略地図信憑性のための地理的特徴によるデフォルメ不整合分析手法

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1 Introduction

Digital maps are widely used for integrating content, for example, Google Maps, Yahoo! Maps and a web page of shop's access information. Users often use digital maps for planning travel, event, and so on. However, digital maps contain incorrect information because of delayed updating, mistaken making and intentional emphasizing. For example, a user may find a restaurant with a erroneous digital map, but that restaurant already have moved to other place. In this case, the user might end up stranded at the incorrect location they found on the map because that restaurant is not there. If modified map was reflected correctly to real world, user can get correct location. Therefore, a credibility analyzing method for digital map contents is needed.

Digital map contents available on the Web are two types. One is an online map, and the other is a modified map. Online maps are represented by Google Maps, Yahoo! maps, Bing maps and so on. The user can manipulate an online map interactively by moving, zooming-in, zooming-out operations, etc. This map contents is made for general-purpose. Therefore, object's shapes, positions and presentations are correct. On the other hand, modified maps are static pictures. That is, they are not interactive contents. Modified maps are made for specific purposes such as route guide, showing geographical objects' positions. Geographical objects on a modified map are able to be transformed by emphasizing and deleting for their own purpose. However, editors often added excess emphasizing and deleting for showing their purposes in some modified maps.

We consider that modified map credibility analysis consists of the consistency with real world and the consistency with a web page. In this paper, we explain the consistency with real world especially. The consistency with real world means that a modified map shows correct position of objects. We consider that detecting correctness of modification is needed at first. If we can analyze correctness of modified map, we can further develop a retrieving system for modified maps based on correctness ranking.

This paper is structured as follows. Section 2 reviews related works. Section 3 describes analyzing consistency.

2 Related Work

Methods for generating modified maps have been extensively researched. These researches can be divided to selecting objects, transforming objects' shape and arranging objects' position. At first, we describe about methods of selecting objects. Arikawa et al. [3] proposed detecting showed objects using ontology of geographical objects for adapting users purposes. Nakazawa et al. [1] developed selecting objects using attribute such as type, position, and so on. Then, we explain about methods of transforming objects' shape and arranging objects' position [2]. A major way is simplifying borders such as road, coastline, edge of building, and so on to straight lines and right angle based on cognitive science of maps. And then, objects are arranged by morphing techniques to adapt simplifying with distortion. These researches aim to generating wanted modified map by users. We aims detecting excess modifying for map credibility. In other words, our proposed method evaluates validness of map modification.

3 Analyzing Consistency with Real World by Online Maps

3.1 Consistency of relative distances

We explain the consistency of real world in detail. The consistency of real world is calculated by online maps that are as represented real world. In the modified map, we have to think over their modification. Therefore, we propose analyzing methods of relative distances and approximate positional relations. In this section, we describe the consistency of relative distances. The relative distance analyzes only order relations of distances between two objects. In other words, we check inconsistency of distance's length between modified map's objects and online map's objects.

Analyzing Consistency of Map Modifications based on Spatial Features for Information Credibility
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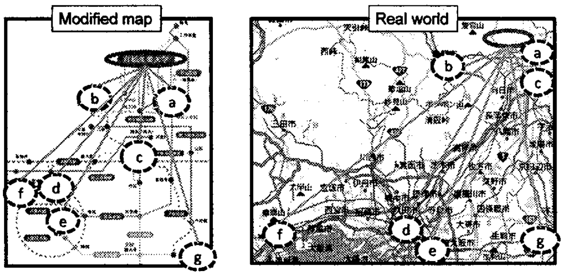

Order of distance	In modified map	In real world
1	a	a
2	b	c
3	c	b
4	d	g
5	e	d
6	f	e
7	g	f

図 1: An example of relative distances

We use following expression for calculation of relative distances.

$$Dist = 1 - \frac{6\sum dist_i^2}{n(n^2-1)} \times \frac{1}{2} \quad (1)$$

We use Spearman's rank correlation coefficient. Spearman's rank correlation coefficient returns score between -1.0 and 1.0. We use this formula as consistency of relative distance. Therefore, we divided by 2 for normalize. Where $dist_i$ is difference of order of two object's distance between a modified map and an online map. n is a number of object pares. Figure 1 shows example of relative distances. In Figure 1, a consistency of relative distances is 0.875. It means high consistency.

3.2 Consistency of approximate positional relations

In this section, we describe the consistency of approximate positional relations. The approximate positional relation analyzes only direction from two objects. We compare that directions are same or not between modified map's objects and online map's objects. In this time, far object from target objects is unimportant as approximate positional relations. Because of, if a position of far object is wrong, we can consider that this object's is changed by any modification. However, when a position of near object is wrong, we are tricked that their positions are correct.

We explain approximate positional relation as follows:

$$Pos = \frac{\sum_{o_i\in O}\sum_{o_j\in O, o_i\neq o_j} p(o_i,o_j)}{|O|^2} \quad (2)$$

$$p(o_i,o_j) = 1 - \sum_{o_k\in O, o_k\neq o_i\neq o_j} (c(o_i,d_j,o_k) \quad (3)$$

$$\times \frac{min(d(o_i,o_k),d(o_j,o_k))}{\sum_{o_k\in O, o_k\neq o_i\neq o_j} min(d(o_i,o_k),d(o_j,o_k))})$$

$$c(o_i,o_j,o_k) = \begin{cases} 1(\text{the same position on online maps}) \\ 0(\text{different position on online maps}) \end{cases} \quad (4)$$

where o_i, o_j and o_k are geographical objects. $d(o_i,o_j)$ is the distance between two objects. $p(o_i,o_j)$ calculates degree of positional correctness of an object pair. $c(o_i,o_j,o_k)$ returns 1 when these object ' s positional relations are the same relations on online maps.

4 Concluding Remarks

We proposed a method for analyzing credibility using analyzing consistency with real world. We define consistency with real world as relative distances and approximate positional relations. By this method, users know correctness as a map and validness as modifications.

We will develop a prototype system using our proposed method. In the future, we will also evaluate a method of each consistency analyzing measures. Furthermore, we will apply to retrieval system of modified maps based on correctness.

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