Positioning Locality Based on Cognitive Directions and Context in Indoor Landmark Reference System

Yankun Wang [a, *], Weixi Wang [a], Xiaoming Li [a], Shengjun Tang [a], You Li [a]

[a] Research Institute for Smart Cities, School of Architecture and Urban Planning, Shenzhen University, Shenzhen, China; risc@szu.edu.cn, lxmingster@163.com, shengjuntang@szu.edu.cn, liyou@szu.edu.cn

* Corresponding author: yankun.wang@whu.edu.cn

Abstract:

Geographic information sciences (GIS) have been entering an era of information explosion. The data-related geographic can be divided into many classes, according to their sources and format, such as raster dataset, shape file, textual information, and voice. Locality description, which is a common form of voice, conveys considerable spatial information and can be derived from our daily communication. The issue of dealing with the locality description information is a research hot spot of next-generation GIS for many scholars.

Locality description reflects direct or indirect human interaction with environment directly. As an external expression of cognition, the uncertainty that is associated with locality description is inevitable. Locality description generally contains spatial relationships (i.e., topological, distance, and direction relations) and reference objects (ROs). Any feature with a name can be regarded as an RO. Topological relations, which convey rough information-related locality and can be refined by distance or direction relations, are seldom used directly in locality description positioning. The distance and direction relations are usually combined to describe locality, which conveys many clues to position locality.

Humans have a weak sense of direction indoors, and relative directions are used frequently in locality description. For example, locality description indoors can be given as follows: "Object A is in front of me, and object B is on my left. Context is an unavoidable topic of Locality description. The locality description is complex, either explicitly or implicitly, especially in a landmark reference system (i.e., a reference system where people can describe his locality with one or several landmarks), in which the nearest landmark can be selected easily to describe locality. On the basis of this context, the locality description ("Object A is in front of me, and object B is on my left") stated above in an indoor landmark reference system (ILRS) implies that objects A and B are near the individual. Hence, the meaning of "Object A is in front of me, and object B is on my left" in ILRS is the same as that of "Object A is in front of me, object B is on my left, and they are all near to me".

This paper introduces a novel method of positioning localities indoors by using locality description in ILRS. To achieve positioning of localities with directions description and context in ILRS, we propose a joint probability function that consists of qualitative distance (i.e., near relation) and relative direction membership function. The qualitative distance membership function that considers both minimum Euclidean distance and the stolen area is based on fuzzy set. For consistency with cognition, some definitions are provided during the calculation of relative direction, which can also reduce the number of points to be explored from an algorithmic point of view.

The whole method is described in detail as follow:

Algorithm 1
Obtain the domain that the positioning localities may be located.
Calculate the probability of relative direction in the domain.
Calculate the probability of near in the domain.
Calculate the locality using a joint probability function which consist of qualitative distance and relative direction function.
End for

A group cognitive experiment is conducted to estimate the positioning accuracy. Figure 1 shows the result for locality description "*Front is PlayBoy, left is LaoFX*". A darker color corresponds to an increased probability that it is the positioning locality. The positioning errors, is the distance from the maximum probability point or center point of the maximum probability to the locality of participant, is shown in Figure 2. It is demonstrated that a positioning accuracy of 3.55 m can be achieved within a 45 m visual space in ILRS when there are two reference objects in locality description.
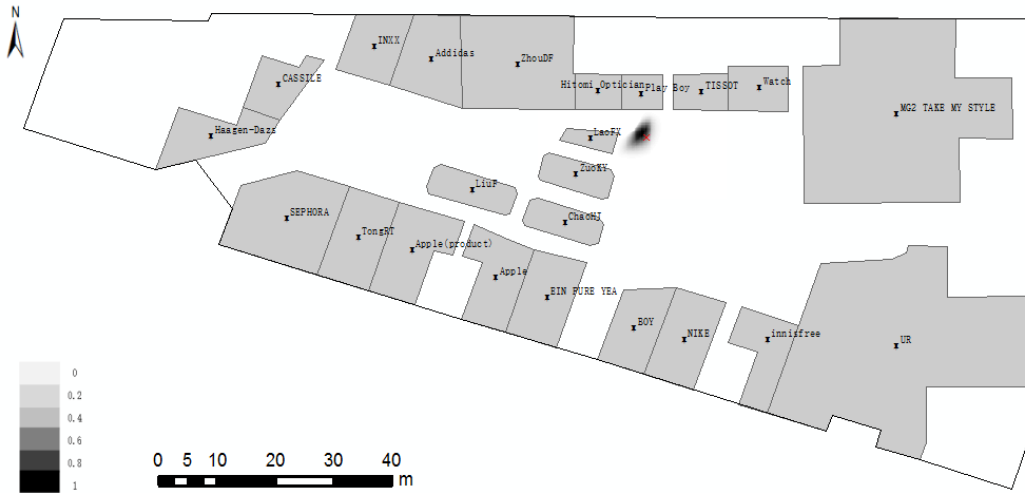
Figure 1. Positioning with two ROs. The locality description is "Front is PlayBoy, left is LaoFX".
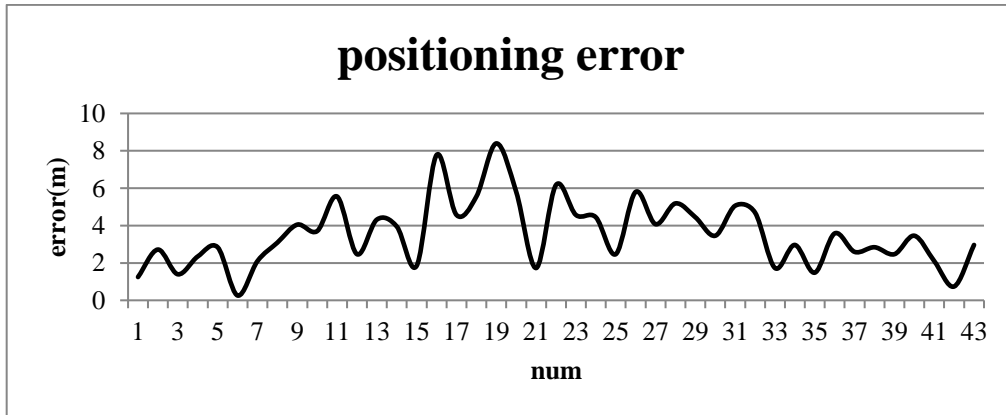

Figure 2. Positioning errors with two ROs.