Middle-East Journal of Scientific Research 23 (7): 1300-1304, 2015
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2015.23.07.22308

Classification of Mobile Phone Positioning Techniques by Decision Tree

Muhammad Akram, Malik Sikandar Hayat Khiyal and Munir Ahmad

Faculty of Computer Sciences, Preston University, Islamabad, Pakistan

Abstract: Growth of mobile phones location estimation techniques in recent years shows its importance and popularity. Researchers try to find mobile phone's location for the location of mobile user because of its continuous connectivity and normally it is anticipated that a user is most probably with his mobile phone. So it is an easy way of finding people in a coverage area. A classification of location finding techniques is required for the better understanding and support for the researchers who are building new techniques. In this study available classification of location finding techniques are analyzed and then categorized them accordingly as environment type, precision level, execution cost and time to fix position etc. Finally a decision tree is designed which classify location techniques according to their class. The "Decision Tree" offered in this study is complete and pruned tree. This tree provides a better understanding of location finding techniques. It is a flexible and scalable tree and classifies the location techniques because "classification of data" is a property of the decision tree.

Key words: Cellular Networks · Mobile Location Finding · Classification · Decision Tree

INTRODUCTION

Whenever in any scientific field knowledge is extended up to an extent and its diverse aspects are explored [1] then there is a need to classify this area of knowledge. This classification helps new researcher to make further research in this field of study and for better understanding of existing knowledge.

To classify location estimation techniques we need a tool which can classify available techniques. We design hierarchy like structure with the help of a classification tool which is called "Decision Tree". Decision tree can be implemented in many areas for example [2, 3]. The developed tree classifies available location estimation techniques.

In Section 2 discussion on the literature about location finding methods/techniques in cellular network is made. The study about location finding technique advantages/disadvantages and there constraints on the basis of requirements are also presented. Factors differentiating techniques from each other and the importance of decision tree are also discussed. In next Section findings from literature Review (accuracy testing results and the applicability analysis for indoor and outdoor environments) are presented. In Section 4 classifies the available location estimation techniques. Building blocks and design requirements for the decision tree are specified. In Section 5 a Decision Tree is presented. This decision tree will classify location estimation techniques. In last section Results and Conclusion are given with Future work. At the end a Reference list of the literature cited is given.

Litterature Review: Mobile phone is a handy device and habitually people carry it with them any time anywhere. So it is considered that the user is there where the mobile phone is [4, 5]. Some more applications of positioning are in the field of Crime Control, Traffic administration, Route Designing, disaster Services, calamity Management, Friend finder, Asset Monitoring, etc. The location information of a mobile user up to a required accuracy level in a particular scenario by bearing a reasonable cost can be achieved by different methods.

Basic Positioning: Some basic mobile Positioning methods are Cell-ID and distance finding between MS and BS. Distances between Base Station and Mobile Station can be found by some calculation like Timing Advance. Received Signal Strength, Radio Mapping, Dead Reckoning etc. Two primary principles, Trilateration and Triangulation are mainly used for the estimation of mobile location.

Corresponding Author: Muhammad Akram, Faculty of Computer Sciences, Preston University, Islamabad, Pakistan.

Table 1: Application of positioning techniques

Example Application	Accuracy Requirement	Application Environment	Proposed LocationTech.
Emergency Calls	Med-High	Out-door	TDOA
Automotive Assistance	Med	Out-door	AOA / TOA
Travel Services	Med	Out-door	Cell-ID
People Tracking	High	In-door /Out-door	A-GPS
Indoor Routing	High	In-door	A-GPS
Vehicle Tracking	Med	Out-door	A-GPS
Traffic Management	Med	Out-door	A-GPS
Customer Support	Med	Out-door	TOA
Field Personal Support	Med-High	In-door /Out-door	A-GPS
Banners, Alerts, Marketing	Med-High	Outdoor	TOA

Table 2: Decision Table

	Level 1	Level 2
LocatIon Finding	Calculation Device	Network
		Handset
		Hybrid
	Terrain	Urban
		Sub-Urban
		Rural
		Hilly
	Latency	Fast
		Medium
		Slow
	Accuracy	Low
		Medium
		High
	Situation	Crime Control
		Indoor
		Outdoor
		Moving
		Traffic Management
		Stationary
	Cost	Low
		Medium
		High

Advance Positioning Techniques: By combining or improving above given positioning techniques some advance positioning techniques are developed. These techniques improve the accuracy level reduce the implementation cost and boost the speed to calculate the position of handset. These techniques are RSS and Trilateration, Angle of Arrival (AoA), Time of Arrival (ToA), Time Difference of Arrival (TDOA), Observed Time Difference (OTD), Enhanced Observed Time Difference (E-OTD), Assisted-Global Positioning System (A-GPS), Location Fingerprinting (LF).

