



Introduction

Sensor-rich mobile videos

- Videos recorded using mobile devices (e.g., smartphones) in a casual way (e.g., street shot).
- Videos recorded automatically getting geo-metadata (e.g., locations, directions, etc.) from GPS and compass sensors.

Range temporal queries

- Given a query circle, and a time period, they are finding all the video frames that are overlap with the query circle and their timestamps are within the time period.

Applications

- Event detection. E.g., finding crime events from the videos taken by passerby in the same time period and location of the crime.

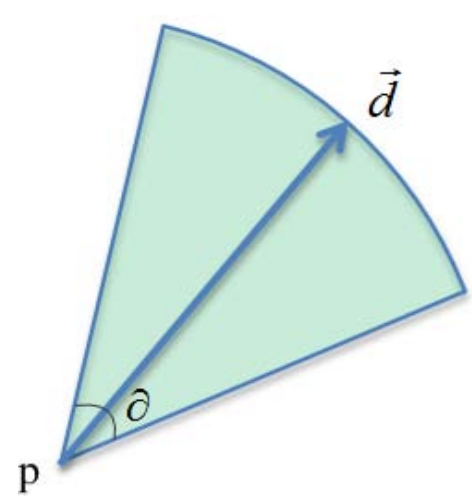
New features of this work

- Treating a video as a set of video frames, i.e., our queries are based on the video frames instead of the entire video, and can exactly return users their specified video segments.
- Accelerating query processing by making full use of the video geo-metadata.

Preliminaries

FOV model

- A video as a set of video frames
- Each video frame is modeled a *Field Of View* (FOV) based on the metadata (location, orientation, timestamp, etc.) of the video.
- Note the size of \vec{d} is the maximum visible distance, and the orientation of \vec{d} is the view direction.



p : camera location
 \vec{d} : camera direction vector
 α : viewable angle
 t : timestamp

Figure 1: FOV Model

Query Processing

Range temporal queries

A FOV f overlaps query circle q are in two cases:

- Case 1) camera location p is within the query circle, as shown in Figure 2(a)
- Case 2) p is outside of the query circle q , f partially overlaps with q , as shown in Figure 2(b)

- Circle p intersects with circle q , and
- $\text{Angle}(\vec{d}, pq) < \frac{\alpha}{2} + \frac{\beta}{2} = \frac{\alpha}{2} + \text{acos}\left(\frac{\text{dist}(p,q) - r}{2R}\right)$ where, $\frac{\beta}{2} = \text{acos}\left(\frac{|op|}{R}\right) = \frac{|pq|}{2R} - \frac{r^2 - R^2}{2 * |pq| * R}$



Figure 2: Circle range queries

Query video results representation

- Query results are composite of video segments, each of which is a set of continuous video frames in the same video.
- For example, as shown in Figure 3,
 - For query q_1 , all the frames f_1, \dots, f_{10} are results, then the entire video (V, t_1-t_{10}) is returned.
 - For query q_2 , two groups of video frames f_1, f_2, f_3 , and f_9, f_{10} are the results, then video segments (V, t_1-t_3) and (V, t_9-t_{10}) are returned.

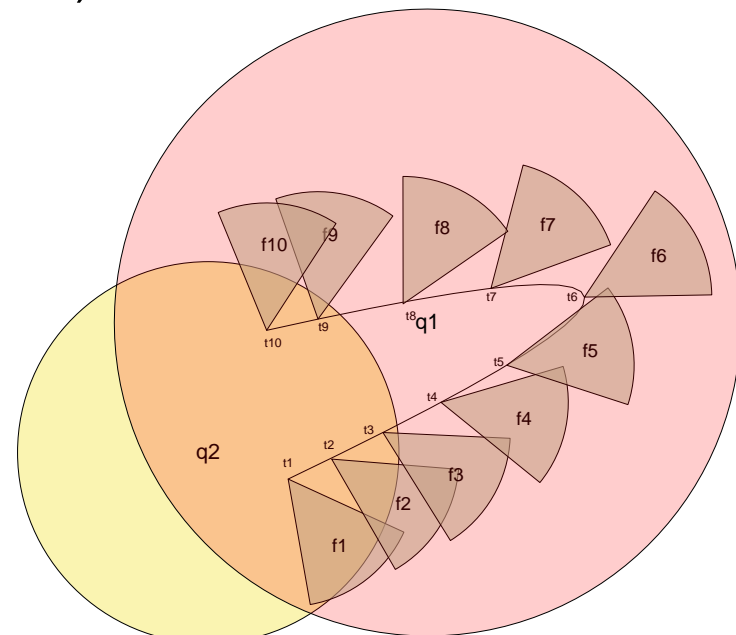


Figure 3: Circles q_1 and q_2 are two query circles, sectors f_1, \dots, f_{10} are ten video frames in a video V , and t_1, \dots, t_{10} are corresponding timestamps of the frames in the video V .

