www.ijemr.net ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962

Volume-7, Issue-2, March-April 2017

International Journal of Engineering and Management Research

Page Number: 120-126

Indoor Localization

Sudheesh K[1], Nidhin Krishna K[2], Aparna Krishnan P[3] , Susmitha K[4] , Swathy Mol S[5], Anjali O[6]

[1,2,3,4,5]B.Tech students, Department of Computer Science and Engineering, Ammini College of Engineering, Mankara, Palakkad, Kerala, INDIA

[6]Assistant professor, Department of Computer Science And Engineering, Ammini College of Engineering Palakkad, Kerala, INDIA

ABSTRACT

Indoor localization is of great importance for a range of pervasive applications, attracting many research efforts in the past decades. Most radio-based solutions require a process of site survey, in which radio signatures of an interested area are annotated with their real recorded locations. Site survey involves intensive costs on manpower and time, limiting the applicable buildings of wireless localization worldwide. In this study, we investigate novel sensors integrated in modern mobile phones and leverage user motions to construct the radio map of a floor plan, which is previously obtained only by site survey. Considering user movements in a building, originally separated RSS fingerprints are geographically connected by user moving paths of locations where they are recorded, and they consequently form a high dimension fingerprint space, in which the distances among fingerprints are preserved. The fingerprint space is then automatically mapped to the floor plan in a stress-free form, which results in fingerprints labeled with physical locations. On this basis, we design Locating in Fingerprint Space(LiFS), an indoor localization system based on off-the-shelf WiFi infrastructure and mobile phones. LiFS is deployed in an office building covering over 1,600 m^2, and its deployment is easy and rapid since little human intervention is needed. In LiFS, the calibration of fingerprints is crowd sourced and automatic. Experiment results show that LiFS achieves comparable location accuracy to previous approaches even without site survey.

Keywords— Android project; Indoor localization, User tracking; Crowd sourcing.

I. INTRODUCTION

The popularity of mobile and pervasive computing stimulates extensive research on wireless indoor localization. Many solutions are introduced to provide room-level location-based services, for example, locating a person or a printer in an office building. The majority of previous localization approaches utilize Received Signal Strength (RSS) as a metric for location determinations. RSS fingerprints can be easily obtained from most off-the-shelf wireless network equipments, such as WiFi- or ZigBee-compatible devices. In these methods, localization is divided into two phases: training and operating. In the first stage, traditional methods involve a site survey process(a.k.a. calibration), in which engineers record the RSS fingerprints (e.g., WiFi signal strengths From multiple Access Points, APs) at every location of an interested area and accordingly build a fingerprint database (a.k.a. radio map) in which fingerprints are related with the locations where they are recorded. Next in the operating stage, when a user sends a location query with his current RSS fingerprint, localization algorithms retrieve the fingerprint database and return the matched fingerprints as well as the corresponding locations.

Although site survey is time-consuming, labor-intensive, and vulnerable to environmental dynamics, it is inevitable for fingerprinting-based approaches, since the fingerprint database is constructed by locationaly labeled fingerprints from on-site records. In the end of 2011, Google released Google Map 6.0 that provides indoor localization and navigation available only at some selected airports and shopping malls in the US and Japan. The enlargement of applicable areas is strangled by pretty limited fingerprint data of building interiors. If ordinary mobile phone users are able to participate in site survey by contributing their data, the burden of indoor map providers like Google will be effectively reduced. The development of wireless and embedded technology has fostered the flourish of smart phone market. Now a day's mobile phones possess powerful computation and communication capability, and are equipped with various functional built-in sensors.

