관광 지도 시각화

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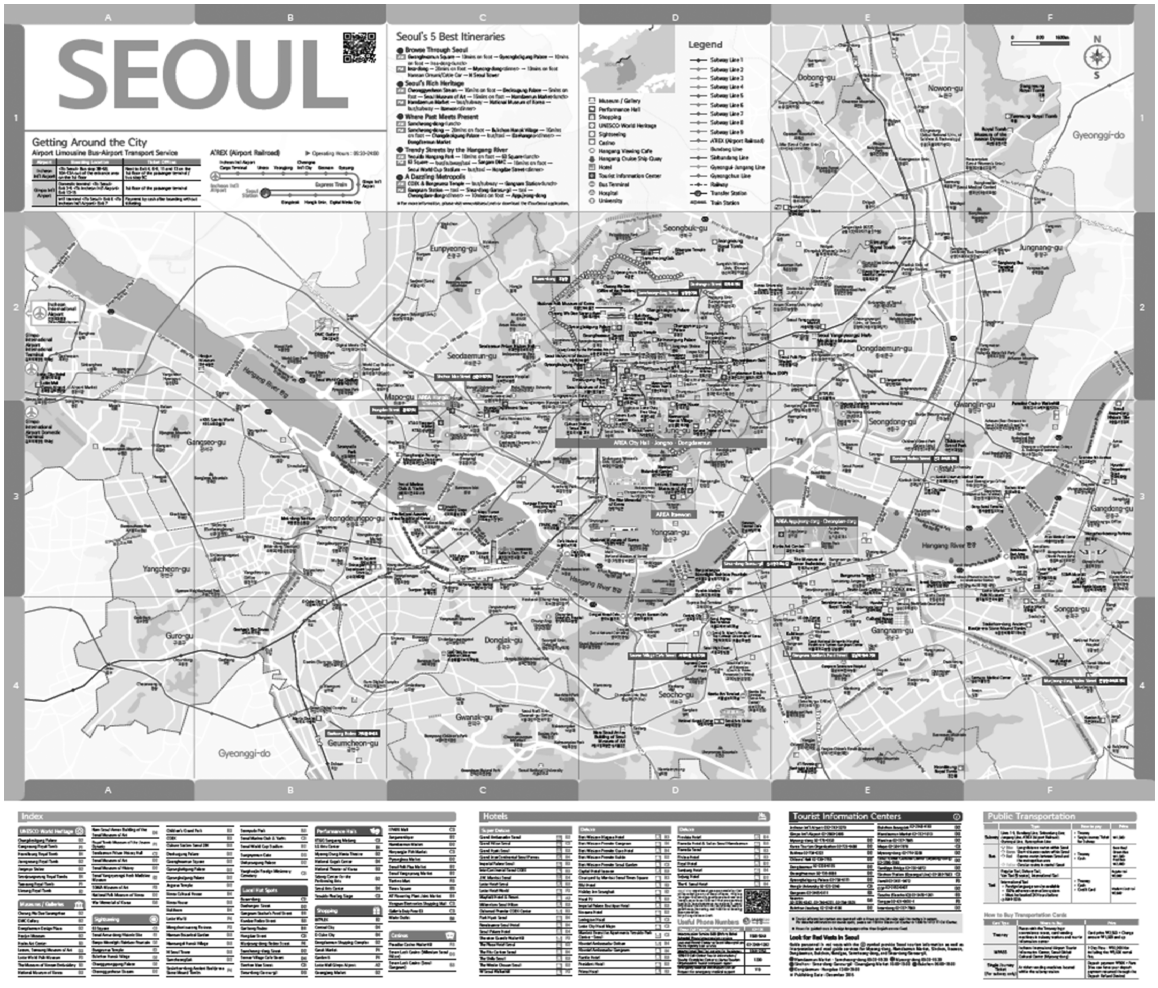

Fig. 1 Seoul paper tourist map (http://www.visitseoul.net/)

1. Introduction

For travelers, tourist maps are essential guides in unraveling a city. It gives an overview of a city's unfamiliar features by showing travel destinations and major thoroughfare. Traditionally, tourist maps are in a booklet format that is conveniently provided at stations or lodgings for presenting travelers a pocket guide and introduction to a city.

In a recent tourism study [1], it is considered that a tourist map helps three things: discover potential attractions, plan routes, and give spatial information. A tourist map influences the activities that travelers could do by controlling aspects of its objectives. Published maps are based on

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† This work was supported by MSIP/IITP R0101-16-0176.

various approaches whose effectiveness differs by catering to objectives. In this way, paper tourist maps have been a utility for travelers, but its static nature shows its limitations. With increase of ownership of mobile devices, travelers have learned to utilize general purpose digital maps to assist them in their travels, yet these digital maps have yet to fully address the tourist map objectives.

