Indoor WiFi Positioning System for Android-based Smartphone

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***Abstract*—WiFi positioning system has been studying in many fields since the past. Recently, a lot of mobile companies are competing for smartphones. Accordingly, this paper proposes an indoor WiFi positioning system using Android-based smartphones.**

Keywords- Wi-Fi, Wi-Fi Positioning System, Android, smartphone

I. INTRODUCTION

Wi-Fi positioning system (WPS) [1] is widely being studied in many fields. WPS usually uses Wi-Fi signals from already-installed private and public WiFi APs in order to provide the location based service (LBS). WPS complements the measurement error of global positioning system (GPS) in the center of the city or indoor.

There have been several studies about WPS. RADAR [2] has the position calculation using the WiFi signal strength and has an average of three meters error on the coordinate of two dimensions. In another WPS [3], KF (Kalman Filter) stabilizes Wi-Fi signals and is used to calculate the position. In [4], a method to calculate the position by combining Wi-Fi with the GPS is proposed. However, the Wi-Fi signals provide a low precision for tracking the locations. Therefore, in order to acquire more accurate location of a target, Wi-Fi APs dedicated for localization should be installed in the target area.

In this paper, we propose a personal indoor/outdoor WPS system on the smartphone using RSS (Received Signal Strength) of signals from dense Wi-Fi access points dedicated for localization. In Section 2, the proposed algorithm for tracking the position is presented. In Section 3, the implementation of the algorithm and the results of experiments are described. In section 4, we conclude the paper.

II. POSITIONING ALGORITHM

RSS from each AP is measured three times and the mean value of three RSSs is calculated. We use the difference between the mean value and each training value. If the difference is below a threshold (T), the training value is withdrawn and then the mean of filtered training values is calculated again. Finally, the mean value is compared with the value of database and a proper location on the map is found.

Figure 1 shows the flow chart of the proposed algorithm. We decided a threshold that gives the lowest error rate through experiment.

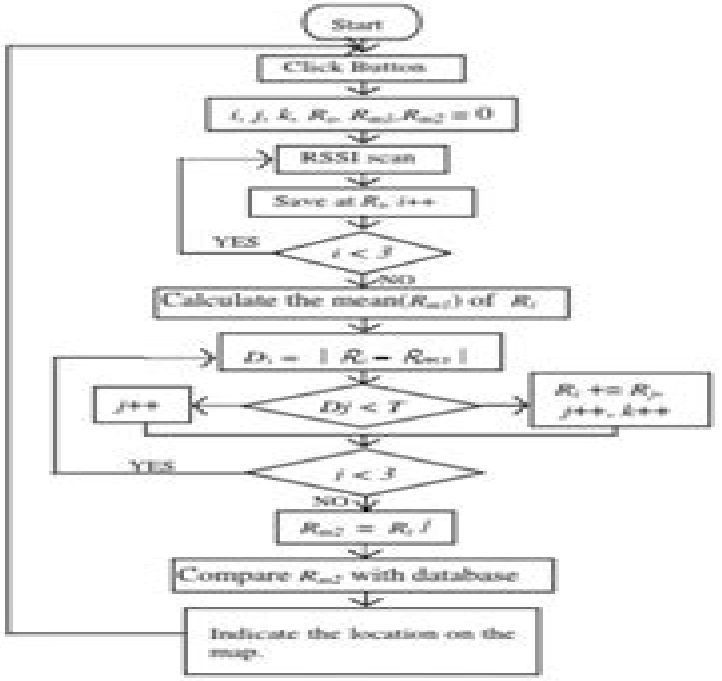

Figure 1. Flow chart of positioning algorithm.