Along with users round-the-clock, mobile phones can be seen as an increasingly important information interface between users and environments. These advances lay solid foundations of breakthrough technology for indoor localization. On this basis, we reassess existing localization schemes and explore the possibility of using previously unavailable information. Considering user movements in a building, originally separated RSS fingerprints are geographically connected by user moving paths of locations where they are recorded, and they consequently form a high dimension fingerprint space, in which the distances among fingerprints, measured by footsteps, are preserved. In addition, we reform the floor plan of a building to the stress-free floor plan, a high dimension space in which the distance between two locations reflects their walking distance according to the real floor plan. The spatial similarity of stress-free floor plan and fingerprint space enables fingerprints labeled with real locations, which would be done only by site survey previously. These observations motivate us to design practical, flexible, and rapidly deployed localization approaches with little human costs and intervention.

In this project, we propose Locating in Fingerprint Space (LiFS), a wireless indoor localization approach. By exploiting user motions from mobile phones, we successfully remove the site survey process of traditional approaches, while at the same time, achieve competitive localization accuracy. The key idea behind LiFS is that human motions can be applied to connect previously independent radio fingerprints under certain semantics. LiFS requires no prior knowledge of AP locations, which is often unavailable in commercial or office buildings where APs are installed by different organizations. In addition, LiFS' users are in no need of explicit participation to label measured data with corresponding locations, even in the training stage. In all, LiFS transforms the localization problem from 2D floor plan to a high dimension fingerprint space and introduces new prospective techniques for automatic labeling.

II. RELATED WORK

2.1 Wireless Localization

In the literatureo findoorlo calization ,many techniq ues have been proposed in the past two decades. Generally, they fall into two categories: finger printing-based and model-based. Finger printing-based techniques. A large body of indoor localization approaches adopts fingerprint matching as the basic scheme of location determination. The main idea is to fingerprint the surrounding signatures at every location in the areas of interests and then builds a fingerprint database. The location is then estimated by mapping the measured fingerprints against the database. Researchers have striven to exploit different signatures of the existing devices orreduce the mapping effort. Most of these techniques utilize the RF signals such as RADAR, Horus, improved upon RADAR, LANDMARC, ActiveCampus, PlaceLab and OIL. SurroundSense performs logical location estimation based on ambience features including sound, light, color, WiFi, etc. In two recent works, FM radio and Channel Frequency Response are explored to use as finger prints. All these approaches require site survey over areas of interests to build a finger print database. The considerable manual cost and efforts, in addition to the inflexibility to environment dynamics are the main drawbacks of finger printing-based methods.

Model-based techniques: These schemes calculate locations based on geometrical models rather than search for best-fit signatures from pre-labeled reference database. The prevalent log-distance path loss (LDPL) model, for instance, builds up a semi-statistical function between RSS values and RF propagation distances. These approaches trade the measurement efforts at the cost of decreasing localization accuracy. Turner et al. [34] investigate several approaches based on AP locations and radio propagation models, and reports average error greater than 5 meters. Apart from power-distance mapping, Time of Arrival (ToA) , Time Difference of Arrival (TDoA) , and Angle of Arrival (AoA) have brought a host of alternative perspectives to capture geometric relationship between signal transmitters and receivers.

2.2 Simultaneous Localization and Mapping (SLAM)

While the robotics and computer vision communities have developed techniques for jointly estimating the locations of a robot and a map of an environment, the nature of wireless signal strength prohibits the use of standard SLAM techniques. These techniques typically depend on two facts: 1) the ability to sense and match discrete entities such as landmarks or obstacles detected by sonar or laser rangefinders; 2) precisely controlled movement of robots to depict discovered environments. Both of them are unreasonable for Smartphone-based localization. WiFi-SLAM uses the Gaussian process latent variable models to relate RSS fingerprints and models human movements (displacement, direction, etc.) as hidden variables. When a small portion of RSS measurements are tagged with the real coordinates, semi-supervised localization estimate the others' locations according to RSS dissimilarity. Graph SLAM further improves WiFiSLAM regarding computing efficiency and relying assumptions.

