A Review on Mobility Tracking in cellular Network

Mrs. V.M.Lakshe(Bagal) , Dr.Mrs. A.V.Patil
Assistant Professor, Electronics and Telecommunication Department,DYPCOE Akurdi, Savtribai Phule Pune University, Pune, India.

Abstract:
As wireless services become more pervasive and location- aware, the need to locate and track mobile stations accurately and efficiently becomes increasingly important. A key technical challenge for modern wireless networks is to provide seamless access and quality-of-service (QoS) guarantees for mobile users. QoS provisioning can only be achieved by means of efficient mobility management to handle the frequent handoffs and rerouting of traffic that are experienced by a typical mobile station. This review paper describes the various mobility tracking methods for improving quality-of-service.

Keywords:
Mobility model, Cellular networks, Geolocation, pilot signal strength.

I. Introduction:

Mobility tracking is one of the most important features of wireless cellular communication networks. Data from two types of stations are usually used: *base stations* which position is known and *mobile stations* (or mobile users) which location and dynamic motion is being estimated.

Mobility tracking techniques can be divided in two groups [1]: methods in which the position, speed, and acceleration are estimated versus conventional geo-location techniques, which only estimate the position coordinates. Knowledge of velocity and acceleration information can be used to predict the future locations of the mobile stations, which in turn can be used to optimize resource allocation in the network. One application of great practical interest is fast handoff in cellular networks. If the occurrence of a handoff from one cell to another can be predicted ahead of time, the handoff procedure can be initiated in advance to allocate resources.

Many geolocation technologies have been developed that can pinpoint the position of a mobile user on the surface of the earth. The most popular technology in current use, the Global Positioning System (GPS), provides the user with position estimates accurate to within a radius of 10 meters or better by means of at least four satellites from a system of 24 satellites, spaced equally in six orbital planes To operate properly, however, GPS receivers require a clear view of the sky, in the line-of-sight of the satellites, which precludes their use in indoor or RF-shadowed environments. Moreover, the cost and size of GPS receivers may be prohibitive for small devices (e.g. sensors) with very limited battery lives that may be used in pervasive computing environments. Assisted GPS (AGPS) can work in indoor environments as well as outdoors, but this technology requires additional signaling equipment, i.e., AGPS receivers.

Geo-location techniques based on time of arrival (TOA), time difference of arrival (TDOA), angle of arrival (AOA), timing advance, and location fingerprinting offer inexpensive network-based alternatives to GPS, but are far less accurate. These techniques use the radio signals transmitted by the users instead of additional satellite signals. However, some of these techniques have additional infrastructure requirements; for example, AOA requires an adaptive antenna array to measure the angle of arrival and the location fingerprinting scheme requires a large amount of memory to maintain a location database.

II. Various Algorithms used for Mobility:

A. Mobility Modeling in ADHOC network:

In [2] work is done on mobility estimation and prediction for a variant of GSM network which resembles an adhoc wireless mobile network using Robust Extended Kalman Filter (REKF) as a location heading altitude estimator of mobile user for next node (mobile-base station) in order to improve the connection reliability and bandwidth efficiency of the underlying system. The application and performance of the Robust Extended Kalman Filter in an Adhoc type network is examine, simple simulations are carried out for a mobile-user in a three car coverage area. The network is assumed to have location and acceleration information of the mobile base stations via GPS and accelerometer reading while no such information is available with respect to the mobile user of an arbitrary kind. In this they simulated the two fold scenarios .