System Architecture

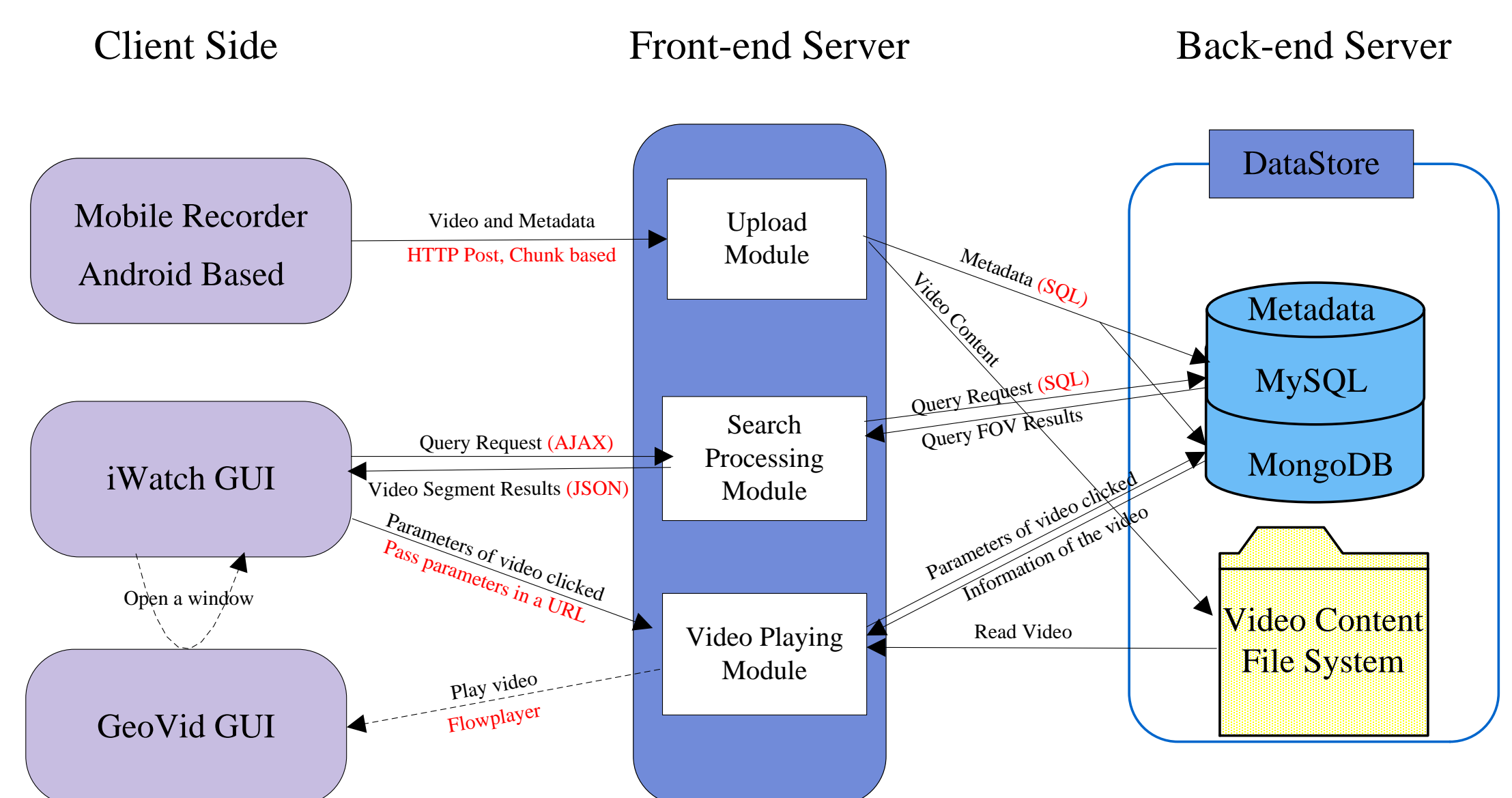


Figure 4: Architecture

Client side

- Video record & upload. Android based video record application.