Similar in leveraging human mobility, Zee devises techniques for accurate dead-reckoning using Smartphone and places recorded user paths into an indoor map according to the constrains imposed by the map (e.g., that a user cannot walk through a wall or other barrier marked on the map), such that wireless fingerprints are related to locations. Different from previous SLAM solutions and, LiFS only measures walking steps and is free of using dead reckoning based on noisy inertial sensors of smartphones. In the proposed solution, neither digital compass nor gyroscope is involved. Instead, we use accelerometer (as pedometer) torecordonly the number of footsteps, which canbe accurately measured by now a days smartphones, with respect to the displacement and directions of users' movements. Locations are computed through the deterministic MDS method. The mapping of discovered world and the ground-truth one has not been specifically discussed in SLAM and the solution relies on global references. In contrast, LiFS exploits the geometry of fingerprint space to construct fingerprints databases.

2.3 Multidimensional Scaling

Multidimensional scaling is a set of related statistical techniques often used in information visualization for exploring similarities or dissimilarities in data. An MDS algorithm starts with a matrix of item-item dissimilarities, then assigns a location to each item in d-dimensional space, where d is specified a priori. For sufficiently small d (d ¼ 2;3), the resulting locations may be displayed in a 2D graph or a 3D structure.

Seeing inter-device distances as a metric of dissimilarity, many approaches of network localization adopt MDS as a tool for calculating the locations of wireless devices. For example, in wireless sensor networks, sensor nodes are capable of measuring the distances to neighboring nodes by RSS, ToA, TDoA, etc. MDS is used to assign a coordinate to each node such that the measured inter-node distances are as much preserved as possible. Some researchers propose MDS to figure out WiFi AP locations. In their approach, AP-AP distances are determined by a radio attenuation model. Although being similar to our solution in terms of the usage of MDS, it is neither for user localization nor fingerprinting-based.

III. SYSTEM ANALYSIS

System analysis is the term used to describe the process of collecting and analyzing facts in respect of existing operation of the solution of the situation prevailing so that an effective computerized system may be designed and implemented of proved feasible. It also diagnosis the problems and using that information recommends improvement to the system.

System analysis is the reduction of the entire system by studying the various operations performed and the relationship with the system and requirement of its successor. A system can be defined as an orderly grouping of independent component linked together according to a plan to achieve a specific objective.

System analysis may be considered as an interface between the actual problem and computer. Before a computer can perform, it is necessary to investigations are called system analyst. System analysis also embraces system design which is an activity concerned with the design of a computerized application based on the facts disclosed during the analysis stage. The same personwho knows as the system analyst carries out both activities. In feasibility study in most cases project is being driven by a problem in the business.

IV. PROPOSED SYSTEM

In this study, we propose Locating in Fingerprint Space (LiFS), a wireless indoor localization approach. By exploiting user motions from mobile phones, we successfully remove the site survey process of traditional approaches, while at the same time, achieve competitive localization accuracy.

The key idea behind LiFS is that human motions can be applied to connect previously independent radio fingerprints under certain semantics. LiFS requires no prior knowledge of AP locations, which is often unavailable in commercial or office buildings where APs are installed by different organizations. In addition, LiFS' users are in no need of explicit participation to label measured data with corresponding locations, even in the training stage. In all, LiFS transforms the localization problem from 2D floor plan to a high dimension fingerprint space and introduces new prospective techniques for automatic labeling.

V. CONTENTS

5.1 System Design

The most creative and challenging phase of the life cycle is system design. The term design describes a final system and the process by which it is developed. It refers to the technical specifications that will be applied in implementations of the candidate system. The design may be defined as "the process of applying various techniques and principles for the purpose of defining a device, a process or a system with sufficient details to permit its physical realization". The designer's goal is how the output is to be produced and in what format. Samples of the output and input are also presented.

