Improving Energy Efficiency of Finger Printing System Through Geo Localized Radio Database Compression

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Abstract- **Although location based finger printing positioning method on cellular networks is effectively implemented, still there is a need in optimizing the energy efficiency of the finger printing system with respects to green networking. In this paper we develop a new analytical model to shrink the fingerprint database through geo localized radio database compression. We apply identifying the fingerprints based on geo location leaving the unnecessary fingerprints. This location based geo compression reduces the computational load and improves the energy efficiency and time. The geo localized compression targets by reducing the errors in identifying the distance.**

Keywords: **positioning method, analytical model, geo compression, computational load.**

I. INTRODUCTION

There are various ways approached world-wide in mobile positioning. Generally, Mobile positioning is of two types. Network based positioning and device based positioning. In context mobile positioning and mobile location are entirely different things, as mobile positioning relates to the mobile device position, where as mobile location relates to the location derived from mobile positioning.

Basically the mobile positioning utilizes techniques such as time-of-arrival and the time-difference-of-arrival for localization. RSS is the general feature that is used in Wireless network. The Received Signal Strength (RSS) metric is used to verify or validate the measurement of Wireless LAN positions.

II. LOCATION ESTIMATE TECHNIQUES

A. Triangulation: The RSS can be interpreted into distance from the particular Geo Location according to experimental signal propagation model. Then, with distance measurements from at least 3 Geo Location with recognized places can be performed to figure the Geo locations. This type of interpretation does not give an accurate estimate, as the mobile movement path is highly unpredictable and thus the use of the movement based model is not reliable.

B. Proximity: Proximity estimate technique identifies the specific RSS from a given Geo Location and assumes the location as it is from the particular Geo Location. As this technique concludes a rough estimate on the location, it is difficult to predict the accuracy of the location, as it is easy to implement.

C. Finger Printing: In this method the RSS readings are collected from known locations, which are referred to as fingerprints, in the area of concern. Later it is estimated by comparing the online measurements with the fingerprint database with the received RSS. This method is used by most WLAN positioning systems, as it is able to calculate precise location estimates.

In radio database systems, the magnitude of the radio database is an important factor with respect to computation and transmission loads problem. Although location based finger printing positioning method on cellular networks is effectively implemented, still there is a need in optimizing the energy efficiency of the finger printing system with respects to green networking. The RSS read from various points are then compared to the radio database to determine the location. When a geo location based finger printing technique is applied, the compression of the database is

drastically improved and also it helps to get additional information such as weak signal points or null signal points.

As the database statistical properties may depend on the underlying radio system, one may expect different methodologies for different radio networks. One suggested approach for database compression, especially in the context of WLAN fingerprinting, is to reduce the dimension of the radio feature space and various techniques such as Principal Component Analysis (PCA) and Kernel Canonical Correlation Analysis (KCCA) have been proposed to implement this approach. An alternative solution might be envisaged by reducing the number of records, i.e., to reduce the database density [21].

One simple way to reduce the database density in the context of cellular network's, is to cover the considered area by a uniform grid, and to perform an averaging function with over all the measurements which fall in the same grid zone. The grid resolution is defined as the length of a side of each square zone. We notice that in the grid method, selection of the gathered measurements depends only on their location parts; the radio parts do not intervene in the grouping procedure.

In this paper we propose a clustering method based on geo localized fingerprinting technique to reduce the computational load leaving the unnecessary fingerprints and improves the energy efficiency. The geo localized compression targets by reducing the errors in identifying the distance given. This geo localized location based compression provides a choice for clusters, that is, when we utilize geo-localized compression, we can fix the number of clusters in advance and when fixing the number of clusters suggests a wide opportunity to explore the processing load time and the energy consumption rate. We believe that this type of clustering will improve the compression rate and reduce time.

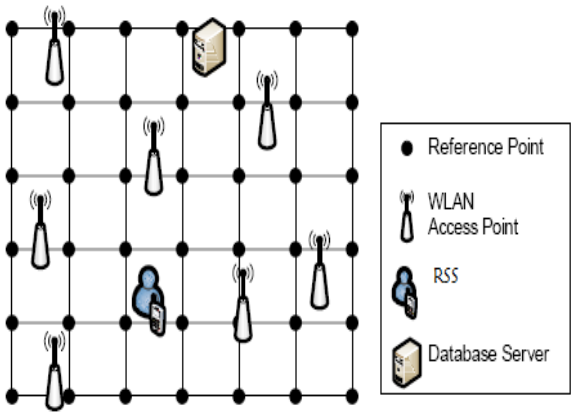

Fig:1 Example of various points for a device

III. GEO-LOCALIZED QUERIES

Location Fingerprinting works in two phases, First training phase, in which radio map is constructed over the area of interest. During the localization phase, by matching mobile terminals received signal to the radio map entries a mobile terminal is localized. The stored signal information in the radio map may be the signal time delay, Received Signal Strength (RSS), channel impulse response or any other location-dependent information [22].