The information about the application and there requirements of positioning are tabulated in Table 1.

During this study scrutinize the location techniques for their accuracies required in a particular environment and there execution cost. Completion complexity (Software and hardware updation or installation) and the factors effecting the precision and completion are also analyzed. In Table 2. a concise idea for the location techniques is given. In this table evaluation of applications environments, cost, implementation complexities and accuracies ranges in different environments (In-Door / Out-Door, urban, Rural etc.) are presented.

Classification of Positioning Techniques: In [6] it is discussed that there is no good framework for the understanding of different options while building a framework for location finding. There is no systematic classification for better comparison of proposed Location finding system. New developers cannot find a good framework for a better understanding of available options. It becomes more challenging today because studies are continuously growing. Some factors differentiate the location finding techniques and provides basis for the classification.

Decision Tree: Decision trees are well-liked for their relative power, ease of use, robustness with a variety of and ease of interpret-ability [7]. Decision trees are developed incrementally so the combined set of manifold influences is a compilation of one-cause, one-effect associations. Decision trees turn raw data in to rules and then enable us to deploy that knowledge in a simple, but powerful set of human understandable rules.

Objective and Proposed Solution: Identification of possible factors is made by analyzing the recent studies on location estimation techniques. Then a classification of the location techniques is done and. then designs a decision tree. In this research we try to design a decision tree for classification of location techniques in a cellular network.

Design: The classification and the rule are defined for the tree. All the levels of tree and their hierarchy are discussed in this section too.

Accuracy: It is a measure exactness of that technique. Accuracy of the location estimation is geometric distance between the true location and the estimated location of the terminal in meters. Accuracy may be categorized as

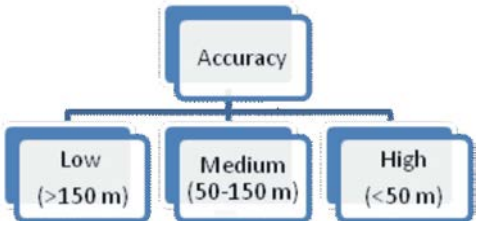

Fig. 1: Accuracy

Time Consumption: Also called latency is a time required (in Sec) to fix Position from power-up to the instant when the first location measurement is obtained. Latencies of positioning techniques may be categorized as

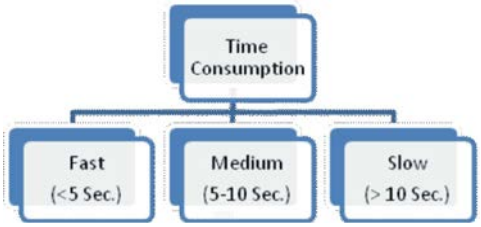

Fig. 2: Time Consumption

Terrain: Positioning techniques behave differently in different kind of terrain environment. Techniques are introduced for the location finding in a specific kind of terrain. This factor may be categorized as

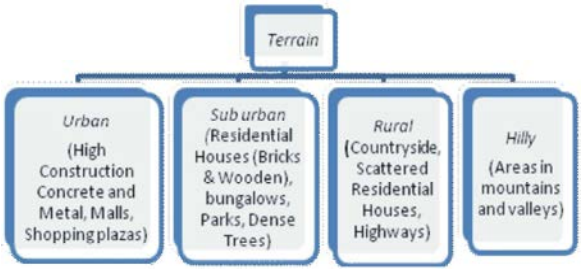

Fig. 3: Terrain Type

Calculation Device: Calculation device mean in the process of position calculation are made on the Network end, or Handset calculates location. Calculation function can be hybrid. Network based technologies use only network components (H/W and S/W). Handset based techniques used only handset components (H/W and S/W) for calculation. But hybrid technologies uses both hand set and network components on the basis of calculation operation of location finding techniques, it may be categorized as