Second input data and database files have to be designed to meet the requirements of the proposed output. The processing phases are handled through the program Construction and Testing. Finally, details related to justification of the system and an estimate of the impact of the candidate system on the user and the organization are documented and evaluated by management as a step towards implementation. The importance of software design can be stated in a single word "Quality". Design provides us with representations of software that can be assessed for quality. Design is the only way where we can accurately translate a customer's requirements into a complete software product or system. Without design we risk building an unstable system that might fail if small changes are made. It may as well be difficult to test, or could be one who's quality can't be tested. So it is an essential phase in the development of a software product.

The design phase focuses on the detailed implementation of the system recommended in the feasibility study. The design phase is a transition from a user-oriented document to document oriented to the programmers or database personnel. In other words, Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development. There is some overlap with the disciplines of systems analysis, systems architecture and systems engineering. The system is organized as a set of sub systems interacting with each other. While designing the system as a set of interacting subsystems, the analyst takes care of specifications as observed in system analysis as well as what is required out of the new system by the end user. As the basic philosophy of Object-Oriented method of system analysis is to perceive the system as a set of interacting objects, a bigger system may also be seen as a set of interacting smaller subsystems that in turn are composed of a set of interacting objects. While designing the system, the stress lies on the objects comprising the system and not on the processes being carried out in the system as in the case of traditional Waterfall Model where the processes form the important part of the system. The first step we like to do is to high-level design the application we are going to build. We do this no matter the size of the application, if we are cloning another application or creating one from scratch.

5.2System Architecture

The working process of LiFS consists of two phases: training and operating. The major output of training phase is a fingerprint database in which an RSS fingerprint and its corresponding location are associated. The fingerprint database is further used in operating phase to process location requests.

We describe the training and operating phases in detail next. The core task of training phase is to build the fingerprint database. We divide this task into three steps: (1) transforming floor plan to stress-free floor plan; (2) creating fingerprint space; (3) mapping fingerprints to real locations. A floor plan shows a view of a building structure from above, including the relationships between rooms, spaces, and other physical features. The geographical distance between two locations in a floor plan is not necessary to be the walking distance between them due to the block of walls and other obstacles. Hence, we propose stress-free floor plan, which puts real locations in a floor plan into a high dimension space by multidimensional scaling, such that the geometrical distances between the points in the high dimension space reflect their real walking distances.

Through stress-free floor plan, the walking distances collected by users can be accurately and carefully utilized. Fingerprint space is a unique component in LiFS, different from traditional approaches. According to the inter fingerprint distances, MDS is used to create a high dimension space, in which fingerprints are represented by points, and their mutual distances are preserved. In traditional approaches, fingerprints are geographically unrelated, losing the possibility of building fingerprint space. In fingerprint database, fingerprints are associated with their collecting locations (i.e., fingerprints are labeled with locations). Such associations are achieved by mapping fingerprint space (fingerprints) to stress-free floor plan (locations). In LiFS, the fingerprint database is updated continuously according to newly collected data, such that the database reflects the up-to-date radio signal distribution. As shown in Fig. 1, fingerprint database, as the core component, connects training and operating phase. Operating phase. When a location query comes, usually an RSS fingerprint sent by a user, LiFS takes it as a keyword and searches the fingerprint database. The best matched item is viewed as the location estimation and sent back to users. To find the best matches, many searching algorithms can be used. In this design, we adopt a simple one, the nearest neighbor algorithm. More specifically, we assume that a fingerprint f is collected at the same location as f0, if f0 is the most similar to f in the fingerprint database. Besides the classical nearest neighbor algorithm, we also propose a continuous trajectory matching scheme to reduce the localization error caused by the fingerprint ambiguity for mobile users. In this scheme, a user’s location is estimated based on his/her moving trajectory, instead of one single RSS report, by measuring successive RSSs and the accompanying mobility information when a user is moving.

