**Title:**

**An Anonymous Communication Technique using Dummies for Location-based Services**

**What is the research problem?**

In order to use Location based services with highly accurate devices user must send his positioning location to service provider and this compromises the user’s personal information and location privacy. This paper tries to solve the issue by sending multiple false positioning data to service providers along with true positioning so, it becomes difficult for service provider to find accurate user position.

**Overview/main points of the proposed approach/architecture**

* As stated in research problem false locations - dummies are sent over to location services to hide user true position. Two important issues like dummy movement and communication cost between user and LBS (location based services) are experimented using four evaluation functions based on anonymity set for dummy movement, cost reduction tested in GeoLink Kyoto service provider. The paper proposes two approaches for a dynamic scenario where the objects are moving frequently.
* LBS gathers information like userId and position data of user. This paper doesn’t worry about the userId because the assumption is userId is fictitious or pseudonyms. Even user id is protected but the position of data compromises. Hence, the focus is about hiding user true position.
* Location anonymity - Masking of position data of user, method to prevent LBS to learn the user position information.
* Location anonymity can be enhanced by considering two requirements like Ubiquity: user exists in entire region and Congestion: K-anonymous idea, large numbers of users in once region.
* Though both Congestion and Ubiquity enhances anonymity, Ubiquity has better scope for each user anonymity. Furthermore, if Ubiquity is more, anonymity of user is less. So this paper considers Uniformity.
* Uniformity: Each distributed region includes the same number of users. So, new technique is introduced to provide LBS with Uniformity, Ubiquity and Congestion.
* For anonymous communication anonymity set is used but for LBS new enhanced anonymity set must be defined.
* Enhanced anonymity set - set of all subjects (users) defined by information about location they are in.
* Anonymous communication technique is introduced between LBS and user in two ways
  + Accuracy reduction - User will not send his accurate location but will send nearby location but after several movements his location can be compromised.
  + Dummy generation - To solve problem with accuracy reduction, user sends noise data [set of dummy positions] to service provider. So the provider replies with all requested services to all dummy positions. Only user know his true location and service is anonymous.
* **Dummy generation algorithm** plays a vital role in this technique, two major dummy generation algorithms are defined.
  + Moving in neighborhood - next position of dummy is decided by current position of dummy. So, Initial positions are important.
  + Moving in Limited Neighborhood - next position of dummy is decided by current position of dummy but next position is limited by region density.
* **Communication Cost** - Increase in dummies will increase user anonymity but it cause huge cost of communication. (cost of communication increases with the increase in dummies and replies)
  + With previous approach cost of requiring messages is O (n) but with positioning data in X and Y sets order becomes O (n log n) which is less than previous.
  + So reduction of cost of messages causes less cost for communication for this four techniques are proposed.
    - Range limitation - Degree of location anonymity is reduced
    - Category limitation - user send limit categories which affect services
    - Setting keyword - If cost is too high LBS will reply with limit text
    - Removal of unnecessary data - technique limits data if user feel unnecessary.

**Experimental Evaluation**

* The trajectory shows in their observation that if number of dummies increases so as the anonymity of data.
* Communication cost observation shows that communication technique generates dummies O (n log n) cost when the proposed cost reduction technique is used.

**Positive points of the paper**

* Simple approach to handle the anonymity of user in location based services
* Used existing studies and enhanced anonymity set and anonymous communication techniques (Gruester and Grunwald techniques)
* Enhanced anonymity set extended to define evaluation functions for location services

**Negative points**

* This technique not only sends false location but also true location if a user access same service provider multiple times from constant position his true location is common in all the times. So it is easy to filter the correct location.
* This paper did not consider the pre-processing cost. Though research claims its cost is low when replying to all dummies created by user but in the real world with millions of LBS users the pre-processing cost will be hectic.

**Conclusion**

The new anonymous techniques is proposed in location based services to safeguard the accurate location of user by creating the dummies and sending them to location based services and in turn service cannot identify the true location of user. Even if someone interrupt data they cannot identify the true location of user from the created noise. Since many dummies are getting create the communication cost is reduced by applying cost reduction technique.