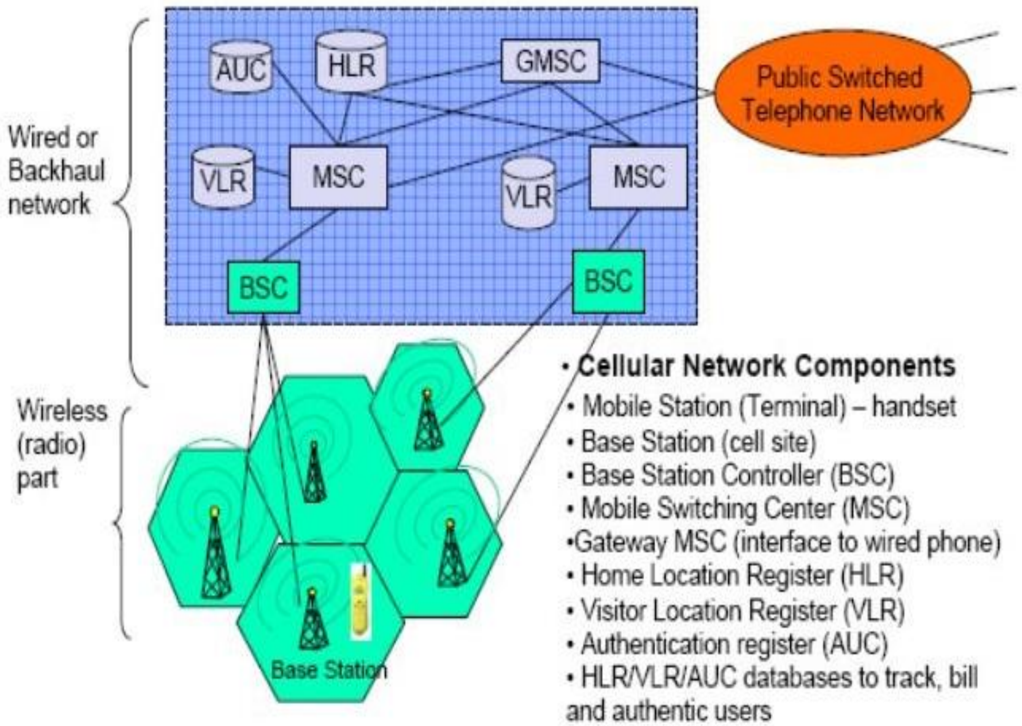

Fig.1 Cellular Network Architecture

1. Measurement from the closest base station i.e., the largest measurement from the three neighboring base stations. The tracking is performed by the closest car.
2. Two base stations which are closest to the mobile terminal are used for measurement. The tracking is performed by the closest car however the second closest car is also performing measurements.

Second proposal further improves the system performance by using measurements from only two base stations which are closest to the mobile user eliminating the need to sample with more (six) base stations as in PCS networks. This considerably reduces the network traffic while improving the computational efficiency.

B. Mobility tracking based on Kalman filtering*:*

Zainab R. Zaidi and Brian L. Mark[1] proposed two algorithms for real-time tracking of the location and dynamic motion of a mobile station in a cellular network using the pilot signal strengths from neighboring base stations.

The first algorithm, which was call MT-1, in that the RSSI measurements are preprocessed with an averaging filter to obtain coarse position estimates, which are then provided as inputs to a modified Kalman filter. Kalman filter is used only to generate estimates of the discrete command process. component of the MT-1 algorithm is a second Kalman filter, which produces mobility state estimates from the raw RSSI measurements and the discrete command estimates.

In realistic mobile networking scenarios, there may be limitations on the amount of observation data available. Considered two such limitations:
1) RSSI measurement samples from a given base station may not be available at every time slot.
2) Fewer than three independent RSSI measurements maybe available. In the first case, there may be an insufficient number of observation samples to perform the averaging properly, as required in the MT-1 algorithm. To avoid this problem, a simplified mobility tracking algorithm called MT-2 is proposed, which

consists of only a single (extended) Kalman filter, without a prefilter.

Performance of these two algorithm shows that two independent RSSI measurements were sufficient for mobility tracking but a single RSSI measurement was not. The proposed mobility tracking algorithms can be used in mobility-based resource allocation schemes such as fast IP handoff and precaching of Webproxy servers.

C. Mobility tracking with Sequential Monto Carlo Filters:

Mobility tracking [3] involves on-line estimation of the position and speed of a mobile unit. Sequential Monte Carlo algorithms include a particle filter (PF) and a Rao-Blackwellised particle filter (RBPF) and their performance evaluated over a synthetic data example.

