

Module

11

VIDEO INDEXING AND RETRIEVAL

Version 2 ECE IIT, Kharagpur

Lesson 40

Video Sequence Query Processing

Instructional Objectives

At the end of this lesson, the students should be able to

1. Define the query types in a typical video sequence
2. Outline the box – to – box matching and point matching
3. Define *good match* in a query processing system.
4. Define the box –to-box and point – to- point similarity measures.
5. Describe the algorithm for approximate box searching.

40.0 Introduction

Generally speaking, the time-series video content query is the problem of pattern matching with the help of indexing. Two steps must have been done before proceeding to the matching process ---

- (a) the choice of video content query type
- (b) the choice of query constraints

40.1 Query types

The contents of a video segment should be expressed in terms of a set of low level primitive features and / or combine low level features to form more complex high level semantics.

For example, we can specify the query “ A person walks on the side walk, then suddenly runs across the street and sits on a street chair by a high level query pattern” (Walk) (run) (sit)”. From the bounding box principle, no matter what kind of video content expressions, the query patterns are considered to be a sequence of values provided by query bounding boxes.

Multi level approximate queries of video segments can be divided into several categories:

40.2 Box to-box matching

- Existence matching

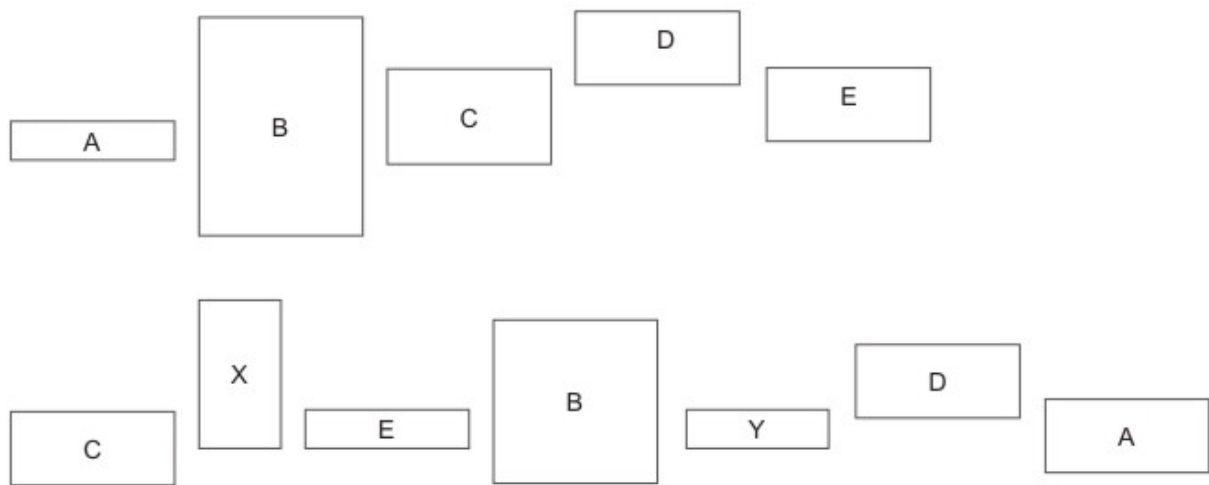


Fig. 40.1 Query pattern using existing matching.

Find those shortest sample box sequences that for each box in the query box sequence, there exists at least one box which has the same box type in the matched sample sequence. The order of box type in the matched sample sequence can be neglected.

- Sequence matching
 - Case – 1 : Exact sequence matching – exact one to one mapping
 - Case – 2 : Partial order matching – can have a redundant pattern within the sample sequence.

40.3 Point to point matching

- **Exact curve matching:** Find those sample sequences that the corresponding values are exactly the same as query types
- **Approximate curve matching with error tolerance.** Find those sample sequences such that the distance between query and sample sequences is within the tolerance of similarity threshold.

Both types of point-to-point curve matching are based on a definition of the good match.

40.4 Good match Criterion

Definition –40.1 : Given two sequences of patterns

$$X = x_1 x_2 \cdots x_n \quad (\text{sample pattern}) \text{ and}$$

$$Y = y_1 y_2 \cdots y_m \quad (\text{query pattern})$$

over an infinite alphabet of real numbers, where n and m are the respective lengths of sequences X and Y , if there exists a position (alignment) K in X such that for each pair of corresponding alphabet in these two sequences the similarity measure is smaller than the similarity threshold τ , then the subsequence $X' = x_k x_{k+1} \cdots x_{k+m-1}$ is a good match with Y .

40.5 Query constraints and similarity measure of query types :

The query result for each query type by some specific query constraint is a set of qualified candidates and the candidates' similarity factor. The result returning from the filtering process of query constraint is a list of qualified candidates that have perused all the checking of the selection conditions. The similarity factor (or the accumulated penalty) is the summation of similarity measures between the query pattern and the qualified sampled pattern for the selected query types.

Definition-40.2 (point to point similarity measure)

The point-to-point similarity (point to point distance) of a specific view between two video frames at time t_i and t_j is defined as

$$S_p(V_1, V_2, A, t_i, t_j) = \left| E(V_1, V_2, A, t_i, t_i) - E(V_1, V_2, A, t_i, t_j) \right|$$

where t_i determines the frame in sample video sequence V_1 and t_j determines the frame in query video sequence V_2 . A is the set of features.

Definition-40.3 (box – to-box) similarity measure)

The box –to- box similarity measure of a specific view between two bounding boxes b_i and b_j is defined as

$$S_b(V_1, V_2, A, C, b_i, b_j) = \sum_{k=1}^n \text{Penalty}(C_k, b_i, b_j)$$

where b_i and b_j are bounding boxes of sample video sequence V_1 and query video sequence V_2 , respectively. C is the set of n query constraints for this query. $\text{Penalty}(\cdot)$ is the penalty function for each specified type of constraint C_k .

Definition-40.4 : Similarity Relation:. The evaluation function $E(V_1, A, t_i, t_j)$ and $E(V_2, A, t_i, t_j)$ or bounding box b_i and b_j have the similarity relation \sim , if and only if

$$S_p(V_1, V_2, A, t_i, t_j) < \tau_p \quad \text{for point-to-point matching or,}$$

$$S_b(V_1, V_2, A, C, t_i, t_j) < \tau_b \quad \text{for box-to-box matching}$$

where τ_p and τ_b are the similarity threshold of point – to- point matching and box – to box matching respectively.

40.6 Matching strategies and box-to-box approximately matching

In the matching processes, we first divided the query sequence into its bounding box representation from. Then, these bounding boxes are compared with the sample sequence in the video information system with the help of an index structure. No matter, what kind of query type it is, either box –to-box or point-to-point basis, we always start our matching process from an approximate box searching approach, as shown in Algorithm-1.

Algorithm-1 : Approximate Box searching

Input: A sequence of bounding boxes with related box information corresponding to query sequence, an index structure, and similarity threshold.

Output: A list of similar subsequences with good match criterion.

Method :

find first bounding box with connecting type 1,2, or 3

search index structure by prominent point value of the first bounding box to find the link list of the starting position of candidates boxes.

for each of the candidate boxes

if a consecutive sequences of boxes related to the candidates starting box satisfy the query constraints,

then print out the sequence ID, starting position and similarity factor.

end- of-if

end-of –for

End-of Algorithm Approximate Box Searching.

This approximate box checking algorithm acts as a filter to quickly reduce the number of possible candidates and generates a candidate set as the result of query constraint checking. Notice that false alarms are possible in these steps, but no false dismissal will occur. Further processing of the candidates set is necessary to avoid mismatching.