Suggesting Resource Locations in Mobile Environment

S. R. Balasundaram and A. Saravanan

***Abstract*—Mobile technologies play a significant role in almost every application. The users can access the data from anywhere and at any time for their requirements. Location prediction is an essential component of mobile based applications. Consider the scenario where a traveler is wishing to know the location details of the required resources. The location prediction process involves careful computation to be performed that includes a mechanism linking the static and dynamic data available in the mobile environment. This paper focuses on providing a model to locate the resource(s) with optimal policies.**

***Index Terms*—Location prediction, Mobile data, Mobile technology.**

I. Mobile Applications

The popularity of wireless hand-held devices such as mobile phones, smart phones and PDAs are increasing day by day and they are widely used in almost each and every application because of their processing and storage capabilities. Mobile applications are extensively involved in transportation, air traffic control, weather forecasting, emergency responses, resource management, workforce etc [7], [9].

These applications make use of information on the user's environment to provide essential services. In location management, the information is delivered to the mobile users for enabling them to obtain relevant details such as driving directions, nearest resource information regarding the availability of shopping malls, local restaurants, hospitals, ATM machines, or fuel stations.

II. Querying

Apart from using mobiles for chat or SMS purposes, users are also interested to get the location dependent services related to their requirements through hand held devices. According to the necessities, the mobile users can send queries to the service provider.

A mobile user can send any query during his/her journey like :

- ‘Can you please send me the list of nearest restaurants?’
- ‘List the nearest ATM machines’
- ‘Get me the nearest Fuel/Gas stations’

These kinds of queries can be called as ‘Location Based Queries’, which will be addressed by the resource database to the mobile users. Basically, the query management involves two major categories, one the ‘static’ data (e.g. Restaurant, ATM centre, Hotel) and the other ‘dynamic’ data (e.g., Taxi, Ambulance), from where the queries are generated.

In order to facilitate the mobile user requirements, it is necessary to combine and analyze the static data details with the dynamic data details. Sometimes, the mobile user likes to know about the nearest two or more amenities of his choice. For example, the mobile user can send the query during his/her journey like ‘Can you please send me the nearest fuel station along with restaurant facilities?’. In this situation, the location based query mechanism can be extended and the relevant location details can be provided by combining all related data.

III. Location Prediction System

Location prediction is one of the biggest challenges in mobile technology which helps to manage the data during mobility [4], [6]. In order to locate the mobile user worldwide, say with in a city, with in a campus or with in a single room, the location prediction mechanism can be applied. Location prediction is extensively linked to the applications related to location management, handoff management and resource reservation for providing the timely services [8],[10]. GSM mechanism is supported to identify the mobile user’s current location, which is involved in the determination process of location predictions. A number of methods have been discussed by many for predicting locations [1-3],[5].

In this paper, the significance of the static data combined with dynamic data, is discussed to provide the relevant details to the mobile users for meeting out the emergency requirements during their journey. The actual locations of resources kept in database, are used to take appropriate decision for determining the optimal location prediction of resources.

IV. Trajectory Model

A trajectory of a moving vehicle can be represented in

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three-dimensional space (two-dimensional geography, time), with sequence of points $(x_1, y_1, t_1),(x_2, y_2, t_2), ..., (x_n, y_n, t_n)$, where $\{t_1 < t_2 < ... < t_n\}$. The route of a trajectory is projected on the X-Y plane. Let us assume that vehicle is at (x_i, y_i) location at time t_i and moves along a road (being followed) at constant speed. The current location of the vehicle with the past locations travelled, so far will enable the system to calculate the future location to perform certain decisions.

Assume the vehicle driver sends a query to the server, to know the nearest fuel station along with restaurant facilities. Normally, the current location of initiating the query may be taken as the index to locate the required resources. After submitting the query, the server will check the availabilities of resources on that location and will send the results to the mobile user. There is a possibility that, the vehicle might have moved from that location.