The ubiquity of mobile devices supports the wide spread of web services or apps utilizing the geo-spatial and social networking information. The data gathered can result in real-time changes in trends that can only be shown in dynamic representations. In this way, digital tourist maps can reflect time and location based information that enables the user to get personalized recommendations to attractions, routes and information. This article explores approaches to enhance tourism experiences by dynamic updating and adding interactivity to maps. We also cover approaches that augment the experience by highlighting helpful information through personalization, enhancing readability of map annotations, or deforming geometries.

Before going in depth, we would like to recall the contrasting properties of paper and digital tourist maps. Paper tourist maps are usually expandable-as-unfolded brochures that have a large display area for an overview map, close-up of smaller important areas, and a list of points-of-interest. Digital tourist maps can display the said paper map features too, yet in a smaller display area. In contrast to a static paper tourist map, dynamic digital maps make up for a small display area by a combination of basic functionalities like interactive zooming and panning, and level-of-detail hierarchies for visualization.

2. Map Information

As more map data have become more available and portable screens get ubiquitous, displaying digestible map information has also become a challenge. There are ways to display useful relevant information without presenting an overwhelming amount of data. Personalization of data can prioritize which information is useful to a specific user. Decluttering can filter out unnecessary elements and annotations in a map. Focus+context, a technique where significant elements are highlighted against a background of low-significance elements, can help users focus on essential information.

User personalization has been applied in many internet services based on preferences and browsing history. With mobile services increasingly integrating more as part of human lifestyle, movement behaviors of users can also be analyzed and thus be utilized for customizing a unique map information. For instance, Google has employed personalization of its search results based on a user's previous search history and recently applied this approach in their maps [2]. Their maps show a personalized set of landmarks and points-of-interest based on the user's profile.

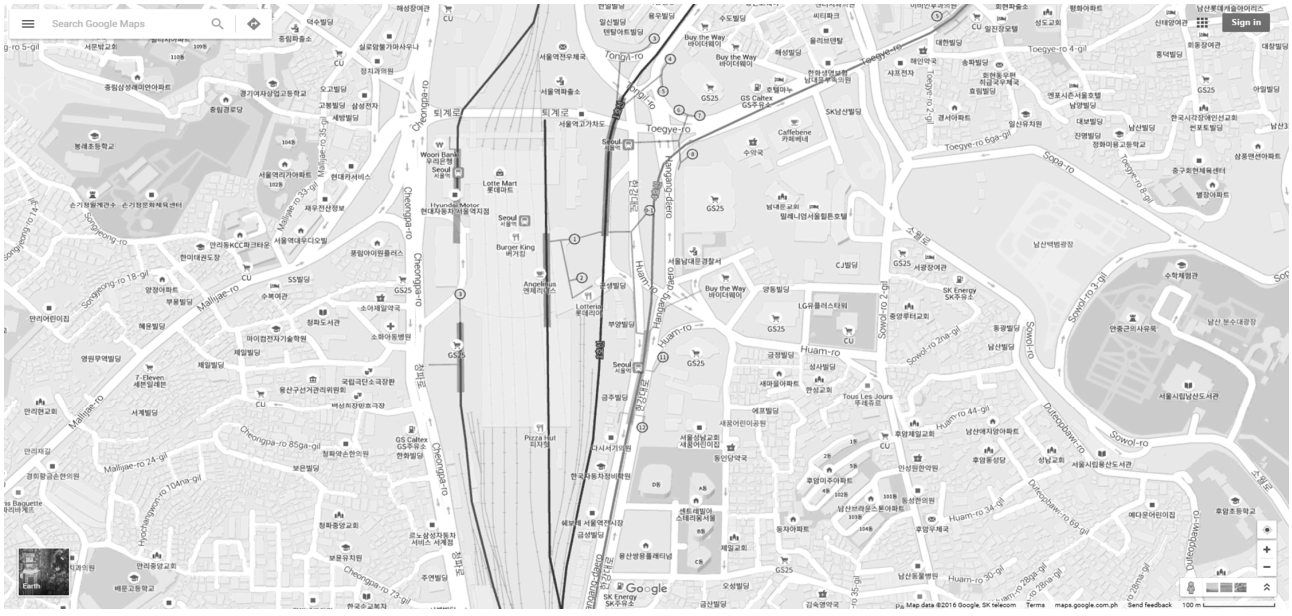

Fig. 2 Google Maps

Decluttering a map involves minimizing clutter that occurs when there is too much information in a map. Usually in this approach, elements with lower priority are removed or hidden from the view. In a work by Jaffe et al. [3], decluttering is applied to a map filled with geo-tagged images. They apply a significance function to determine priority and creates a clustering hierarchy to display only the top images in a specified area and view.