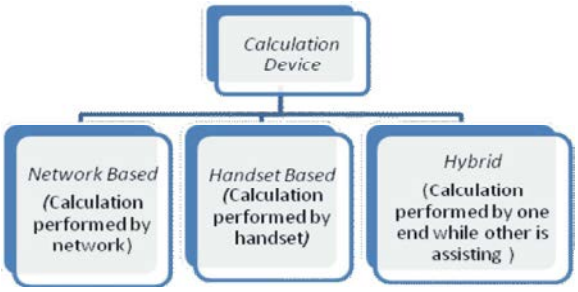

Fig. 4: Calculation Device

Situations: Location estimation techniques are used in different situations. In each situation requirements are different. The situations can be categorized as

Fig. 5: Situations

Implementation Cost: It is the cost of implementation and use of certain technology in terms of financial aspects. Some techniques required no software/hardware update but some require software/hardware update or any one from each. It may be categorized as.

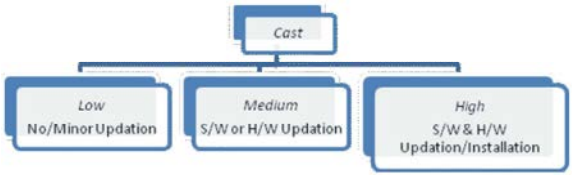

Fig. 6: Cost

These options are founded for the selection of the area of the study in the location estimation. These can be classes for the location estimation techniques also.

Decision Table: Decision table is the basic requirement for building a decision tree. It defines the breadth and width of decision tree. Column of Decision Table show the levels of "Decision Tree" and rows show the breadth of "Decision Tree".

In the 1st column of Table 3, the Basic Idea "Location Finding" is displayed. In next column classification of location finding techniques are tabulated. In third column sub classes are described.

Table 3: Comparisons of location techniques

		Finger prints	GPS	A-GPS	O-TDOA	E-OTD	TOA	AOA	Cell-ID + TA/RTT	Cell-ID + RSS	Cell-ID
Based Type		Network Based	Handset Based	Network Based -Handset Assisted	Handset Based -Network Assisted	Handset Based -Network Assisted	Network Based -Handset Assisted	Network Based	Network Based -Handset Assisted	Network Based	Network Based
Accuracy	Urban	5-20m	5-20m Open	5-20 m	50 m	35-265m	50 m	100 m	200 m	250 m	300 m
	Rural	5-50m	5m Open	10-20m	200 Km	25-475m	200 Km	200 m	11Km	12Km	20 Km
Implementation Cost		Moderate	Low	Moderate	High	High	Low	Moderate	Moderate	Moderate	Low
Time Cons.		Moderate	Slow	Moderate	Moderate	Moderate	Moderate	Moderate	Fast	Fast	Fast
Result	Best	no change in surveyed area	Variable (Moderate in Urban High in Rural & sub-urban)	Urban	No Multipath Propagation	No Multipath Propagation	No Multipath Propagation	LOS	Rural/Plain	Rural/Plain	Urban
	Worst	change in surveyd area	Multipath Propagation	Indoor	Multipath Propagation	Multipath Propagation	Multipath Propagation	NLOS	Urban	Urban	Rural/Plain
Handset Requirements		Addl. H/W & S/W	Addl. H/W & S/W	Addl. H/W & S/W	S/W Modification	S/W Modification	None	None	None	None	None
Network Requirements		H/W & S/W	Minor Modification	Addl. H/W & S/W	Addl. H/W &S/W (LMU)	Addl. H/W &S/W (LMU)	H/W & S/W Modification	H/W & S/W Modification	S/W Modification	H/W Modification	None

Implementation: Main objective or question to be solved in this system is Location Finding, so at the "top level" or "Root Node" of "Decision Tree "is "Location Finding". After this there will be about the classification of the location finding techniques are described. In the next level the subclasses of the location finding techniques are shown.

Graphical Representation: As this tree is graphically presented so it can be easily understandable and useable for the untrained users. As with all Decision Making methods, decision tree analysis should be used in conjunction with common sense [7].

Flexibility: As tree can adjust new and updated data at any level of its breadth and width so it is flexible to maintain it as updated requirement and options are considered [7].

Scalability: We can add or remove new updated option and techniques in it so it provides a good scalability to us [8].

General Solution: It provides a general solution so maximum of the users can use it easily and can modify it according to their requirements [9].

