The Seamless Localization System Based on Indoor-Outdoor Environments Using Received Signal Strength for Android Platform System

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Presentation Outline

- Introduction
- Seamless Location works
- Implementation and Performance the seamless localization based RSSI
- The experiment results
- Conclusion

Introduction

- Mobility tracking has currently been an important need for many people in order to integrate different environments
- Location awareness is an example of localization technique
- The systems able to sense position in physical and computational environments such as the current location of a user, the relative location of people, hosts, accessible devices, network connectivity
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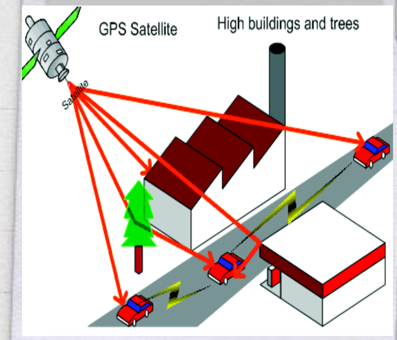
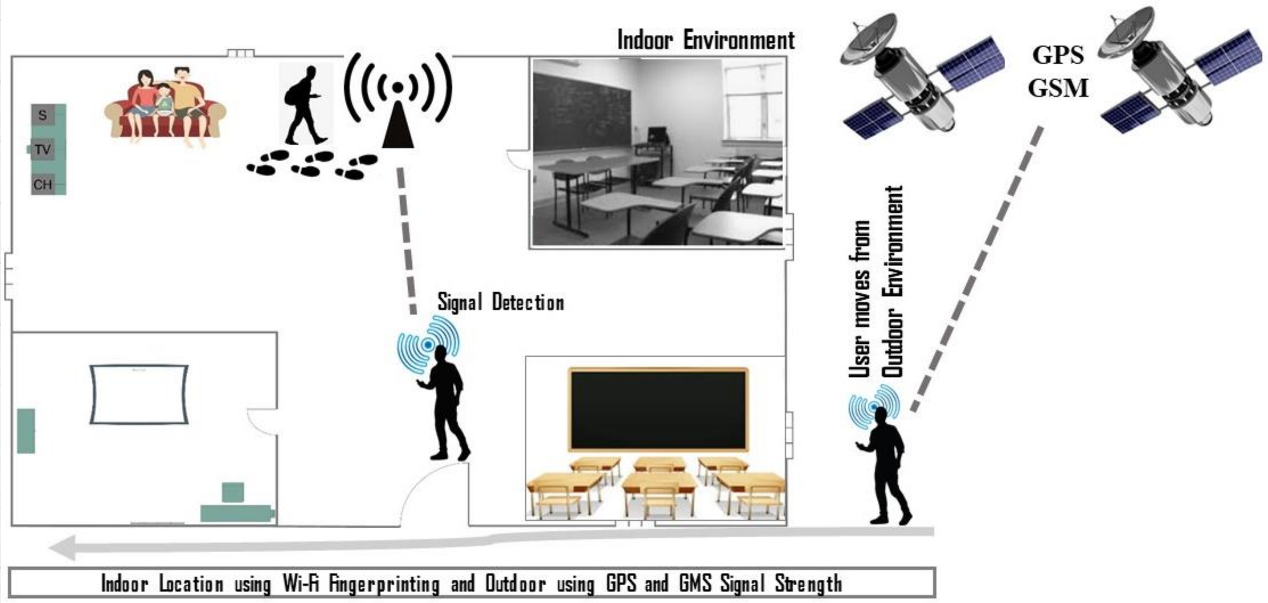
Seamless Location works

- A seamless indoor-outdoor navigation system based on GNSS (global navigation satellite system), INS (inertial navigation system)
- The federated Kalman filtering (FKF)
- Light sensor signal, the magnetic sensor signal and GNSS signal were integrated into navigation algorithm
- A real time Google map and Arduino- based vehicle tracking system with global positioning system (GPS) and global system for mobile communication (GSM) technology