Focus+context has helped distinguish important regions against a backdrop. A common implementation of this in maps is by applying a fisheye lens [4] to enlarge focus regions by distorting map images. A similar approach of enlarging focus regions is shown to be applied to vector maps [5] without distorting road edges by defining an optimization framework with edge scaling objectives.

3. Discovering Points-of-Interest

Another essential function of tourist maps is showing potential points-of-interest (POIs) of a city. Correct, updated and verified information about POIs would help the tourist in planning a tour. A dynamic map can generate and update information about POIs by using multiple sources including social driven crowd-sources.

In representing POIs in a map, their annotations come in the form of representative text, image, geometry or symbol. The following examples describe approaches in helping users discover POIs in tourist maps.

Grabler et al. [7] describe an approach to automatically generate tourist maps with POIs that pop-out in 3D using POIs' pre-acquired building geometries. In addition, relevant POIs are selected by importance that can be set depending on information (user ratings, genre, etc.) gathered from internet sources or user preference. Following the style of some hand-drawn paper tourist maps, they render a 2D road map in an oblique / perspective projection that highlights the relevant 3D POI models.

In another approach, Claudio et al. [6] proposed a metro-centric tourist map that lets users discover POIs around the metro network. It highlights POIs by showing top ones with high significance values based on travel website rankings, proximity to metro, etc. An interactive interface that provides zoom and pan features lets the user change the view to reveal more POIs.

A work by Birsak et al. [8] tries to create automatic generation of tourist brochures and put the annotations around map boundaries. Multiple frames of maps are shown wherein a central overview map of the city is with marked areas whose close-up views are shown in smaller frames. Each frame has a set of pins showing relevant POIs in that specific view. A similar method of fetching relevancy of POIs from Internet sources are also applied in this approach.

***POI Annotation placement.** POI annotations can be placed in a map externally or internally. External annotations are conveniently put around the map boundaries and may be connected by 1) lines to the actual location or 2) respective symbols (number or letter) placed on the location. Internal annotations place them in the vicinity of the sources that allow for instant association of POI to the actual location in the map.

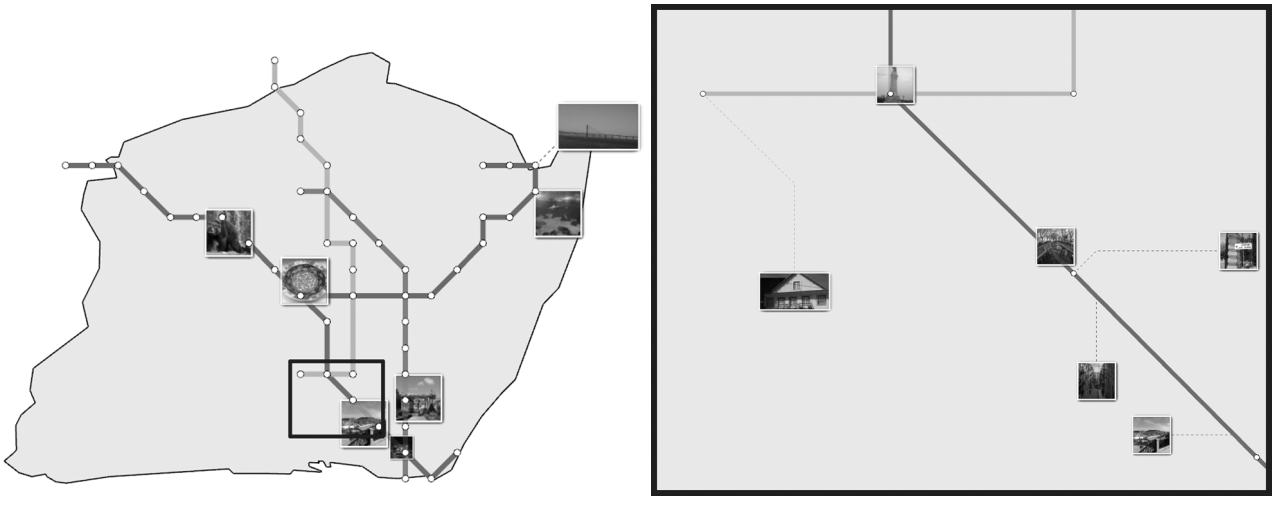

Fig. 3 Discovering POIs in an interactive tourist map[6].

4. Route Planning

There are two ways that tourist maps guide users in their route planning: by showing roads in the vicinity of POIs and by showing a transportation network (typically a metro). In dynamic maps, route planning is enhanced by highlighting the road or metro network through deformation of the map. It has been studied that deformation has been used to assist users in improving their cognitive tasks [9] in many different applications, e.g., road network and metro network map generations. Maps can be easily re-generated and customized as desired by using different parameters. In addition, performance improvement of map deformation has given a way to interactive explorations of such maps.

Road Map. In map deformation approaches, road networks are represented as graphs. In most applications, a set of design objectives is defined in order to control characteristics of layouts of road maps, and is modeled into a minimization problem.

