Multimedia Travel Story Retrieval using Location Data and Spatial Queries

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Abstract. We propose a system for retrieving multimedia related to a person's travel using location data captured with a GPS receiver, mobile phone or camera. The user makes simple sketches on a map displayed on a computer screen to submit spatial, temporal and spatio-temporal queries regarding his travel. The system segments the location data and images, analyzes sketches made by a user, identifies the query, and retrieves relevant results. These results, combined with inline maps and virtual tours rendered using street view panoramas, form multimedia travel stories.

1. Introduction

People create digital travel photo albums to preserve the good memories of their trips and share the experience with others. Selecting photos relevant to a specific trip has to be done manually and consumes time. GPS receivers, mobile phones and new models of digital cameras support location data acquisition during travel. Online travel blog sites such as *EveryTrail* facilitate creating "trips" combining photos and continuously recorded location data. However, intuitive and nonrestrictive input methods are necessary to facilitate entering *spatial* queries such as "Photos that I took when I traveled from Kyoto to Himeji", for fast creation of travel photo albums.

This paper presents an interactive system that dynamically creates multimedia travel stories by combining photos and location data captured during travel. The user makes simple sketches on a map displayed on the screen, to specify the trip for which the story is to be created. The system interprets the sketches and retrieves the corresponding photos and location data. It also queries online multimedia collections for maps and panoramas. The data are combined using a visualization that creates a multimedia travel story that is easy to view.

2. User Interaction for Querying

The proposed system supports spatial queries that specify information related to locations and paths, and temporal queries that specify time intervals for retrieval. It is also possible to submit spatio-temporal queries that combine both types.

The user submits spatial queries by making a sketch, using a mouse or a stylus, on a map displayed on the user interface. For this interaction strategy to be effective, the sketches should be intuitive, simple and unambiguous. We define three types of spatial queries to represent travel patterns. The first type specifies staying or traveling within a given region. We provide two methods to specify a region. In the first method, the user specifies the region by positioning a semi-transparent circle over it (Figure 1a). The circle can be moved by clicking the left mouse button on it and dragging it. The size of the circle can be changed by rotating the mouse wheel. For a more accurate specification of a region, the user can sketch a closed curve around it (Figure 1b). The second type

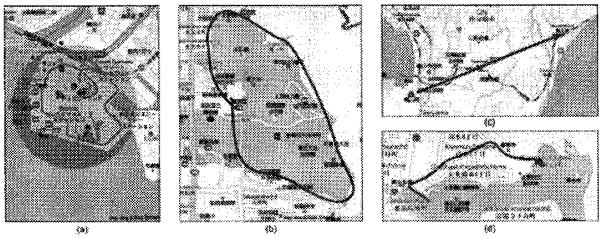

Figure 1: Different types of spatial queries.

specifies movement between two locations, irrespective of the path taken. The user draws an arrow from the originating location to the destination, by clicking the two locations in the correct order (Figure 1c). The third type specifies a specific path. The user draws the path that he/she wishes to retrieve, on the map. The path can be drawn either by making a freehand sketch (Figure 1d), or clicking on points along the desired path to join them with straight line segments.

Temporal queries too can be specified using sketches, making the interaction consistent with spatial queries. The users sketch on a calendar-like interface to select duration to retrieve data from. Temporal querying is facilitated using two additional methods, to allow easier input and flexibility. The user can choose some frequently-used 'relative' time intervals (such as "last month") directly from a combo box. In addition to the above easy-to-use methods, controls for custom querying are also provided in a separate tab.

3. Multimedia Retrieval

The first step of retrieval is to select images and location data for the time interval specified by the temporal query, if any. These results are used as the domain for the spatial query. If continuous GPS data are available, the system groups the GPS data in to non-overlapping *locomotion segments* 5.[1] before applying search algorithms. If location data are available only as image metadata, we cluster the locations using a self organizing map. The images in each cluster are ordered by time to form *sequences*.

The locomotion segments and the clusters of location data correspond to two types of locomotion; *moving* (changing location in a non-random manner) and *non-moving*. The segments can now be searched to retrieve multimedia relevant to the query. If continuous GPS data are available, the GPS data points in relevant segments