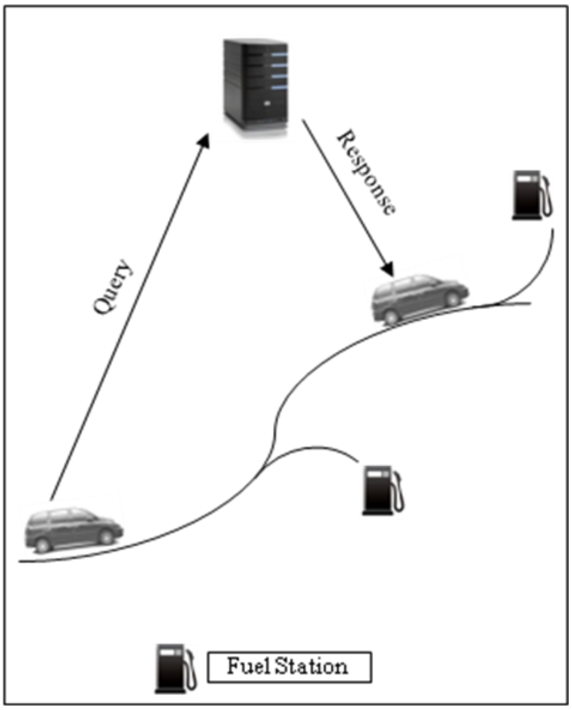

Fig.1(a) Location Prediction

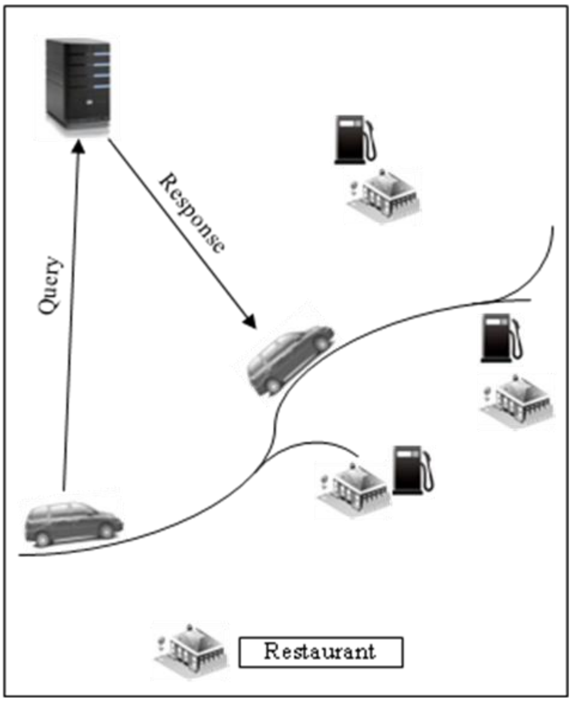

Fig.1(b) Optimal Location Prediction

So, the current location may not be a proper index to locate the resources. Because when this result comes to the driver, he/she might have traveled some distance (may be crossing the resource location).

That is, the location fetched from the database may not be of use by the requester (Fig.1(a)). To ensure the driver to get the appropriate location of resources, the optimal location predication mechanism is suggested (Fig.1(b)). Also, it is necessary to choose the optimal location from the available set of resources based on the requirements.

V. Optimal Location Prediction

This prediction mechanism provides the location of the availability of resources such as ATM centers, fuel stations, restaurants and their distances.

Fig. 2 represents the vehicle traveling path with the locations $P_1, P_2, \ldots P_5$, where P_1, P_2 are past locations and P_3 is current location and P_4 is the future location. To facilitate resource identification, the entire traveling region can be divided into several sub regions. If the predicted point belongs to one such sub region, then the sub region based 'location details' will be fetched from the database for immediate delivery based upon the query issued by the requestor and stored in a temporary database.