The Monte Carlo approach relies on a sample-based construction of conditional probability density functions. Multiple particles of the variables of interest are generated, each one associated with a weight characterising the quality of a specific particle. An estimate of the variable of interest is obtained by the weighted sum of particles. Two major stages can be distinguished: prediction and update. During the prediction each particle is modified according to the state model, including the addition of random noise in order to simulate the effect of the noise on the variable of interest. In the update stage, each particle's weight is re-evaluated based on the new sensor data. The resampling procedure is dealing with the elimination of particles with small weights and replicates the particles with higher weights.

D. Mobility tracking using Particle filtering:

In this mobility tracking [4] is based on signal strength measurements. Mobility tracking is formulated as an estimation problem of hybrid systems which have a base state vector and a mode (modal) state vector.

A particle filter and a Rao-Blackwellised particle filter are used over synthetic and real data. A particle filtering having a drawback that it can become prohibitively expensive when a large number of particles is used. This complexity can be reduced by a procedure called Rao-Blackwellisation.

Rao-Blackwellisation is a technique for improving particle filtering by analytically marginalising some of the variables from the joint posterior distribution. The linear part of the system model is then estimated by a Kalman filter (KF), an optimal estimator, whilst the nonlinear part is estimated by a particle filter (PF). This leads to the fact that a Kalman filter is attached to each particle. In the mobility tracking problem the positions of the mobile unit are estimated with a particle filter , whilst the speeds and accelerations with a Kalman filter . Since the measurement equation is highly nonlinear, the particle filter is used to approximate this distribution. After estimating the positions, these estimates are given to the Kalman filter KF as measurements.

Advantages of the RBPF compared with the PF are: i) decreased computational complexity because it exhibits similar accuracy with smaller number of particles; ii) smaller peak-dynamic errors during abrupt manoeuvres which is very important for the practice.

E. Advanced Localization of Mobile Terminal:

Geolocation of mobile terminals [5] relies on the cellular network infrastructure and protocols to provide a reliable and accurate estimate of mobile terminals' position, without the need of global positioning systems, such as GPS, because GPS systems are not suitable within urban areas, due to the high costs of their adaptation to urban settings. In this they have used novel lookup table correlation technique for geolocation, with multiple position estimations and optimal location techniques.

Precise location and tracking of mobile terminals is done by exploiting advanced propagation models for mobile radio networks design, and by querying Geographical Information Systems (GIS), in conjunction with Kalman predictive filtering.

This technique relies on additional information extracted from a GIS database covering the area of interest, used in conjunction with advanced predictive filtering. In general GIS maps can include information about the roadways (*Type 1*), to improve tracking and trajectory prevision, and about the environment (*Type 2*), used especially for EMF or time delay prediction. They have contributed certain points can be summarized as follows.

• Improved database technique for multiple candidates' localization. :

This technique is based on a Lookup Table (LUT) signal strength approach where the lookup table is filled with path loss provisions of each antenna. These previsions take advantage from environmental information extracted by GIS map (Type 2), and consider the antenna's shape to better fit real environments. The lookup table is then used to perform a multi-candidates selection. A local minimum management strategy is included to improve the precision in multi-candidates selection process.

• Time-Forwarding Tracking (TFT):

This technique exploits GIS map (Type 1) information and predicts motion model to select one among all candidates' locations. Each candidate is previously projected on the road to check whether the mobility model1 is compatible with the actual movement. TFT is also able to deal with EMF fluctuation building a time forwarding graph.

• Constrained Advanced Filtering: Here they perform an advanced filtering for better enforcing other map constraints, such as, one-way streets.