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China Satellite Navigation Conference (CSNC 2021) Proceedings Changfeng Yang,Jun Xie,2021-06-10 China Satellite Navigation Conference CSNC 2021 Proceedings presents selected research papers from CSNC 2021 held during 22nd 25th May 2021 in Nanchang China These papers discuss the technologies and applications of the Global Navigation Satellite System GNSS and the latest progress made in the China BeiDou System BDS especially They are divided into 10 topics to match the corresponding sessions in CSNC2021 which broadly covered key topics in GNSS Readers can learn about the BDS and keep abreast of the latest advances in GNSS techniques and applications **Signal and Information Processing, Networking and Computers** Songlin Sun,Na Chen,Tao Tian,2017-12-16 This proceedings book presents the latest research in the fields of information theory communication system computer science and signal processing as well as other related technologies Collecting selected papers from the 3rd Conference on Signal and Information Processing Networking and Computers ICSINC held in Chongqing China on September 13 15 2017 it is of interest to professionals from academia and industry alike **Computational Science and Technology** Rayner Alfred,Yuto Lim,Ag Asri Ag Ibrahim,Patricia Anthony,2018-08-27 This book features the proceedings of the Fifth International Conference on Computational Science and Technology 2018 ICCST2018 held in Kota Kinabalu Malaysia on 29 30 August 2018 Of interest to practitioners and researchers it presents exciting advances in computational techniques and solutions in this area It also identifies emerging issues to help shape future research directions and enable industrial users to apply cutting edge large scale and high performance computational methods HCI International 2021 - Posters Constantine Stephanidis,Margherita Antona,Stavroula Ntoa,2021-07-03 The three volume set CCIS 1419 CCIS 1420 and CCIS 1421 contains the extended abstracts of the posters presented during the 23rd International Conference on Human Computer Interaction HCII 2021 which was held virtually in July 2021 The total of 1276 papers and 241 posters included in the 39 HCII 2021 proceedings volumes was carefully reviewed and selected from 5222 submissions The posters presented in these three volumes are organized in topical sections as follows Part I HCI theory and methods perceptual cognitive and psychophisiological aspects of interaction designing for children designing for older people design case studies dimensions of user experience information language culture and media Part II interaction methods and techniques eye tracking and facial expressions recognition human robot interaction virtual augmented and mixed reality security and privacy issues in HCI AI and machine learning in HCI Part III interacting and learning interacting and playing interacting and driving digital wellbeing eHealth and mHealth interacting and shopping HCI safety and sustainability HCI in the time of pandemic

Game + Design Education Özge Cordan,Demet Arslan Dinçay,Çağıl Yurdakul Toker,Elif Belkıs Öksüz,Sena Semizoğlu,2021-07-19 This book gathers the papers of the PUDCAD Universal Design Practice Conference Game Design Education organized by Istanbul Technical University and held online on June 24 26 2020 The conference represented one of

the key events of the Practicing Universal Design Principles in Design Education through a CAD Based Game PUDCAD project which developed a design game on a CAD based platform enabling students and designers to learn about universal design principles and develop accessible and innovative design ideas As such the PUDCAD project met one of the foremost goals of the European Commission making sure the inclusion and efficient accessibility for people with disabilities into everyday life The main topics of the conference include universal design and education universal design and user experience game and design studies gamification virtual reality experiment e learning in design and playful spaces and interfaces The contributions which were selected by means of a rigorous international peer review process highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaboration among different specialists

