An Efficient Index Structure for Large-scale Geo-tagged Video Databases

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Introduction

- **Motivations:**
  - Mobile videos are prevalent
  - Rich sensors are available
  - Video frame-level geo-tagged (FOV) model
  - Spatial queries on videos are demanding,
    e.g., find videos at the University of Southern California.
  - Casual recording
  - Orientation
  - Pie-shaped
  - Directional relationship; Direction-aware queries; Moving directions.

- **Related work on directions**
- **Related work on geo-tagged video**
- **Related work on geo-video modeling and representation**
- **Related work on directions**
  - Directional relationship; Direction-aware queries; Moving directions.

- **Problem:**

  - Problem of video index and search
  - Problem of FOV index and search

  ![Field Of View (FOV) model](image)

- **Challenging characteristics of FOVs:**
  - Pie-shaped
  - Large dead space in the MBR
  - Orientation
  - No orientation optimization
  - Casual recording
  - No pattern for condensed storage

Spatial queries on geo-tagged videos

- **Range queries**
  - E.g., search videos in an area at the USC.

- **Directional queries**
  - E.g., search videos that shooting the North.

Related Work

- **Related work on geo-tagged video**
  - Geo-video modeling and representation
  - Geo-video indexing and querying (e.g., R-tree, Grid-based index [1])

- **Related work on directions**
  - Directional relationship; Direction-aware queries; Moving directions.

  ![Various moving trajectories and view orientations](image)

Existing Indexes

- **R-tree**
  - Range query $q_r$
    - unnecessary visit: $R_1, R_4, f_3, f_6, f_7$
  - Directional query $q_d$
    - unnecessary visit: $f_3, f_6, f_7 > f_8$
  - Drawbacks
    - Large “dead space”
    - Large MBR
    - No orientation filtering
    - No orientation optimization

- **Grid based index [1]**
  - A three-level grid-based index based on viewable scene, camera locations and view directions.
  - Drawbacks
    - Store location and orientation info separately
    - Not suitable for indexing FOVs with various zoom levels
    - Perform poor for skewed distribution of FOVs

- **OAR-tree (Orientation Augmented R-tree)**
  - Store smaller MBRs
  - Incorporate orientation into the index nodes for filtering

- **DO2R-tree (Distance O2R-tree)**
  - Distance optimization
  - Orientation optimization

![An R-tree indexing a set of FOVs](image)

Experimental Results

- **Observation**
  - O2R-tree and DO2R-tree significantly outperform the baseline indexes for both range and directional queries.
  - OAR-tree outperforms Grid slightly for directional queries and even performs worse than R-tree for range queries.

  ![Illustration of optimization criteria on view distance](image)

  ![Varying dataset size for range queries](image)

Conclusion and Future Work

- We proposed a class of new index called OR-tree for efficient geo-tagged video search.

- Future directions: 1) cloud FOV indexing and 2) batch insertion and update of videos.

Acknowledgements

This research has been funded in part by NSF grant IIS-1320149, the USC IMSC, and unrestricted cash gifts from Google and Northrop Grumman. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of NSF.