A Summarization and Visualization Technique for Traffic Paths

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1 Introduction

Observation of traffic paths of people is useful for various purposes, such as urban planning, security, investments for advertisements, and optimization of establishments. Recent computer vision and sensor technologies have realized very accurate acquisition of such traffic paths. There have been several reports on summarization of traffic paths of large number of persons, and some of the reports have shown the acquisition results. However, it may be difficult to look over the paths since many of the works directly draw them. We therefore think that visualization of summarized traffic paths is an interesting research topic. This poster presents a technique for summarization and visualization of traffic paths. The technique firstly quantizes the paths with a grid surrounding the 2D space, then collects the similar paths to construct clusters of segments of the paths, and finally draws the segments.

2 Related Works

2.1 Summarization of Traffic Paths

There have been several reports on summarization and visualization of traffic paths. Katabira et al. presented a technique that generates primary flows of crowds and then represents them as thickness-varied arrow curves [4]. Shen et al. presented a technique that summarizes the paths by constructing adjacent matrices and effectively visualizes them [5].

2.2 Clustering of Jammed Lines for Visualization

Huge traffic path data may construct collections of jammed lines. Readability of jammed lines is a common problem of information visualization techniques, and several works have addressed the problem. We are inspired by such works while developing the technique presented in this poster.

Several Parallel Coordinates techniques resolved the problem by applying clustering algorithms. Fua et al. presented a technique to cluster polylines of parallel coordinates [2]. Ellis et al. also presented a series of works on cluttering reduction [1].

In graph drawing area, readability of jammed edges is an important problem. Holten's technique addressed this problem by bundling edges of hierarchical graph data [3]. Zhou et al. also addressed the same problem, and presented a new technique [6] that clearly visualizes edges of geographic graphs without moving the nodes on the maps.

3 Proposed Technique

3.1 Path Data

We formalize a set of paths as $S = \{P_1, ..., P_n\}$, which P_i is a path, and n is the total number of paths. We suppose that a path consists of a sequence of passing points, $P_i = \{p_{i1}, .., p_{im}\}$, while p_{ij} is the j-th point of the i-th path, and m is number of points of the i-th path. The point p_{ij} contains the time t_{ij}, and x/y-coordinates x_{ij} and y_{ij} in a 2D space.

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We acquired the example of the traffic path data presented in this paper from movie files taken by a fixed camera. The presented technique summarizes the traffic path data by constructing clusters of similar paths, and draws them as a set of segments. Following sections describe technical components of the presented technique.

3.2 Path Acquisition

We can suppose the traffic path data is acquired from movies or sensor data, or calculated by computer simulations. We currently use the traffic path data acquired from movies. Our current implementation detects moving objects by Mean-Shift method, and assigns identical numbers to each of the objects. It then extracts positions of the moving objects in the image space for each frame.

3.3 Quantization

The technique then quantizes the set of paths. It maps a grid onto the 2D path space as shown in Figure 1(1), while we suppose intervals of grid lines are much bigger than average interval of the adjacent two points $p_{ij}p_{i(j+1)}$. It then calculates intersections between the paths and grid lines, shown as red circles in Figure 1(1). Let the intersections of the i-th path as $P'_i = \{p'_{i1}, .., p'_{il}\}$, while l is the number of intersections between the i-th path and grid lines. It then quantizes the paths by moving the intersections onto the vertices of the grid, shown as blue circles in Figure 1(1). Let the quantized intersections of the i-th path as $P''_i = \{p''_{i1}, .., p''_{il}\}$. Finally, it constructs the quantized paths by connecting the vertices of the grid, as shown in Figure 1(2). Here, double circles in Figure 2(2) denote that the quantized path passes these points twice.

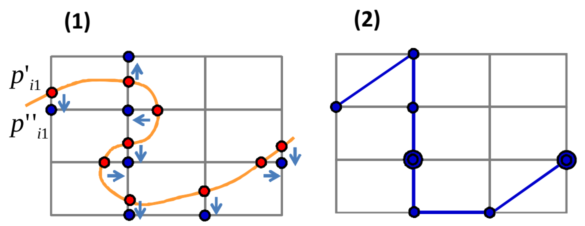

Figure 1: Quantization of paths.

3.4 Collection and categorization

The technique then categorizes the segments of the quantized paths for each rectangular space divided by the grid. Let the k-th rectangular space as r_k, and its four vertices as v_{k1} to v_{k4}. The technique collects all the intersection segments $p'_{ij}p'_{i(j+1)}$ of the all paths P_1 to P_n passing through r_k. It then categorizes the segments into 10 patterns r_{k1} to r_{k10} according to the combination of the two vertices of the segments after the quantization. Figure 2 denotes the 10 patterns drawn in 10 colors. Here r_{k7} to r_{k10} denotes the patterns that two end points of the quantized segments are same positions. Finally, the technique unifies geometrically overlapping categories. Suppose a rectangular space r_p and its lower adjacent r_q. The technique unifies the geometrically overlapping categories, r_{p1} and r_{q3}, r_{p7} and r_{q10}, r_{p8} and r_{q9}, respectively.