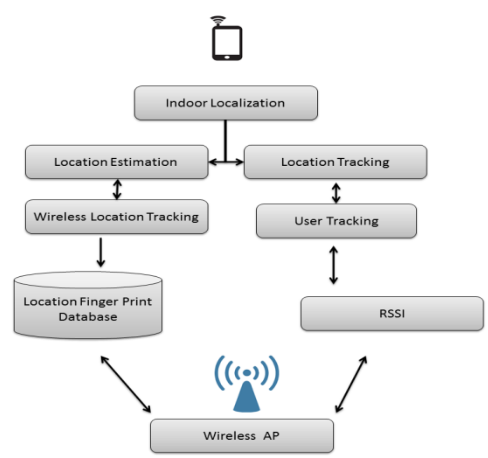


Fig 1 system architecture

VI. MODULES

6.1 RSSI

Received signal strength indication (RSSI) as a metric for location determination. In this phase indicate the collection of signals from different access points placed in the floor. The collected RSS are used to create the fingerprint space.

6.2 Wireless Localization

In this module we locate the different access points in the selected floor and collect the signals from each point.

6.3 Fingerprint Database

A large body of indoor localization approaches adopts fingerprint matching as the basic scheme of location determination. The main idea is to fingerprint the surrounding signatures at every location in the areas of interests and then builds a fingerprint database. The location is then estimated by mapping the measured fingerprints against the database. fingerprints are associated with their collecting locations (i.e., fingerprints are labeled with locations). Such associations are achieved by mapping fingerprint space (fingerprints) to stress-free floor plan (locations). In LiFS, the fingerprint database is updated continuously according to newly collected data, such that the database reflects the up-to-date radio signal distribution.

6.4 Localization

In this module performs fingerprint database look-up to response to current location query using the nearest neighbor algorithm. User’s current location is estimated as the location of which the fingerprints pre-stored in the database are the most similar to the query measurements in terms of Euclidean distance.

6.5 User tracking

By using the created fingerprint database, query the locations of both user and crowd. If the user want to need its own position then map the user position to corresponding floor with time to time updation. Otherwise show the locations of the crowd.

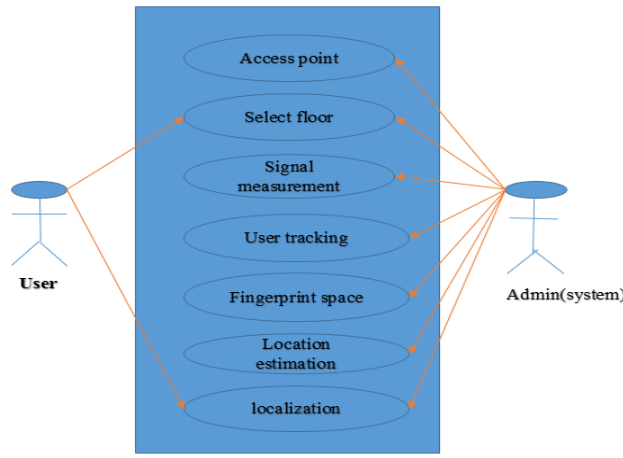
6.6 Location Estimation

When a location query comes, usually an RSS fingerprint sent by a user, LiFS takes it as a keyword and searches the fingerprint database. The best matched item is viewed as the location estimation and sent back to users.

VII. DETAILED DESIGN

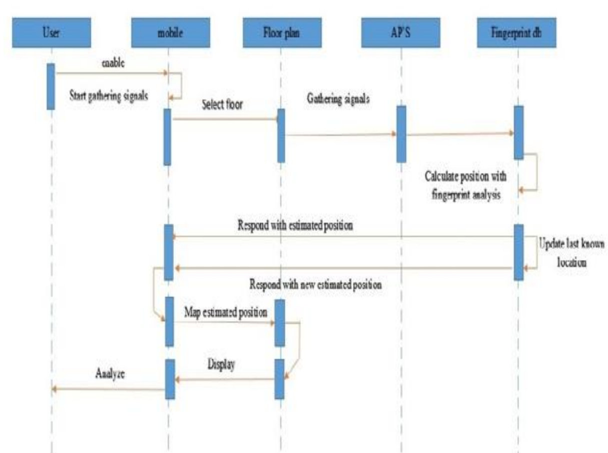
Use case Diagram:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted



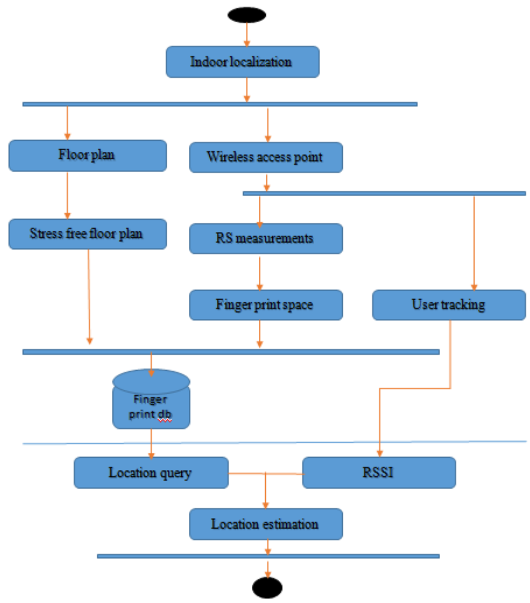
Sequence Diagram:

A Sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario.



Activity Diagram

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams are intended to model both computational and organizational processes (i.e. workflows). Activity diagrams show the overall flow of control.



Data Flow Diagram:

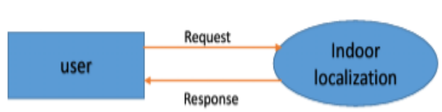
The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.

The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process, an external entity that interacts with the system and the information flows in the system.

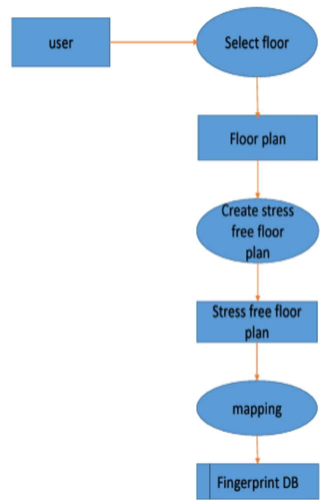
DFD shows how the information moves through the system and how it is modified by a series of transformations. It is a graphical technique that depicts information flow and the transformations that are applied as data moves from input to output.

DFD is also known as bubble chart. A DFD may be used to represent a system at any level of abstraction. DFD may be partitioned into levels that represent increasing information flow and functional detail.

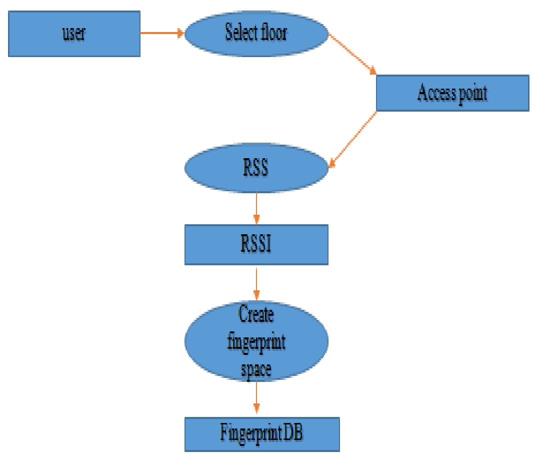
Level 0



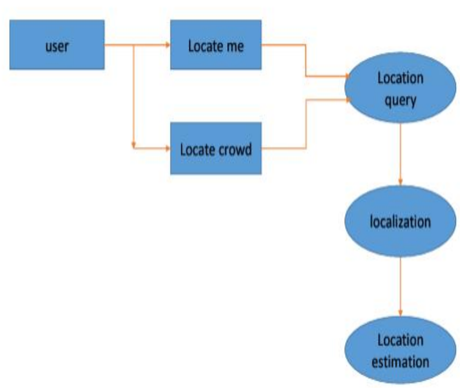
Level 1



Level 1.1



Level 2



ER Diagram:

An entity-relationship diagram (ERD) is a graphical representation of an information system that shows the relationship between people, objects, places, concepts or events within that system. An ERD is a data modeling technique that can help define business processes and can be used as the foundation for a relational database.