In the work of Haunert et al. [5], regions of a road network are scaled to give focus to selected roads. Its road network graph is formulated as a quadratic programming problem. Its follow-up work [10] reformulates the problem as a linear programming problem to achieve interactive rates for small maps consisting of a few thousands of edges.

Agrawala et al. [11] and Kopf et al. [12] describe automatic approaches to generate route / destination maps, i.e., a map summary of directions to a particular point of interest. Given a set of selected roads, an optimized layout that rescales and reorients road edges is computed in order to increase the readability of these road maps. Similarly, in the work of Lin et al. [13], the goal is to create mental maps, aiming to help easily recall a featured area. The road map is deformed such that certain formations can be recognized from shapes of the streets.

Metro Map. Different approaches have been proposed for computing layouts for metro network [15]. Among them, octilinear layouts using diagonal edges as well as horizontal and vertical edges have been widely adopted for visualizing metro networks.

Automatic generation of octilinear metro map layouts has been studied in recent years. One of the initial works was of Hong et al. [16]. This approach utilizes mass spring techniques, where forces dictate relative positions to achieve octilinear layouts. Stott et al. [17] used a hill climbing algorithm to optimize the positions of the stations. Nollenburg et al. [14] viewed the layout problem as an optimization problem, and employed a mixed integer programming (MIP) approach to find a global solution maximally satisfying design constraints. Its resulting layouts show a strict compliance to octilinearity and feature almost uniform spacing. Similar MIP techniques have been used in related layout problems [18].

These introduced metro map layout generation techniques can then be utilized to generate a metro-centric tourist map. In this way, POIs near metro stations are connected by a line to annotations of POI which are placed externally[19] or internally[20, 6].

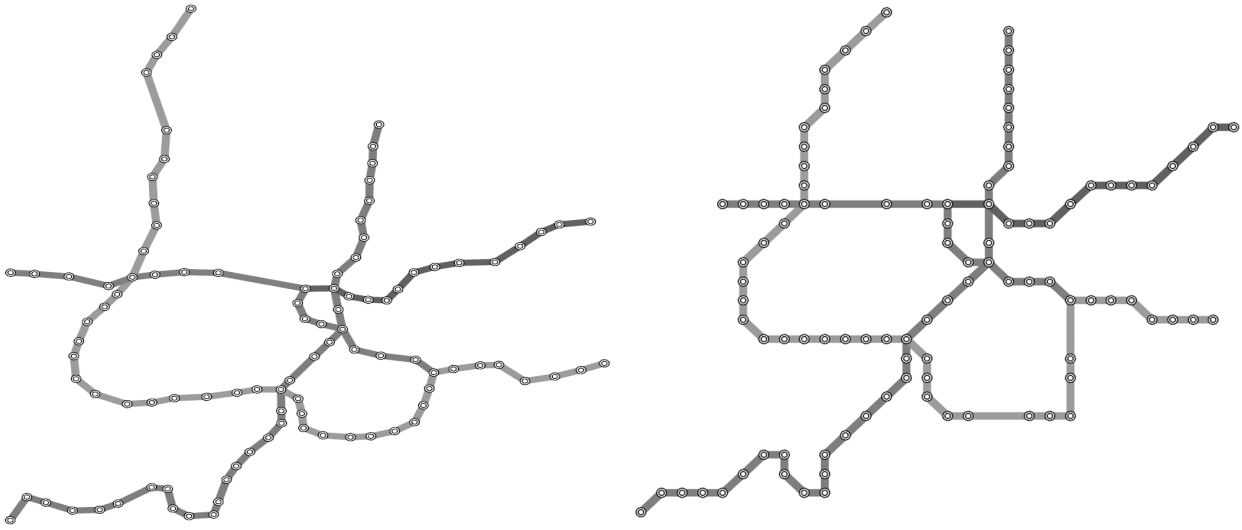

Fig. 4 Busan metro map deformation[14].

5. Conclusion

Creating an effective tourist map would assist a traveler in touring of a city: learn local spatial information, discover POIs and plan a route accordingly. Instead of going around using traditional paper tourist maps, an array of enhancements can be experienced through using a dynamic digital map that employs a combination of approaches described above. While some of the mentioned approaches can be also applied to preprocess maps for printing, they would be better suited in an interactive medium.

Personalization of maps not only applies to the information, but also to the type of map visualization that a user can interact with. This trend is just beginning to be utilized in changing map representations [21], as more freely accessible and updated map data arises. It is therefore useful to formulate fast map transformations that show specific maps for specific tasks [22].

Besides improving the main functions of a tourist map, there are many other ways to enhance maps like applying visual styles and themes [23]. Finally, digital maps can be combined with augmented reality and gamify touring similar to recent popular applications like Ingress and Pokemon GO.

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