Time-Forwarding Tracking (TFT):
In this a tracking method is developed based on a time-forwarding algorithm. This algorithm uses *m* time position estimates and *n* nodes candidates at each time to define a directed acyclic graph, called Time Forwarding Graph (TFG). Every node *p* in the graph represents one of the possible positions of the mobile terminal, while edges, defined by the bounded nodes (source and destination nodes), represent motion between them. Each edge has associated a weight that is computed based on reachability and map constraints. this weight was defined by taking into account the estimated velocity and acceleration at the source node, and by evaluating the reachable velocity and acceleration considering the position of the destination node. The obtained values were then compared with information inferred from the map. This type of advanced function works well when a reasonable upper bound to the position error can be assumed. Since here the deal with real environments, an acceptable error for every position cannot be guaranteed. Therefore the aforesaid weighting techniques cannot be applied so they adopt a simpler weighting technique postponing the refinement to the filtering stage. They only evaluate the edge weight to exclude the unreachable nodes. This techniques is suitable for many location-based services and applications even in a highly diverse urban environment.

CONCULSION:

Mobilty tracking in adhoc network gives position of mobile station by using measurements from only two base stations which are closest to the mobile user.

Advanced localization of mobile terminal gives better output in highly diverse urban environment but it requires larger data for lookup table that may require large memory as well as improve time delay.

The Kalman filtering algorithm gives position and speed of mobile station in cellular networks but having limitations due to the necessity for linearization.

The Partical filtering gives position, speed and acceleration of mobile station in cellular networks over both synthetic and real received signal strength measurement. It gives efficient mobility tracking in wireless networks.

REFERENCES:

[1] Z. R. Zaidi and B. L. Mark., " Real-time mobility tracking algorithms for cellular networks based on Kalman filtering,"

[2] IEEE Trans. on Mobile Computing, 2005.

[3] Pubudu N. Pathirana, A.V. Savkin and S.Jha., " Mobility Modelling and Trajectory Prediction for cellular Networks with Mobile Base Stations," MobiHoc'2003.

[4] L. Mihaylova, D. Bull, D. Angelova, and N. Canagarajah, "Mobility tracking in cellular networks with sequential Monte Carlo filters," in Proc. Eight International Conf. on Information Fusion 2005

[5] L. Mihaylova, D. Bull, D. Angelova, and N. Canagarajah, "Mobility tracking in cellular networks using Partical Filtering," IEEE Trans. On Wireless Communication, 2007.

[6] M.Anisetti,C.A. Ardagna, V. Bellandi, E. Damiani and S.Reale, "Advanced Localisation of Mobile Terminal in Cellular Networks," I.J. Communication, Network and System Science 2008.

[7] Z. Yang and X. Wang, "Joint mobility tracking and hard handoff in cellular networks via sequential Monte Carlo filtering," in *Proc. IEEE* Conf. on Computer Communications (Infocom) 2002.

[8] T. Liu, P. Bahl, and I. Chlamtac, "Mobility modeling, location tracking, and trajectory prediction in cellular networks," *IEEE J. Sel. Areas Commun.*, vol. 16, no. 6, pp. 922–936, Aug. 1998.

[9] B. Mark and Z. Zaidi, "Robust mobility tracking for cellular networks," in *Proc. IEEE Intl. Communications Conf.*, May 2002, pp. 445–449.

[10] S.-Z. Yu and H. Kobayashi, "A hidden semi-Markov model with missing data and multiple observation sequences for mobility tracking," *Signal Processing*, vol. 83, no. 2, pp. 235–250, 2003

[11] F. Gustafsson and F. Gunnarsson, "Mobile positioning using wireless networks: Possibilities and fundamental limitations based on available wireless network measurements," *IEEE Signal Processing Mag.*, vol. 22, no. 4, pp. 41–53, 2005.

[12] J. Liu and R. Chen, "Sequential Monte Carlo methods for dynamic systems," *J. American Statistical Association*, vol. 93, no. 443, pp. 1032– 1044, 1998.

[13] F. Gustafsson, F. Gunnarsson, N. Bergman, U. Forssell, J. Jansson, R. Karlsson, and P.-J. Nordlund, "Particle filters for positioning, navigation and tracking," *IEEE Trans. Signal Processing*, vol. 50, no. 2, pp. 425–437, 2002.

[14] R. Chen and J. Liu, "Mixture Kalman filters," *J. Royal Stat. Soc. B*, vol. 62, pp. 493–508, 2000.