Energy Science and Applied Technology Zhigang Fang,2015-11-17 Energy Science and Applied Technology includes contributions on a wide range of topics Technologies in geology mining oil and gas exploration and exploitation of deposits Energy transfer and conversion materials and chemical technologies Environmental engineering and sustainable development Electrical and electronic technology power system Advances in AI for Biomedical Instrumentation, Electronics and Computing Vibhav Sachan,Shahid Malik,Ruchita Gautam,Parvin Kumar,2024-06-13 This book contains the proceedings of 5th International Conference on Advances in AI for Biomedical Instrumentation Electronics and Computing ICABEC 2023 which provided an international forum for the exchange of ideas among researchers students academicians and practitioners It presents original research papers on subjects of AI Biomedical Communications Computing Systems Some interesting topics it covers are enhancing air quality prediction using machine learning optimization of leakage power consumption using hybrid techniques multi robot path planning in complex industrial dynamic environment enhancing prediction accuracy of earthquake using machine learning algorithms and advanced machine learning models for accurate cancer diagnostics Containing work presented by a diverse range of researchers this book will be of interest to students and researchers in the fields of Electronics and Communication Engineering Computer Science Engineering Information Technology Electrical Engineering Electronics and Instrumentation Engineering Computer applications and all interdisciplinary streams of Engineering Sciences **Smartphone-based Indoor Positioning Using Wi-Fi, Inertial Sensors and Bluetooth** Viet-Cuong Ta,2017 With the popularity of smartphones and tablets in daily life the task of finding user s position through their phone gains much attention from both the research and industry communities Technologies integrated in smartphones such as GPS Wi Fi Bluetooth and camera are all capable for building a positioning system Among those technologies GPS has approaches have become a standard and achieved much success for the outdoor environment Meanwhile Wi Fi inertial sensors and Bluetooth are more preferred for positioning task in indoor environment For smartphone positioning Wi Fi fingerprinting based approaches are well established within the field Generally speaking the approaches attempt to learn the mapping function from Wi Fi signal characteristics to the real world position They usually

require a good amount of data for finding a good mapping When the available training data is limited the fingerprinting based approach has high errors and becomes less stable In our works we want to explore different approaches of Wi Fi fingerprinting methods for dealing with a lacking in training data Based on the performance of the individual approaches several ensemble strategies are proposed to improve the overall positioning performance All the proposed methods are tested against a published dataset which is used as the competition data of the IPIN 2016 Conference with offsite track track 3 Besides the positioning system based on Wi Fi technology the smartphone s inertial sensors are also useful for the tracking task The three types of sensors which are accelerate gyroscope and magnetic can be employed to create a Step And Heading SHS system Several methods are tested in our approaches The number of steps and user s moving distance are calculated from the accelerometer data The user s heading is calculated from the three types of data with three methods including rotation matrix Complimentary Filter and Madgwick Filter It is reasonable to combine SHS outputs with the outputs from Wi Fi due to both technologies are present in the smartphone Two combination approaches are tested The first approach is to use directly the Wi Fi outputs as pivot points for fixing the SHS tracking part In the second approach we rely on the Wi Fi signal to build an observation model which is then integrated into the particle filter approximation step The combining paths have a significant improvement from the SHS tracking only and the Wi Fi only Although SHS tracking with Wi Fi fingerprinting improvement achieves promising results it has a number of limitations such as requiring additional sensors calibration efforts and restriction on smartphone handling positions In the context of multiple users Bluetooth technology on the smartphone could provide the approximated distance between users The relative distance is calculated from the Bluetooth inquiry process It is then used to improve the output from Wi Fi positioning models We study two different combination methods The first method aims to build an error function which is possible to model the noise in the Wi Fi output and Bluetooth approximated distance for each specific time interval It ignores the temporal relationship between successive Wi Fi outputs Position adjustments are then computed by minimizing the error function The second method considers the temporal relationship and the movement constraint when the user moves around the area The tracking step are carried out by using particle filter The observation model of the particle filter are a combination between the Wi Fi data and Bluetooth data Both approaches are tested against real data which include up to four different users moving in an office environment While the first approach is only applicable in some specific scenarios the second approach has a significant improvement from the position output based on Wi Fi fingerprinting model only **A Wi-Fi-based Indoor Positioning System for Smartphones (Y5Way)** Ka-wai Wong,City University of Hong Kong. Run Run Shaw Library,City University of Hong Kong. Department of Computer Science,2013 **A Mobile-phone Based Indoor WiFi Positioning System** Haibin Guo,Hong Kong Polytechnic University. Faculty of Construction and Environment,2014 A Cost-effective Wi-fi Based Indoor Positioning System for Mobile Phones Richard J. Wandell,2018 Fingerprinting based Indoor Positioning Systems require a

