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# Human Linguistic Perception of Distances for Location-Aware Systems

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## ABSTRACT

Location referencing relative to landmarks or between two points of interest is often presented by navigation systems (e.g., GPS, Google Maps) in quantitative terms (e.g., 100m, 2km, etc.). However, humans refer to distances between points of interests in linguistic forms, such as very close, far, almost there, nearby, etc. When location information is presented to humans in quantitative terms, they often reprocess the quantities into linguistic terms and articulate it in linguistic labels because quantitative articulations are not directly in line with the natural human cognition. Therefore, this research seeks to evaluate the possibility of applying perceptive computing to reprocess quantitative location references from landmarks or two points of interest into linguistic labels easily understood by humans. A comparative analysis between the perception of quantitative distances and similar physical distances in an environment familiar to the subjects has been carried out, and there is a clear disparity between the perceptions in these two contexts.

## KEYWORDS

Assistive Technology, Blind Navigation, Human-Computer Interaction, Indoor Location Authority, Indoor Navigation, Indoor Positioning, Location-Based Services

## INTRODUCTION

Every system that employs the service of location-based computing or navigation systems adopts the use of references to locations, utilizing some specific location authority scheme or notations. Location authority is regarded as *any set of referents for location references* (Shafer, 2003), used in describing locations for location-based services, often expressed in geometrical, topological or hybrid forms. In geometrical models, the underlying approach is Euclidean distance. Euclidean computation is easier to develop and use for computers and easily manipulated graphically for humans. It is, however, deficient in conveying intrinsic meaning to ordinary humans. The topological scheme is an attempt to make location referencing more suited for humans and utilizes hierarchical, descriptive or symbolic notations, such as room name, in a particular floor, in a particular building or expressed as a displacement from some landmarks (Mantoro, 2006). Several previous work has been dedicated to localization

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of mobile devices in indoor environments utilizing topological referencing for locations (Mantoro, Olowolayemo & Olatunji, 2010; Mantoro *et al.*, 2011; Olowolayemo, Md Tap & Mantoro, 2014). This is very common currently in most navigation and transportation systems. The idea is mainly to express location as a set of atoms in the location authority which are more meaningful to humans yet lack universality at present and are more complex to implement. Hybrid location authority combines geometrical schemes with topological notations to achieve a more robust location referencing model. Hybrid schemes are employed in most powerful location authorities (Shafer, 2003).

However, in spite of the aforementioned schemes, location referencing still lacks universality and human friendliness. This is due to the fact that users refer to location with references to landmarks, such as *the office behind the main stairwell*, more than *I am on latitude and longitude so, so and so*, or at *2m away from the stairwell.* This is clearly in line with human natural cognition but rather complex to model. Therefore, an approach that could simplify this complexity and make conveying locations more meaningful especially with inexactness and imprecision is imperative for human centered design in navigation and related systems, thereby making location authority more user-friendly or intuitive.

Location authority in indoor spaces using the topological approach in which users' descriptions and natural references are used to provide a more user-friendly navigation has gained prominence in many navigation systems and mobile transportation services. However, a more intuitive location reference, especially one that requires the user's input to set a location, such as using voice recognition in which a user describes their position for a navigation system, might be better resolved using computing with words. This is especially suitable for voice recognition systems meant to serve the blind, handicapped or even people who are not able to type their locations such as firemen or rescue workers in dangerous or emergency situations. They may quickly respond using voice recognition systems to pinpoint their locations by describing their locations in linguistics terms, which can be modeled using computing with words.

This work proposes a linguistic perception approach using computing with words to model distances from landmarks or a pair of points of interest. The main focus is examining humans' perception of distances and discern how best to model distances in an indoor environment.

## BACKGROUND

### Location Authority Challenges

Location authority is required for every location-based service. Location depiction and references in GPS and other Global Navigation Satellite System (GLONASS), is mainly geometric or coordinate which is insufficient intrinsically for humans, especially people that may rely on voice recognition or text to speech (and vice versa) systems. The sets of people include the visually impaired, physically challenged, the elderly or rescue workers that may not have sufficient time or are too preoccupied to conveniently use their hands to enter input. Examples of current systems geared towards helping the disabled, visually impaired or the blind have been proposed or examined by studies such as Suganya, (2017), Kim *et al.*, (2016), Bhowmick and Hazarika, (2017), Elmannai and Elleithy, (2017) and Kiuru *et al.*, (2018). Most of these systems rely entirely on audio input and output for all activities. However, in all these systems, quantitative distances are used in situations that require location referencing. Therefore, this state of the present location authorities demands development of new opportunities for location referencing to make it more user-friendly and intuitive especially for the class of users highlighted above. This requires proper evaluation particularly making it more human-centric to develop the possibility of a new perception-based location reference that accommodates the systematic co-existence of human-centric variations. It is therefore necessary to explore an approach towards making location referencing more meaningful in line with human cognition.

The motivation for this is rooted in the fact that when gadgets, such as GPS, which are often used for positioning and location references provide location updates, its outputs are presented in numerical