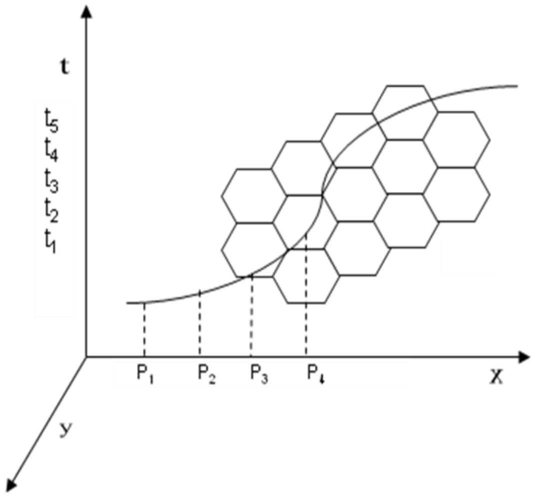

Fig. 2 Trajectory Model – Extended

The temporary database contains the details of nearby locations with services. From the set of available data, the minimum distant resource location is suggested (Fig. 3).

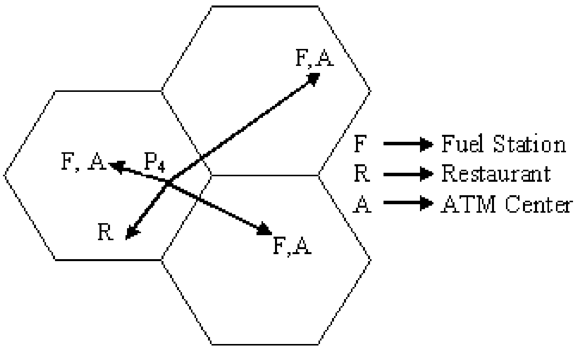

Fig. 3 Locating Resources

VI. Prediction Calculation

The location (region) preference is determined by the server with consideration of query processing time between the server and mobile user. The query processing time (T_{QP}) involves :

T_{QP} = { Query transmission time from vehicle to server
+
Query Processing time at the server including database searching
+
Response time from server to the vehicle }

Assuming that, a vehicle is traveling on a straight path at constant speed, the past and current locations of the mobile users obtained through GPS mechanism, and the future location (x_{n+1},y_{n+1}) can be predicted using the formulae:
Current and past positions are : (x_n,y_n) and (x_{n-1},y_{n-1}).
Distance of traveling from past to current position

$$|pc| = \sqrt{(x_n - x_{n-1})^2 + (y_n - y_{n-1})^2}$$

Future position of $x_{n+1} = x_n + |pc|$ and $y_{n+1} = y_n + |pc|$

VII. Work Flow

The work flow for the discussed methodology is shown in Fig. 4. Here, the locations of resources are identified based on the past and current locations on issue of the query. The location with the shortest distance from the predicted position is considered as the required location.

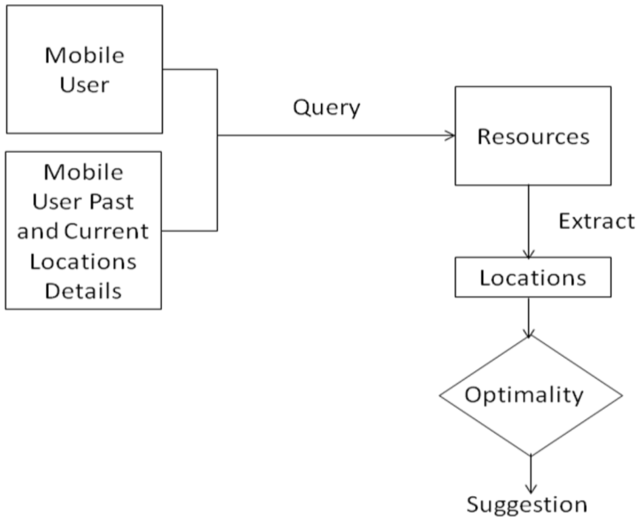

Fig. 4 Work Flow Diagram

Assuming P3 is the predicted location with R1(50 miles), R2 (20 miles) and R3 (80 miles) as resource locations, this approach suggests R2, the nearest one, as the preferred location for the requirement (Fig. 5).

