

INFORMATION ON DOCTORAL THESIS

1. Full name: Dương Ngọc Sơn 2. Sex: Male.....
3. Date of birth: 24/10/1996..... 4. Place of birth: Bac Giang
5. Admission decision number: 1200/QĐ-CTSV Dated: 29/12/2020
6. Changes in academic process: Change of supervisors, decision No. 528/QĐ-DHCN dated March 25, 2024
7. Official thesis title: Wireless localization algorithms for Location-Based Services
8. Major: Communication Engineering 9. Code: 9520208
10. Supervisors: Assoc. Prof. Đinh Thị Thái Mai (main supervisor) and Assoc. Prof. Lâm Sinh Công (secondary supervisor).....

11. Summary of the **new findings** of the thesis: The objective of this thesis is to develop wireless positioning or positioning assistance algorithms for GPS-denied environments such as indoor environments and urban outdoor environments. For indoor positioning using BLE, the thesis proposes novel methods based on geometric optimization, Least Square, or Artificial Neural Networks. They are all well-known, highly rigorous methods, trusted by many domestic and international scientists when researching indoor positioning problems. For outdoor positioning using 5G MIMO mmWave systems, the thesis develops novel channel parameter estimation methods to support positioning based on the renowned works of the positioning research group of Prof. Henk Wymeersch at Chalmers University of Technology, Sweden. They include assumptions that are not practically valid or have too high computational complexity. The basic algorithms used in this part are OMP family algorithms - a widely used class of algorithms for sparse channel estimation. Optimization algorithms to refine the coarse channel parameters used include coordinate descent, Newton Type algorithm, and Golden section search. The thesis uses algebraic analysis combined with simulation and real experiments to evaluate the performance of each proposed method. The main contributions are listed as follows:

Contribution 1: We introduce a novel beacon planning method for indoor positioning systems using BLE. It helps the system achieve relatively high accuracy with the least number of beacons.

Contribution 2: We introduce a novel beacon selection method for indoor localization based on Artificial Neural Network and weighted Least Square.

Contribution 3: We introduce a novel method that is a combination of the distributed StOMP algorithm and the modified Silhouette method. It outperforms the standard OMP method and achieves nearly the same recovery accuracy compared to the Simultaneous OMP method, even without prior knowledge of signal sparsity.

Contribution 4: We introduce a sparse channel estimation method that considers the interaction between paths in the beamspace channel. This method takes advantage of a special structure called Dirichlet to try to incorporate multiple Dirichlet functions into the signal representing the correlation between the columns of the sensing matrix and the received signal. The OMP algorithm that considers this problem gives a higher accuracy in determining the support set.

Contribution 5: We introduce a method for fine-tuning the coarse parameters for mmWave systems using coordinate descent, golden section search and least square. This method has a lower algorithmic complexity than a method using only Newton algorithm.

12. Practical applicability, if any:

13. Further research directions, if any: Utilizing machine learning to improve the accuracy of positioning using RSS and exploiting sensing functionality to support positioning in 6G networks.....

14. Thesis-related publications:

1. Thai-Mai Dinh-Thi, Ngoc-Son Duong, Quoc-Tuan Nguyen, "Developing a Novel Real-Time Indoor Positioning System Based on BLE Beacons and Smartphone Sensors," IEEE Sensors Journal, vol. 21, no. 20, pp. 23055-23068, Oct. 2021, doi: 10.1109/JSEN.2021.3106019. (ISI-Q1)

2. Ngoc-Son Duong, Thanh-Phuc Nguyen, Quoc-Tuan Nguyen, Thai-Mai Dinh Thi, "Improving indoor positioning system using weighted linear least square and neural network," International Journal of Sensor Networks, vol. 41, no. 2, pp. 67-77, Mar. 2023, doi: 10.1504/IJSNET.2023.129632. (ISI-Q3)

3. Ngoc-Son Duong, Lan-Nhi Vu Thi, Phuong-Dung Chu Thi, Sinh-Cong Lam, Thai-Mai Dinh Thi "A novel Distributed Stagewise Orthogonal Matching Pursuit algorithm for mmWave MIMO channel estimation," IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, <http://doi.org/10.1587/transfun.2024EAL2064>. (ISI-Q4)

4. Ngoc-Son Duong, Quoc-Tuan Nguyen, Thai-Mai Dinh-Thi, "OMP-Based Channel Estimation with Dynamic Grid for mmWave MIMO Positioning Systems," IEEE

Communications Letters, vol. 27, no. 10, pp. 2623-2627, Oct. 2023, doi: 10.1109/LCOMM.2023.3303453. (ISI-Q1)

5. Ngoc-Son Duong, Thu-Trang Nguyen, Lan-Nhi Vu Thi, Sinh-Cong Lam, Thai-Mai Dinh-Thi, "An improved OMP-based mmWave channel estimation for MIMO systems," in Proc. The 3rd International Conference on Advances in Information and Communication Technology, 2024, doi: 10.1007/978-3-031-80943-9_97

6. Ngoc-Son Duong, Quoc-Tuan Nguyen, Khac-Hoang Ngo, Thai-Mai Dinh-Thi, "Sparse Bayesian Learning with Atom Refinement for mmWave MIMO Channel Estimation," in Proc. IEEE Statistical Signal Processing Workshop (SSP), 2023, doi: 10.1109/SSP53291.2023.10208044.

7. Ngoc-Son Duong, Quoc-Tuan Nguyen, Thai-Mai Dinh-Thi, "mmWave Channel Estimation for Location-based Application in 5G MIMO systems," in Proc. 2022 IEEE Region 10 Conference (TENCON), Hong Kong, 2022, pp. 1-6, doi: 10.1109/TENCON55691.2022.9977818.

8. Ngoc-Son Duong, Ngoc-Thuy Nguyen, Phuong-Dung Chu-Thi, Quoc-Tuan Nguyen and Thai-Mai Dinh-Thi, "Cải thiện độ chính xác của hệ thống định vị trong nhà dựa trên phân tích lỗi truyền lan", The 24nd National Conference on Electronics, Communications and Information Technology (REV-ECIT), Hanoi, 2021.