as positive instance.**
- **The patches around the target object in the first image are used as negative instance.**
- **The classifier does not change during the tracking.**
- **Limitations:**
  - **All appearance variations need to be covered in advance which implies that the object to be tracked needs to be known beforehand. Tracking will fail if a variation of the object is not covered in the training phase.**
  - **Since the tracker is fixed it has to cope with all different backgrounds(which has not seen in training phase), therefore the classifiers are usually quite complex.**
- **Benefit:**
  - **The time is spent at the training stage and a fast classifier is available at the tracking stage.**

Online supervised tracking

- **In order to cope with these problems the tracker needs to be adaptive, i.e. classifier will change during the tracking:**
  - **The classifier finds the object at time “t”.**
  - **The target patch is labeled as positive and surrounding patches are labeled as negative.**
  - **The tracker train with new arrived labeled data.**
- **Many approaches are used so far:**
  - **Self training**
  - **Co-training (two independent feature extract form each patch)**
  - **Ensemble learning (an SVM is trained from each image and add to the ensemble)**
- **Using on-line adaptation we face drifting as the key problem (Why?)**

Online semi-supervised tracking

- **Labeled data is used as a prior and the data collected during tracking as unlabeled samples.**
- **This allows to formulate the tracker update problem in a natural manner.**

Any Question

End of Lecture

Thank you!

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