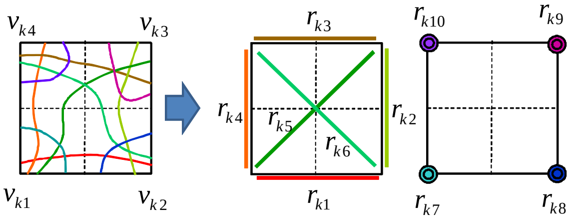

Figure 2: Patterns of path segments. (Left) Division of a rectangular space into four subspaces. (Right) 10 patterns according to quantized positions of start and end points of the segments.

3.5 Rendering

The technique then renders segments for each pattern of each rectangular space r_k. Here, the technique divides the process according to the number of segments. If a pattern r_{pq} has only one segment $p'_{ij}p'_{i(j+1)}$, the technique renders the segment as is. Figure 3 (Upper) shows an illustration that only one path is rendered. Remark that the technique renders the segments connected by the intersections before the quantization p'_{ij}. If the pattern r_{pq} has more than one segment, the technique calculates the average path of the segments and renders it. Figure 3 (Lower) shows an example of an average path. Here, a sky blue segment $p'_{i1}p'_{i2}$ and a green segment $p'_{j1}p'_{j2}$ are the two segments those vertices are quantized to the same two vertices p''_{i1} and p''_{i2}. In this case, the technique displays the average of the two segments, shown as a red segment in Figure 3 (Lower-right).

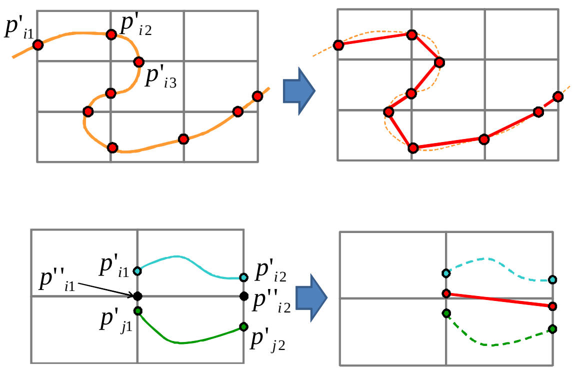

Figure 3: Rendering of segments. (Upper) It renders as is, if there is only one segment in the patterns. (Lower) It renders the average of renders, if the pattern has more than one segment.

4 Results

Figure 4(Upper) shows an example of captured paths. We recorded a movie file around a door of a cafeteria of a university for an hour, from the higher floor of another building. We then captured the paths of moving objects, and manually removed if the data contained the paths of non-human objects. Figure 4(Lower) shows a visualization result by the presented technique. It controls color and thickness of segments according to the number of passing persons, so that users can understand main flows of the traffic. The result shows that the technique effectively simplified the path data and highlighted major flows.

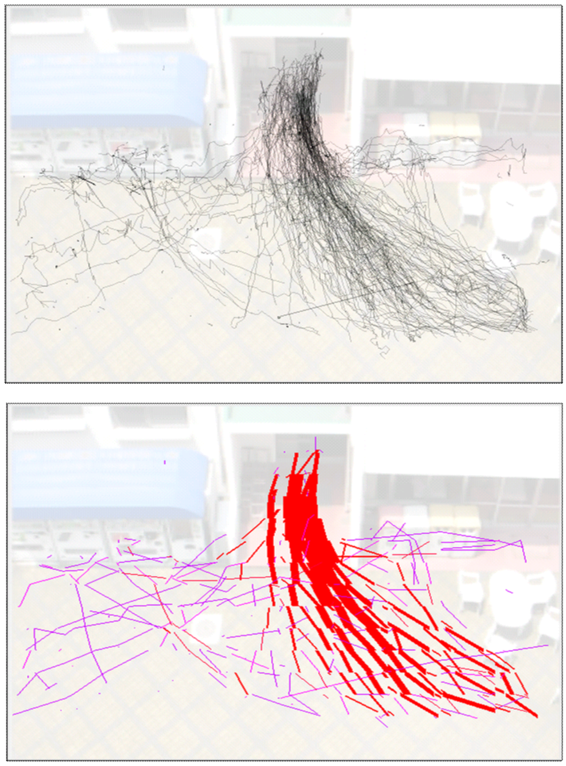

Figure 4: Rendering of segments. (Upper) It renders corresponding one segment as is. (Lower) It calculates the average of corresponding segments and renders.

5 Conclusion and Future Works

The poster presented a technique for summarization and visualization of large collection of traffic paths. As an on-going work, we are implementing a technique to convert the rendered segments into fewer numbers of smoothly connected curves. Another important issue is representation of direction of flows. Our current implementation does not consider the direction of segments during the categorization and rendering, so we would like to extend the implementation so that we can represent the directions.

The presented technique is not limited to path data obtained from movies. It can also visualize the sensor-based or simulation-based path data. We would like to apply such path data to the presented technique.

References

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