Implementation and Performance

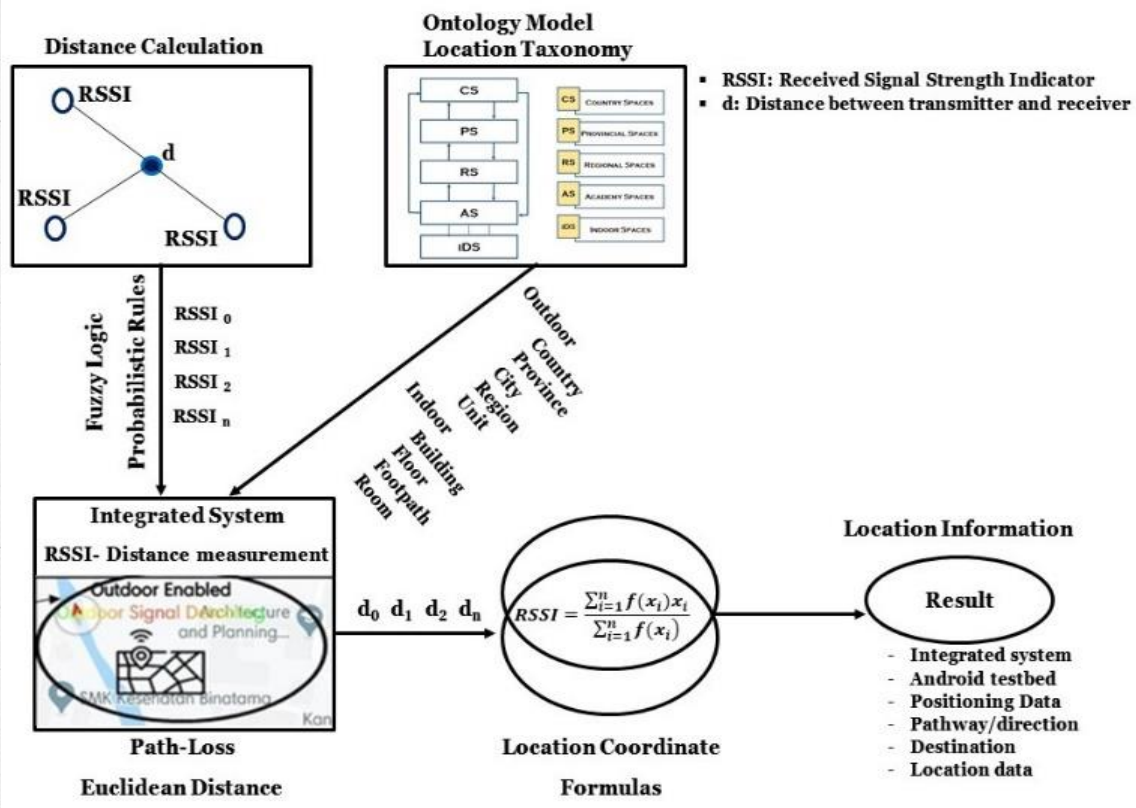
the seamless localization



- Wi-Fi for Indoor detection
- GSM & GPS for Outdoor detection

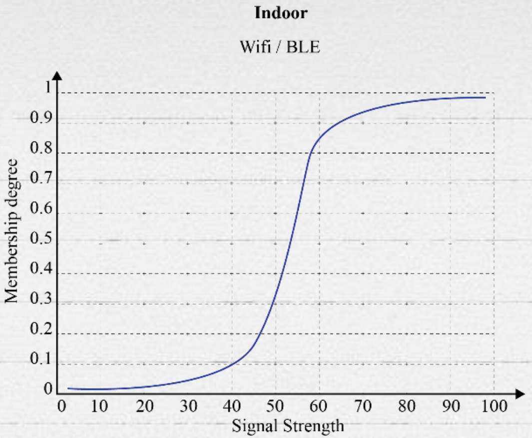
A combination between indoor and outdoor technologies to provide direction for the users by integrating the environment conditions seamlessly.

