

## 相対空間参照を用いた写真内地図統合 Integrating Maps in Photos with Relative Spatial References

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### 1. Introduction

Signboard maps are widely distributed in public places, such as parks, subway stations, universities, and so on. Signboard maps are usually designed specially for the local area. POIs are usually highlighted in the maps. Many signboard maps are also drawn in an artistic way, and the mapping styles are various in different signboard maps. Except for the content, the locations of the signboard maps also provide rich information. The locations of the signboard maps are usually important places, such as the entrance of the facility and the place people easily miss the way. However, one of the disadvantage of the signboard maps is that they are not accessible anytime anywhere if users are far from them. To solve the problem, we propose a method to integrate the signboard maps in photos with digital maps to provide location based services with the signboard maps on smart phones.

### 2. Mapping Signboard Maps onto Digital Topographical Maps

An example of a signboard map we are going to integrate is a map of Kashiwa Campus at the University of Tokyo. We took the high resolution photos of the signboard maps in the campus. And we use a digital topographical map provided by The Geospatial Information Authority of Japan as the base maps.

We use the road intersection points as the control points of the photos. All the road intersection points are picked and are given the same coordinates as the corresponding points on the base maps. With the control points, we can map a user's location coordinates onto the photos including the signboard maps. However, factors such as the generalization, exaggeration, and the different of map projection used in the signboard maps make errors of the mapped user's location on the photo. And the errors of relative spatial relations, like locating the user on the wrong side of roads intersection, will easily mislead the users.

To ensure the relative spatial relationship of user's location with roads, we depict the roads on the photos, record their coordinates, and find the corresponding roads on the base maps. Instead of mapping the user's location directly onto the photos, we first map it onto the base map. Then we find the nearest road in the base map from the user's location. Then we map the location from the base map to the photo, so that the relative distance from user's location to the road keeps same and the foot point cuts the road with same proportion. As shown in the figure, AB and A'B' are corresponding roads in base map and in the photo, U and U' are the user's locations, V and V' are the nearest point on the road from user's location. Then,  $AV/VB=A'V'/V'B'$ ,  $UV/AB=U'V'/A'B'$ .

### 3. Integrating Multiple Various Signboard Maps

As we have mentioned, the locations of signboard maps themselves are usually important places. We annotate in each signboard map the locations of other signboard maps. By doing so, we do not only tell the users the locations of other signboards, but also composed different signboard maps, each may refer to a relatively small local area, to form a larger map. While the user is moving out of the current map, we zoom out of the current map and zoom into another map in which the user's location falls.

### 4. Conclusion

The signboard maps are generally more artistic, more stylish and more thematic than commonly used digital navigation maps. And the locations of the signboard maps are also important. We proposed the method to integrate the signboard maps in photos with digital base map to provide location based service with signboard maps on smart phones.

In this paper, we just made the experiment with the signboard maps of Kashiwa Campus at the University of Tokyo. In the future, we are going to cooperate with local governments and communities to collect and integrate more signboard maps on our proposed framework.

Keywords: Signboard Maps, Photos, Location-based Services, Relative Spatial References

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