significant amount of time to set up due to the need for signal map creation We propose a Wi Fi based mobile phone Indoor Positioning System that can be set up in a short amount of time in any environment with existing Wi Fi infrastructure We introduce interpolation into a fingerprinting based system to reduce the number of reference points needed leading to a reduction in signal map creation time The proposed interpolation method is used in conjunction with a particle filter algorithm to provide an accuracy level comparable to the current state of the art We create signal maps at three separate locations using a 100 % 50 % 20 % and 10 % scan in order to evaluate the effectiveness of our interpolation on the localization error on a lower scan percentage We evaluated our signal maps before and after interpolation using 16 tests which include both walking and stationary tests as well as tests taken two and three weeks after the initial data gathering We show that interpolation is able to reduce the effects of a dimensional mismatch between signal map reference point vectors and a test sample vector as well reduce the effects of signal map aging **A 3D Ubiquitous Multi-Platform Localization and Tracking System for Smartphone** Seyyed Mahmood Jafari Sadeghi,2017 We have designed and implemented an indoor outdoor localization system utilizing several sources of information to provide the accurate location of a smartphone tablet both indoors and outdoors In this system we merge the traditional indoor localization techniques based on Wi Fi fingerprinting with the recent methods which are mostly based on Bluetooth Low Energy BLE beacons to acquire a higher accuracy of positioning and also support a wider range of smartphones such as Android and iOS devices A new format for the advertisement packets of BLE beacons was proposed which embeds all parameters of the beacon including its location Also a transparent scheme is proposed and implemented which combines indoor localization techniques with Global Positioning System GPS to increase the accuracy of the indoor localization and also provides us with a soft switching between the GPS and indoor positioning We have shown that using a Medium Access Control MAC filtering method we can reduce the size of Wi Fi radiomap for fingerprinting techniques and hence reduce their complexity and run time The problem of tracking and floor detection is also investigated and promising results are achieved by using the sensors such as barometer and gyroscope We have also addressed the problem of large scale indoor positioning in which we have the fingerprinting database for thousands of buildings worldwide Efficient algorithms have been proposed to reduce the complexity and the management overhead of the Wi Fi fingerprints A cooperative method was proposed that allows iOS devices through BLE packets broadcast by Android phones tablets to localize themselves using Wi Fi fingerprints inside a building Finally a sensor transmission system for Android devices was built which allows us to simulate our algorithms in real time using real world data on a PC running Matlab software **Ubiquitous Positioning and Mobile Location-Based Services in Smart Phones** Chen, Ruizhi,2012-06-30 Many smart phone users reap the benefits of location based services While tracking users positions using their smart phone is an issue of concern for some others who use Foursquare or rely on their Android GPS view location based services as a necessity Ubiquitous Positioning and Mobile Location Based Services in Smart Phones