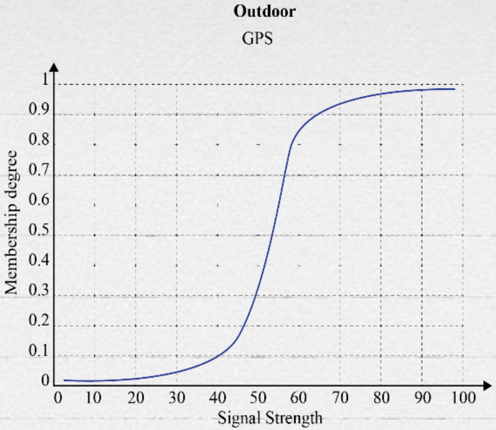
Integrated system design framework for all related components to be merged

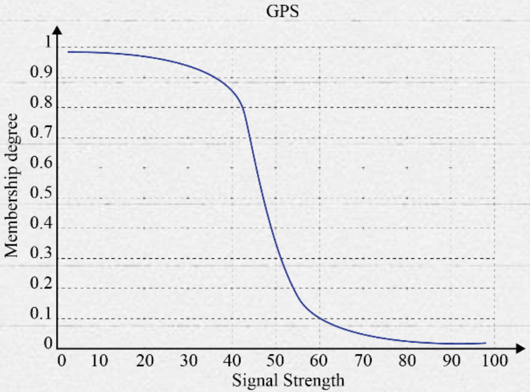


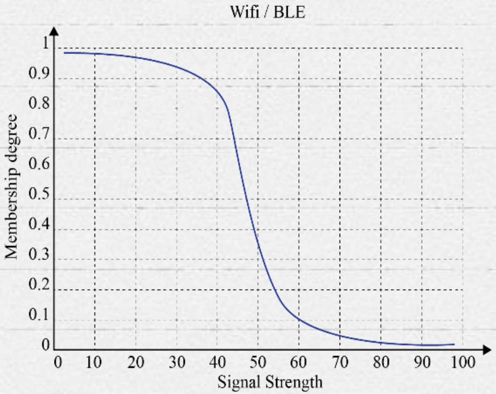
Implementation & Performance

Signal strength indication when movement of the user is detected









Implementation & Performance

Seamless or Integrated Location Tracking

Set	Degree of membership
Signal = GPS	xx
Signal = GSM	xx
Signal = Wi-Fi	xx
Available = few	yy
Available = some	yy
Available = several	yy
Strength = low	zz
Strength = moderate	zz
Strength = high	zz

Implementation & Performance

$$RSSI = \frac{\sum_{i=1}^{n} f(x_i)x_i}{\sum_{i=1}^{n} f(x_i)} \quad (2)$$

$$We\ also\ have:\ RSSI(d) = RSSI(d_0) - 10 \times n \times \log\left(\frac{d}{d_0}\right) \quad (3)$$

Distance Calculation

$$\begin{aligned} d_1^2 &= (x_1 - x)^2 + (y_1 - y)^2 + (z_1 - z)^2 \\ d_2^2 &= (x_2 - x)^2 + (y_2 - y)^2 + (z_2 - z)^2 \\ d_3^2 &= (x_3 - x)^2 + (y_3 - y)^2 + (z_3 - z)^2 \end{aligned} \quad (1)$$

$$d = 10^{\frac{RSSI(d_0) - RSSI(d)}{10 \times n}} \quad (4)$$

$$n = \frac{RSSI(d_0) - RSSI(d)}{10 \times \log(\frac{d}{d_0})} \quad (5)$$

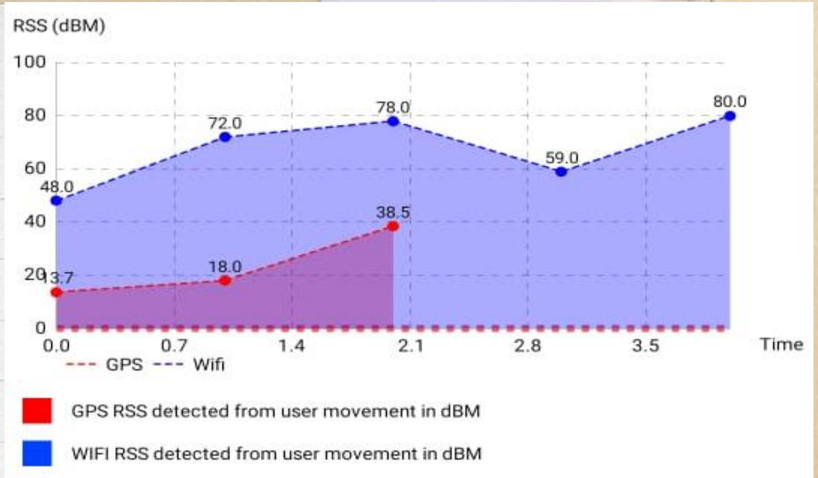
Result of the Experimental and Discussion