CONCLUSION

By the help of the developed "Decision Tree as given in Figure 7, it is concluded that we time for selection process because all out comes are predictable. By the help of this "Decision Tree" we can understand all the aspects

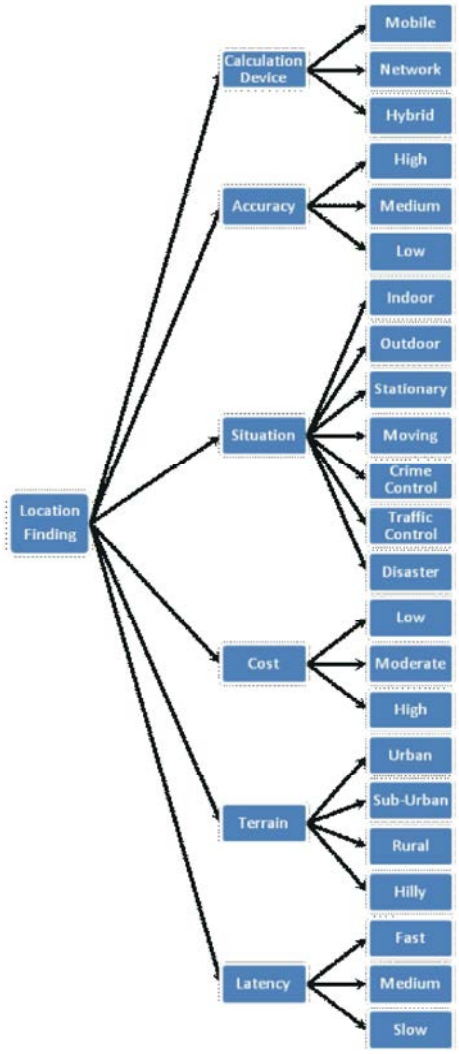

Fig. 7: Decision Tree

for location finding technique in an organized way. This "Decision Tree" can help future developers to understand the taxonomy of location finding. It will also help for future developers in developing new location techniques. Simply this tree classifies the location estimation techniques in different classes. This "Decision Tree" is flexible (can be modified as our requirement) and scalable (can be add more categories where it needed). According to if a decision tree provides a solution at its each termination node and each node can be visited in an algorithmic way and at last these algorithms are terminated then this kind of tree is a complete, valid, Pruned tree. The tree is also terminated according to. So it returns no ambiguous results.

As the definition of decision tree, it classifies the data or the inputs given to the tree. So by the definition of the decision tree it also classifies the location estimation techniques because there is some background knowledge involved to build this tree at each node and level. When user selects the Location finding option then he finds some options which are also classification of the location finding technique. Advantages of this designed "Decision Tree" are explained in a short detail are as described.

REFERENCES

1. Bill, R., C. Cap, M. Kofahl and T. Mundt, 2004. Indoor and Outdoor Positioning in Mobile Environments - a Review and some Investigations on WLAN-Positioning.
2. Eyas El–Qawasmeh, 2003. Word Prediction viaa Clustered Optimal Binary Search Tree, Computer Science Department, Jordan University of Science and Technology, Jordan,
3. Bugra Karabey and Nazife Baykal, 2012. Attack Tree Based Information Security Risk Assessment Method Integrating Enterprise Objectives with Vulnerabilities, Informatics Institute, Middle East Technical University, Turkey.
4. ITU International Telecommunication Union, (http://www.itu.int/ITU-D/ict/definitions/regions/index.html), accessed 05.10.2014.
5. Ling, R., 2004. The Mobile Connection: The Cell Phones Impact on Society, The Morgan Kaufmann series in interactive technologies, Morgan Kaufmann, 1:244.
6. Kjærgaard, M.B., 2007. A Taxonomy for Radio Location Fingerprinting,(J. Hightower, B. Schiele, & T. Strang, Eds.) Lecture Notes in Computer Science, 4718: 139-156.
7. Jensen, W.A., 2006. Decision trees for business intelligence and data mining: using SAS Enterprise Miner, Technometrics.
8. Russell, S.J. and P. Norvig, 2003. Artificial Intelligence: A Modern Approach, (S J Russell & P Norvig, Eds.)Prentice Hall Prentice Hall, 2: 1132.
9. Tversky, A. and D. Kahneman, 1982. Judgment under Uncertainty: Heuristics and Biases, (P. S. D Kahneman & A. Tversky, Eds.) Science, American Association for the Advancement of Science,185(4157): 1124-1131.