# Positioning using Signal Distribution Patterns

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## Abstract

Location determination of moving objects is a fundamental task of a location based service since the current location of mobile users is used to provide better services. GPS and GLONASS technologies are useful for outdoor positioning, as they generally provide good quality real-time position data for users 24/7/365, anywhere on the earth. However, these technologies are not as suitable for indoor environments. As such, indoor positioning of users is the foremost objective of this research. In addition to positioning, indoor route-finding based on users routing preferences is also a challenging problem for location based services, and forms a concomitant component of this work. In this research, a new fingerprinting method of indoor positioning is proposed, also three main location models including: geometrical, hierarchical and graph-based are integrated together to form the base for positioning solution.

## Background

In recent years, indoor positioning based on Wi-Fi signals has received attention from numerous researchers from different disciplines (Yeung & Ng, 2007). A Wi-Fi network is characterized by a number of access points (AP) that are distributed throughout an environment for the purpose of transmitting and receiving signals from mobile devices. Because AP signal strengths varies as the radio waves travel through obstacles and space, researchers have taken advantage of this variation and have proposed numerous methods for determining the location of mobile user. The majority of methods can be classified as either based on radio propagation models or based on location fingerprinting.

## Methods and Data

In this research we investigate the use of the Bhattacharyya distance to determine the location of a user in an indoor environment by comparing statistically a user's real-time signal with calibration points at nodes in an indoor pedestrian network. The primary advantage of this method, when compared to other fingerprinting methods like K-nearest neighbour, Artificial Neural Network (ANN) and Support Vector Machine (SVM) (Brunato M. and Battiti R, 2005) is the reduced calibration set necessary for determining a user's location. In this method the geometrical structure of building are considered as part of a user's contextual information, and a matching algorithm based on the Bhattacharyya distance used to estimate the real-time position of a user on a predesigned pedestrian network.

Environmental conditions affect signal strength in an indoor environment. Wall thickness, wall material, distance between transmitter and receiver, the geometrical structure of buildings, and the presence of people or other moving objects traversing the local environment contribute to signal strength variation. Therefore, signal strength is rarely constant over time and varies even when a user is stationary.

The Bhattacharyya distance measures the similarity of two discrete or continuous probability distributions. The statistic determines the relative closeness of two distributions by considering their distribution parameters: their mean and Covariance matrix, and is similar to the Kullback-Leibler divergence (Kullback & Leibler, 1951; Kullbac, 1987).

## Conclusion

The study area for this work was the first three floors of the Science Theatre building at the University of Calgary. A ground truth campaign was undertaken to determine signal strength, signal variation, and the service set identifier of unique media access control (MAC) addresses within the study area. For calibration, a small number of points were identified, with the vertices at intersections and bends in the pedestrian network for the study area. A combination of the Bhattacharyya distance and filtering, to reduce the initial candidate set, was used to determine the user's position, which produced high precision in position matching.

## References


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