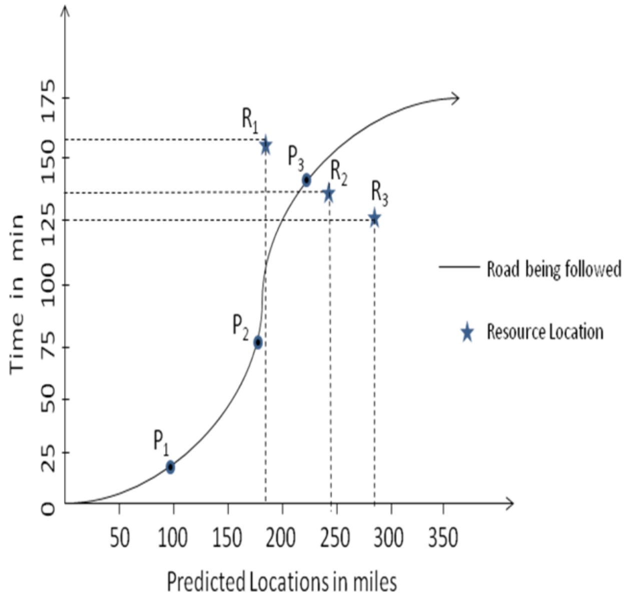

Fig. 5 Location Suggestion

VIII. Conclusion

Mobile technologies have shown tremendous impact in every walk of life in the modern society. Location prediction is one of the significant components of mobile computing helping the people on move to get details of their interest. In this connection, this paper discusses a model for locating resources during mobility, with optimal policies for resource location identification.

REFERENCES

[1] Bae-Hee Lee, Heung-Nam Kim, Jin-Guk Jung, and Geun-Sik Jo, "Location-Based Service with Context Data for a Restaurant Recommendation", S. Bressan, J. Küng, and R. Wagner (Eds.): DEXA 2006, LNCS 4080, Springer-Verlag Berlin Heidelberg 2006, pp. 430 – 438.

[2] George Liu, Gerald Maguire Jr, "A Class of Mobile Motion Prediction Algorithms for Wireless Mobile Computing and Communications", Mobile Networks and Applications1 (1996), ÄJ.C. Baltzer AG, Science Publishers, pp.113-121.

[3] Goce Trajcevski, Ouri Wolfson, Fengli Zhang, and Sam Chamberlain, "The Geometry of Uncertainty in Moving Objects Databases", EDBT 2002, LNCS 2287, Springer-Verlag Berlin Heidelberg 2002, pp. 233–250.

[1] J. Wang, "Fundamentals of erbium-doped fiber amplifiers arrays (Periodical style—Submitted for publication)," *IEEE J. Quantum Electron.*, submitted for publication.

[2] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[3] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces(Translation Journals style)," *IEEE Transl. J. Magn.Jpn.*, vol. 2, Aug. 1987, pp. 740–741 [*Dig. 9th Annu. Conf. Magnetics* Japan, 1982, p. 301].

[4] Liu. T, Bahl. P, and Chlamtac. I, "A Hierarchical Position-Prediction Algorithm for Efficient Management of Resources in Cellular Networks", Proceedings of the IEEE GLOBECOM'97, Phoenix, Arizona, November 1997.

[5] Ouri Wolfson and Huabei Yin, "Accuracy and Resource Consumption in Tracking and Location Prediction", Research supported by NSF Grants,2003.

[6] Rui Huang and Gergely V. Z´aruba, "Location Tracking in Mobile Ad Hoc Networks Using Particle Filters", ADHOC-NOW 2005, LNCS 3738, Springer-Verlag Berlin Heidelberg 2005, pp. 85–98.

[7] Sandeep Jain, "Introduction to Mobile Computing: The way the world is changing!" Available: http://www.acm.org/crossroads/xrds7-2/intro72.html.

[8] Stefano Ceri and Giuseppe Pelagatti, "Distributed Databases: Principles and Systems", McGraw-Hill Publications, 1984.

[9] Vasilis Koudounas, Omar Iqbal, "Mobile Computing: Past, Present and Future". Available : http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/vk5/report.html.

[10] Vijay Kumar, "Mobile Database Systems", John Wiley & Sons, Inc. Publication, 2006.

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