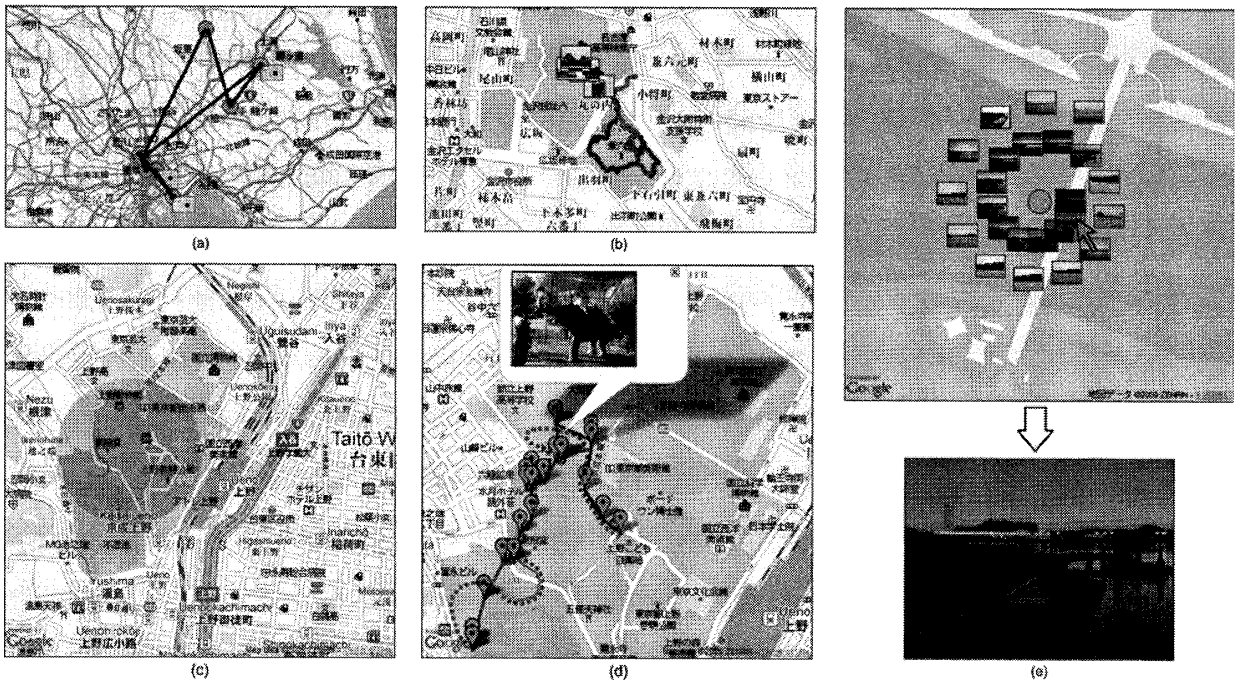

Figure 2: Example queries and results.

and photos taken during the timeframe of the segments are retrieved. Otherwise, photos corresponding to the relevant GPS point clusters are retrieved.

4. Visualization

The retrieved images and location data are combined with online multimedia content to visualize a travel story that is more pleasing and easier to understand than a slideshow. Maps extracted from the *Google Maps* database are used as the base of the travel story.

Figure 2a shows the results of a spatial query, when continuous GPS data were available. The locomotion segments retrieved by the query are shown as circles and arrows. The presence of the camera-like icon on a circle or an arrow indicates that photos have been taken during the corresponding segment. The user can select each segment to view more detailed results. Figure 2b shows the detailed visualization of a navigating segment. The location data plotted on the map change from blue to red with time, indicating the direction of movement. Figure 2e shows the detailed visualization for a non-navigating segment (corresponding to photographing New Year's sunrise). The photos are arranged chronologically on a spiral starting from the mean location of the segment, to minimize overlap. The user clicks on a thumbnail to get an enlarged view of the corresponding image.

For situations where only the location data within the image are available, a marker is positioned on the map showing the location of each image. The markers are joined by lines in chronological order, with the line color gradually changing from blue to red. Clicking on a marker shows the corresponding image. Figure 2c shows a spatial query for photos taken within "Ueno Zoological Gardens". The results are shown in Figure 2d. The dotted line indicates the actual path the user took during this trip.

For path-related spatial queries, we also create a movie-like 'virtual tour' (similar to driving along the path) of the path followed by the user. This is performed by estimating a set of locations and viewing angles by matching the location data with streets on the map, and then rendering a sequence of panoramas from the *Google Street View* database.

The system was tested on two photo collections. The first consisted of images captured using two digital cameras during 11 months. The location data for this collection were continuously archived using a handheld GPS receiver. The second photo collection was captured using an *Apple iPhone*, with location data embedded in images. Preliminary evaluations showed that it was possible to create travel stories quickly and easily using both temporal and spatial queries.

5. Conclusion

We have developed a system for creating multimedia travel stories with the aid of continuously captured or in-image location data. The sketch-based interaction strategy provides an intuitive and fast way to submit queries and retrieve results. The virtual tours created using street view can also be used as a travel guide.

References

[1] G. C. de Silva, T. Yamasaki, and K. Aizawa. Sketch based spatial queries for retrieving human locomotion patterns from continuously archived GPS data. In *IEEE Transactions on Multimedia.*

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