This builds a fingerprinting of geo location database, which is constantly updated. This fingerprinting database can be classified based on different classification required, as the geo localized services are more opportunistic in service industry such as Resource tracking with dynamic distribution (Taxis, service people, rental equipment, doctors, fleet scheduling), Resource tracking (Objects without privacy controls, using passive sensors or RF tags, such as packages), Finding someone or something (Person by skill (doctor), business directory, navigation, weather, traffic, room schedules, stolen phone, emergency calls), Proximity-based notification (push or pull) (Targeted advertising, buddy list, common profile matching). Also the classification of the geo location itself can be done based on geographical features as follows,

TABLE I : CLASSIFICATION OF GEO-LOCATION BASED ON GEOGRAPHICAL FEATURES

Class	Examples
Remote	Open sea, desert, polar regions, and no cell coverage areas.
Rural	Countryside, residential houses, highways.
Suburban	Residential houses (brick or wooden), bungalows, parks, malls, shopping plazas, dense foliage.
Urban	High buildings and constructions, urban canyons
Indoor	Metal roofed, wooden or concrete walls, office buildings.
Underground	Concrete element constructions, parking garages.

IV.DATABASE BASED ON METRICS

Learning distance metric from available side information has attracted much interest in recent studies. The optimal distance metric is found such that the Geo location in must link constraints are close to each other while the objects in the cannot-link constraints are well separated. A number of algorithms have been developed for learning distance metric from pair wise constraints, including the convex programming approach, local distance metric learning, relevance component analysis, discriminative component analysis, support vector machine based approaches, neighborhood component analysis and its extension, maximum-margin nearest neighbor classifier, a boosting approach and Bayesian distance metric learning [3].

Most of the algorithms for distance metric learning assume that the objects in a must-link constraint are separated by a smaller distance compared to the objects in a cannot-link constraint. However, this assumption may not hold if the input space is heterogeneous and the distances between geo Location vary significantly from one network of the input space to another. As a consequence, it is inappropriate to directly compare the distance of any must-link constraint to the distance of any cannot-link constraint [2].

Our proposed classification based approach for distance metric learning overcomes this shortcoming by comparing the distance of a must-link constraint to that of a cannot-link constraint only when they are from the "same location" in the input space or associated with the same query. It is worth mentioning that in addition to the paradigm of learning distance metric from pair wise constraints, there are other approaches for distance metric learning.

V. COMPRESSION

There are different methods for location fingerprinting based on different techniques with different aims and goals to achieve, however on the other side they having their limitations. In recent time new method was presented in [1], efficient method in which geo location based clustering technique is proposed to compress the radio database in the context of mobile based fingerprinting systems. The main goal of this method was to reduce the computation cost and hence to improve the terminal autonomy, with acceptable positioning accuracy with respect to a non-compressed database. This method satisfies the choice of number of clusters. Currently all clustering algorithms requires fixed number of clusters in advance which may be efficient with this geo location based technique for heterogeneous wireless networks.

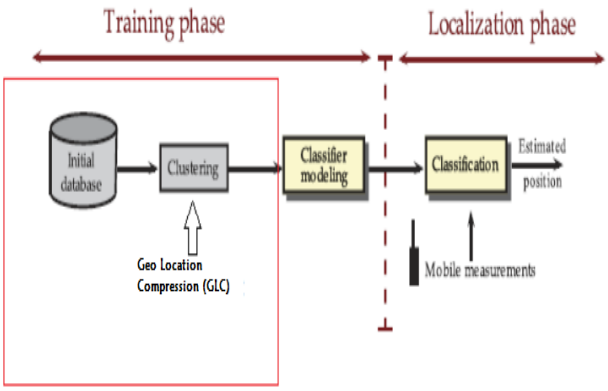

Fig:2 Architecture of the fingerprinting system, with database clustering

Radio database R is a set of records. A record is a vector a =[L: S] where L belongs to geographical position and S belongs to measurement vector in radio space, which describes radio signal at location L. feature type is defined as all the stored parameters in a record that belong to the same nature. We have at-least two different feature types in each record; Location feature type and a single Radio Access Technology (RAT) RSS feature. By applying a clustering algorithm during the training phase, the initial database could be divided into M (M<N) subsets. N is set of data points.

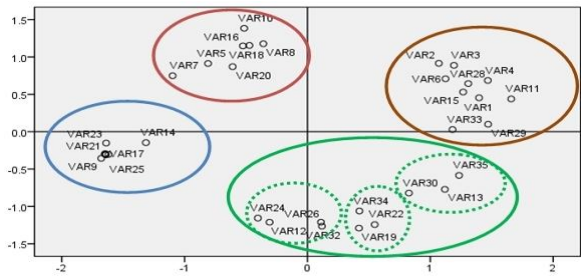

Fig : 3 Example plot with related variables grouped.

VI. REDUCE DATA ERRORS

The important issue which is not treated in this study is the problem of missing data in the radio database. As we mentioned before, a radio database may contain a large number of missing data corresponding to non detected base stations. In this work, we replaced all these missing data by a single reference value. One may expect an improved performance for clustering algorithms if the missing data are taken into account more intelligently. The optimal handling of radio missing data is a part of our ongoing work.

VII.CONCLUSION

In this paper, a clustering technique is proposed to compress the radio database in the context of Location based fingerprinting systems. The goal is to minimize the computation cost and improve the terminal self-reliance, with an acceptable Location accuracy compared to a non-compressed database. The proposed Geo Location based clustering (GLC) method has been proposed. The obtained results confirm the efficiency of the GLC technique, and it shows the improvement in the performance of standard k-means and hierarchical clustering methods and GLC. The achieved positioning accuracy is shown to be competitive to that of a non-compressed database and pre compressed database. Moreover, the proposed Geo Location clustering technique (GLC) outperforms other existing compression methods, while it requires a lower transmission load and computational time.

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