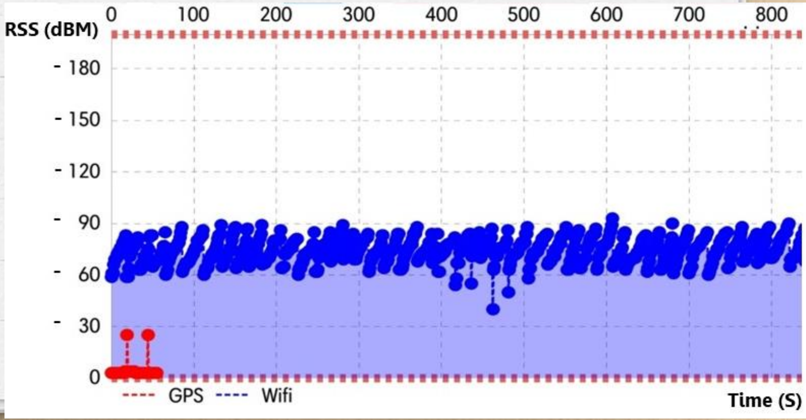
Location detecting based on outdoor (above) and indoor (below) conditions

- Received signal strength indication technique such as the fingerprinting method was utilized for the seamlessness of the localization together with Wi-Fi fingerprinting, GPS, and GSM networks
- The proposed system was programmed as an Android application running on Samsung Galaxy S7 Edge and integrated between outdoor and indoor environments to combine both technologies and scenarios
- The blue dot represented current positioning point of the user, while an indoor map location served as regions when the user hit the recorded path positions

Result of the Experimental and Discussion

- Signals strength based on GPS and Wi-Fi are detected in term of the user's movement. The blue dot is the available signal for Wi-Fi when the user moves from an outdoor to indoor region at the current positioning.
- The blue dot (Wi-Fi indication) will move forward and appear to users whenever they change position and time in terms of seconds. The graph increases or decreases depending on the signal strength detection at that moment.





Result of the Experimental and Discussion

At the seamless point, GPS, Wi-Fi values in Figure 5 are detected from the current location in real-time responding to the environment when the user arrived at his or her destination or stopped somewhere to check the available signals

CONCLUSION

- The proposed system is based on the Android application platform using the received signal strength indicator to prove the seamless scenario.
- Accordingly, the result indicated that the system is able to handle different situations and different locations that maintain the challenges introduced in this thesis.
- Moreover, the proposed system has indicated the certainty value of an accuracy in seamlessness terms that is 98.4% accuracy for outdoor to indoor movement and 97.7% accuracy for the opposite movement.
- This additional result ensures that the proposed system works together with the seamless scheme. This observation is made from outdoor conditions to overlapped and indoor regions which operate smoothly under the proposed system.

References

[1] K. N. Alinsavath, L. E. Nugroho, Widyawan, and K. Hamamoto, "The Seamlessness of Outdoor and Indoor Localization Approaches Based on a Ubiquitous Computing Environment: A Survey," in *Proceedings of the 2019 2Nd International Conference on Information Science and Systems*, New York, NY, USA, 2019, pp. 316–324. doi: 10.1145/3322645.3322690.

[2] Y. J. Lee and K. W. Lien, "Location Based Enabled Context Awareness Information Service," in *2009 International Conference on New Trends in Information and Service Science*, Jun. 2009, pp. 944–947. doi: 10.1109/NISS.2009.160.

[3] Y. Raja Vara Prasad and P. Rajalakshmi, "Context aware building energy management system with heterogeneous wireless network architecture," in *Wireless and Mobile Networking Conference (WMNC), 2013 6th Joint IFIP*, Apr. 2013, pp. 1–8. doi: 10.1109/WMNC.2013.6548976.