explores new research in smart phones with an emphasis on positioning solutions in smart phones smart phone based navigation applications mobile geographical information systems and related standards **Motion Assisted Indoor Smartphone Positioning in Sparse Wi-Fi Environments** Wasiq Waqar,2013 Smartphone-Based 3D Indoor Localization and Navigation Frank Ebner,2021-01-10 During the last century navigation systems have become ubiquitous and guide drivers cyclists and pedestrians towards their desired destinations While operating worldwide they rely on line of sight conditions towards satellites and are thus limited to outdoor areas However finding a gate within an airport a ward within a hospital or a university s auditorium also represent navigation problems To provide navigation within such indoor environments new approaches are required This thesis examines pedestrian 3D indoor localization and navigation using commodity smartphones A desirable target platform always at hand and equipped with a multitude of sensors The IMU accelerometer gyroscope magnetometer and barometer allow for pedestrian dead reckoning that is estimating relative location changes Absolute whereabouts can be determined via Wi Fi an infrastructure present within most public buildings or by using Bluetooth Low Energy Beacons as inexpensive supplement The building s 3D floorplan not only enables navigation but also increases accuracy by preventing impossible movements and serves as a visual reference for the pedestrian All aforementioned information is fused by recursive density estimation based on a particle filter The conducted experiments cover both theoretical backgrounds and real world use cases All discussed approaches utilize the infrastructure found within most public buildings are easy to set up and maintain Overall this thesis results in an indoor localization and navigation system that can be easily deployed without requiring any special hardware components **Indoor Positioning System Using Android** Haytham Idriss,2011 **Smartphone Applications** Yee-Hin Kwok,2013 **WiFiPoz -- an Accurate Indoor Positioning System** Xiaoyi Ye,2012 Location based services are becoming an important part of life Wide adoption of GPS in mobile devices combined with cellular networks has practically solved the problem of outdoor localization needs The problem of locating an indoor user has being studied only recently Much research contributed to the innovative concept of an indoor positioning system By analyzing different technologies and algorithms this thesis concluded that considering a trade off between accuracy and cost a Wi Fi based Fingerprint method is proved to be the most promising approach to determine the location of a mobile device However the Fingerprint method works in two phases an offline training phase collection of Received Signal Strength signatures and an online phase in which data from the first phase is used to determine the current position of a mobile user The number of training points in a certain area has a direct impact on the accuracy of the system As a result the offline phase is a tedious and cumbersome process and the positioning systems are only as accurate as the offline training phase has been detailed Moreover the offline phase must be repeated every time a change in the environment occurs To avoid these limitations we focus on improving the accuracy of the indoor positioning system without increasing the number of training points This thesis presents a Wi Fi based system for locating a user inside a building The system is named

WiFiPoz which means Wi Fi positioning system based on the zoning method WiFiPoz has a novel approach to Fingerprint method that incorporates Propagation and zoning methods Experimental results show that WiFiPoz is highly efficient both in accuracy and costs Compared to traditional Fingerprint methods with the optimization of the accuracy of the location estimation WiFiPoz reduces the number of training points This feature makes it possible to quickly adapt to changes in the environment In order to explore another possible solution this thesis also developed implemented and tested an indoor positioning system named GIS Geometric Information based positioning System which is based on a model proposed by another researcher Several experiments were run in the offline phase and results were compared between the traditional Fingerprint method GIS and proposed WiFiPoz We concluded that WiFiPoz is a more efficient and simple way to increase the accuracy of the location determination with fewer training points Document Indoor Location Based Services Using WiFi Mohammed Abdul Qadeer,Tanwee Kausar,Taru Saraswat,2013 The outdoor positioning system using GPS is well established and has been adopted throughout the world We have various applications on our smartphones like Google Maps Navigation where we can easily find a pathway to our destination or find nearby restaurants tourist attractions and many more However indoor positioning system is not so well established Research work are going on but bringing out its pragmatic nature has not yet got success on a large scale At few places indoor navigation system has been deployed but it is limited to private use It is not yet made public because of the complexities involved in it This project aims at making the indoor counterpart go public like that of outdoor positioning system by using Wi Fi access points Wi Fi access points are easily available in colleges office buildings airports metro stations and various other public places To exploit the infrastructure and cost effective nature of Wi Fi technology we have devised a methodology to establish positioning system inside a public place The availability of efficient mobile devices has paved the way for location based services and applications in internet domain **Design and Development of Indoor Positioning System** Muhammad Irshan Khan,2013 Indoor positioning and navigation in smart phones has become possible with the availability of good processors sensors and connectivity in smart phone The development of a system that utilizes these technologies for indoor positioning has been discussed This system integrates wifi positioning inertial sensors data and buildings map information for indoor navigation Micro electromechanical systems MEMS based gyroscopes and accelerometers have been used for providing pedestrian dead reckoning and a Bayesian filter based on Monte Carlo simulation particle filter has been designed for integration of wifi positioning pedestrian dead reckoning and buildings map information for indoor navigation This filter provides the state of the user estimated as a weighted mean of the approximated distribution obtained from particle filter The positioning system has been built with XSENS MTW IMU Acer ICONIA tablet running MATLAB The developed system provides indoor positioning with mean square error within 1 meter the error value of less than 2 5 m 95% of the time with the consistency of 96 86%

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