While useful for organizing data that can be represented by a relational structure, an entity-relationship diagram can't sufficiently represent semi-structured or unstructured data, and an ERD is unlikely to be helpful on its own in integrating data into a pre existing information system. Three main components of an ERD are the entities, which are objects or concepts that can have data stored about them, the relationship between those entities, and the cardinality, which defines that relationship in terms of numbers.

VIII. CONCLUSION

By utilizing the spatial relation of RSS fingerprints, we are able to create fingerprint space in which fingerprints are distributed according to their mutual distances in real world. On this basis, we design and implement LiFS, an indoor localization system based on off-the-shelf WiFi infrastructure and mobile phones. The preliminary experiment results show that Locating in Fingerprint Space achieves low human cost, rapid system deployment, and competitive location accuracy. This work sets up a novel perspective to cut off human intervention of indoor localization approaches. Our ongoing research focuses on making Locating in Fingerprint Space feasible and pervasive to various applied environments and buildings.

REFERENCE

[1] M. Azizyan, I. Constandache, and R. Roy Choudhury, “Surround sense: Mobile phone localization via ambience fingerprinting,” in Proc. ACM 15th Annu. Int. Conf. Mobile Compute. Newt., 2009, pp. 261–272.
[2] B. Ferris, D. Fox, and N. Lawrence, “Wifi-slam using Gaussian process latent variable models,” in Proc. 20th Int. Joint Conf. Artif. Intell., 2007, pp. 2480–2485.
[3] J. Huang, D. Millman, M. Quigley, D. Stavens, S. Thrun, and A. Aggarwal, “Efficient, generalized indoor WiFi Graph- SLAM,” in Proc. IEEE Int. Conf. Robot. Autom., 2011, pp. 1038–1043.
[4] H. Lim, L. C. Kung, J. C. Hou, and H. Luo, “Zero-configuration indoor localization over IEEE 802.11 wireless infrastructure,” Wireless Netw., vol. 16, no. 2, pp. 405–420, 2010.
[5] J.Park, B. Charrow, D. Curtis, J.Battat, E. Minkov, J.Hicks, S. Teller, and J. Ledlie, “Growing an organic indoor location system,” in Appl.Serv.,2010,pp.271–284.
[6] Rai, R. Sen, K. K. Chintalapudi, and V. Padmanabhan, “Zee: Zero-effort crowd sourcing for indoor localization,” in Proc. ACM Annu. Int. Conf. Mobile Compute. Netw., 2012, pp. 293–304.
[7] Y. Chen, D. Lymberopoulos, J. Liu, and B. Priyantha, “FM-based indoor localization,” in Proc. ACM 10th Int. Conf. Mobile Syst., Appl. Serv., 2012, pp. 169–182.
[8] M. Montemerlo, S. Thrun, D. Koller, and B. Wegbreit, “Fast Slam: A factored solution to the simultaneous localization and mapping problem,” in Proc. 18th Nat. Conf. Artif. Intell., 2002, pp. 593–598.
[9] L. M. Ni, Y. Liu, Y. C. Lau, and A. P. Patil, “LANDMARC: Indoor location sensing using active RFID,” Wireless Netw., vol. 10, no. 6, pp. 701–710, 2004.
[10] N. B. Priyantha, A. Chakraborty, and H. Balakrishnan, “The cricket location-support system,” in Proc. ACM 6th Annu. Int. Conf. Mobile Comput. Netw., 2000, pp. 32–43.