[4] W. Liu, X. Li, and D. Huang, "A survey on context awareness," in *Computer Science and Service System (CSSS), 2011 International Conference on*, Jun. 2011, pp. 144–147. doi: 10.1109/CSSS.2011.5972040.

[5] M. Jia, Y. Yang, L. Kuang, W. Xu, T. Chu, and H. Song, "An Indoor and Outdoor Seamless Positioning System Based on Android Platform," in *2016 IEEE Trustcom/BigDataSE/ISPA*, Aug. 2016, pp. 1114–1120. doi: 10.1109/TrustCom.2016.0183.

[6] W. Jiang, Y. Li, C. Rizos, B. Cai, and W. Shangguan, "Seamless Indoor-Outdoor Navigation based on GNSS, INS and Terrestrial Ranging Techniques," *J. Navig.*, vol. 70, no. 6, pp. 1183–1204, 2017, doi: 10.1017/S037346331700042X.

[7] S. Rezaei and R. Sengupta, "Kalman filter-based integration of DGPS and vehicle sensors for localization," *IEEE Trans. Control Syst. Technol.*, vol. 15, no. 6, pp. 1080–1088, 2007.

[8] Q. Zeng, J. Wang, Q. Meng, X. Zhang, and S. Zeng, "Seamless Pedestrian Navigation Methodology Optimized for Indoor/Outdoor Detection," *IEEE Sens. J.*, vol. 18, no. 1, pp. 363–374, Jan. 2018, doi: 10.1109/JSEN.2017.2764509.

[9] M. M. Rahman, J. R. Mou, K. Tara, and M. I. Sarkar, "Real time Google map and Arduino based vehicle tracking system," in *2016 2nd International Conference on Electrical, Computer Telecommunication Engineering (ICECTE)*, Dec. 2016, pp. 1–4. doi: 10.1109/ICECTE.2016.7879577.

Publications (2017 -2021) | International Conferences Papers

No	Title of Scientific Works	Name of the Conference / Organizer	Indexing Board	Status / Year
1	The Seamlessness of Outdoor and Indoor Localization Approaches based on a Ubiquitous Computing Environment: A Survey	2019 2nd International Conference on Information Science and Systems (ICISS2019) / Tokyo, Japan	ACM Digital Library	Published **2019**
2	Location Context Ontology Model Based On Ubiquitous Computing Environment	2019 the 9th International Workshop on Computer Science and Engineering (WCSE2019), Hong Kong.	Ei Compendex. SCOPUS	Published **2020**
3	Indoor Localization Implementation Based on Wi-Fi Fingerprinting for Android Platform System	The 12 Regional Conference on Computer Information and Engineering 2019 (RCCIE2019) / National University of Laos, Vientiane , Lao PDR.	Conference Proceeding	Published **2019**

Publications International Conferences Journals

No	Title of Scientific Works	Name of the Conference / Organizer	Indexing Board	Status / Year
1	Integration of multilayered context-aware control system for ubiquitous computing environment	Journal of Physics: Conference Series / IOP Science (IOP Publishing Ltd)	**SCOPUS Q4** Journal of Physics: Conference Series	Published **2019**
2	Indoor Location Tracking System Based on Android Application using Bluetooth Low Energy Beacons for Ubiquitous Computing Environment	Journal of Communications / Engineering and Technology Publishing	**SCOPUS Q4** DBLP; CrossRef, EBSCO, Google Scholar; etc.	Published **2020**
3	Integration of Indoor Localization System using Wi-Fi Fingerprint, Bluetooth Low Energy Beacon and Pedometer Based on Android Application Platform	International Journal of Intelligent Engineering and Systems / Intelligent Networks and Systems Society (INASS)	**SCOPUS (Q2)** Scimago, Crossref, EBSCOhost, Ulrich's, OAJI	Published **2020**
4	An Integrated System for the Seamless Localization and Specification of a Position Based on an Indoor-Outdoor Conditions in Ubiquitous Computing Environments	International Journal of Intelligent Engineering and Systems / Intelligent Networks and Systems Society (INASS)	**SCOPUS (Q2)** Scimago, Crossref, EBSCOhost, Ulrich's, OAJI	Published **2020**

Thank you very much

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