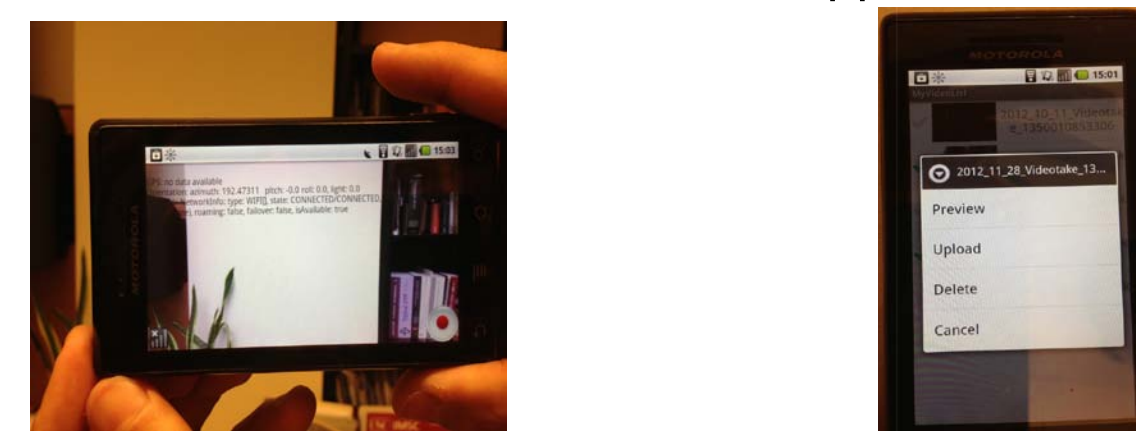
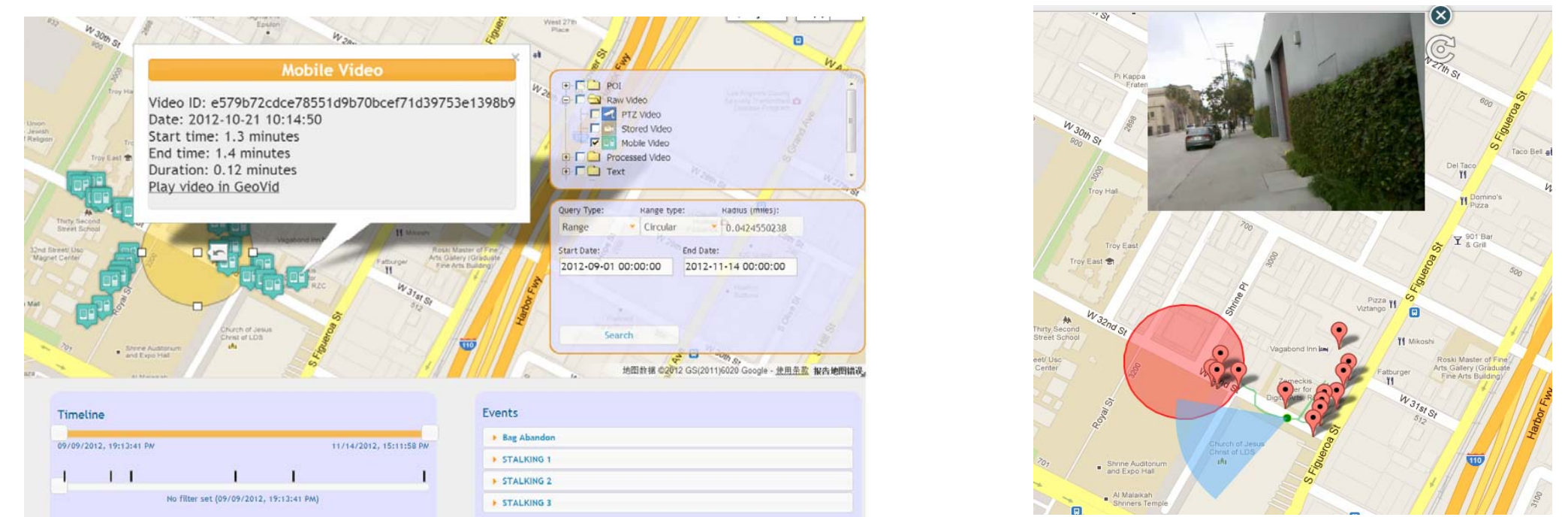


Figure 5: Video record

- iWatch GUI and Geovid GUI



(a) iWatch Search GUI

(b) Video play on Geovid GUI

Figure 6: iWatch GUI and Geovid GUI

Front-end server

- Video playing module: HTML5 < video > tag technique.

Back-end server

- MySQL: Used to index FOVs for fast query processing.
- MongoDB: More scalable for large number of video datasets. We get the metadata information (e.g., trajectory, directions) of the result video clicked by users from MongoDB.

Related Research

- Sakire Arslan Ay, Roger Zimmermann, Seon Ho Kim: Viewable scene modeling for geospatial video search. ACM Multimedia 2008: 309-318.
- Beomjoo Seo, Jia Hao, Guanfeng Wang: Sensor-rich video exploration on a map interface. ACM Multimedia 2011: 791-792.
- Beomjoo Seo, Weiwei Cui, Roger Zimmermann: An experimental study of video uploading from mobile devices with HTTP streaming. MMSys 2012: 215-225.
- Jia Hao, Guanfeng Wang, Beomjoo Seo, Roger Zimmermann: Keyframe presentation for browsing of user-generated videos on map interfaces. ACM Multimedia 2011: 1013-1016.

Conclusion and Future Work

- In this work, we exactly answer range temporal queries on mobile videos by making full use of the geo-metadata of videos, and their geometric properties.
- In future, we will consider range temporal queries on mobile videos in real time.