

INFORMATION ON DOCTORAL THESIS

1. Full name: Duong Thi Hang 2. Sex: Female
3. Date of birth: September 3, 1978 4. Place of birth: Bac Giang
5. Admission decision number: 778/QĐ-CTSV dated August 21, 2017 by the Rector of the University of Engineering and Technology, Vietnam National University, Hanoi.
6. Changes in academic process:

- An additional co-supervisor was appointed according to Decision No. 618/QĐ-ĐT dated September 4, 2020, by the Rector of the University of Engineering and Technology.

Previous responsibility (According to Decision No. 1000/QĐ-ĐT dated October 17, 2017):

- Principal Supervisor: Assoc. Prof. Dr. Trinh Anh Vu, University of Engineering and Technology.

New adjustment:

- Principal Supervisor: Assoc. Prof. Dr. Trinh Anh Vu, University of Engineering and Technology.
- Co-Supervisor: Dr. Hoang Manh Kha, Hanoi University of Industry.

- The title of the doctoral dissertation was changed according to the resolution of the grassroots-level doctoral dissertation evaluation council on November 30, 2023.

Previous title: Research on the Development of Indoor Positioning Techniques Using Wi-Fi Signals.

7. Official thesis title: Performance Enhancement of Indoor Positioning based on Wi-Fi Signals and Inertial Sensor Data

8. Major: Telecommunications Engineering 9. Code: 9510302.02

10. Supervisors:

1. Assoc. Prof. Dr. Trinh Anh Vu
2. Dr. Hoang Manh Kha

11. Summary of the **new findings** of the thesis:

Ojectives and research subjects of the dissertation:

The objective of the dissertation is to develop solutions to improve the accuracy of indoor positioning estimation using machine learning. The research subjects include machine learning and deep learning models, such as LSTM, CNN, KNN, and data feature extraction methods like PCA and TSVD, aiming to enhance positioning performance in complex environments like buildings or enclosed spaces.

Research Methods:

The dissertation employs several modern research methods, including:

- **Stacked Models:** Proposing and evaluating the effectiveness of a simple yet efficient model for step length estimation combined with PDR techniques.
- **Combining Machine Learning and Deep Learning:** Proposing a data augmentation solution that integrates KNN for data partitioning and model utilization.
- **Data Feature Extraction:** Utilizing methods like PCA and TSVD in combination with LSTM or WKNN and Linear Regression or KNN Regression models.

Propose a solution to use some extra statistical features extracted from the raw data set and the stacked ensemble model to improve the accuracy of stride length estimation in pedestrian dead reckoning (PDR).

12. Practical applicability, if any:

The dissertation proposes effective solutions for improving the accuracy and performance of indoor positioning systems. These contributions are not only scientifically significant but also offer high practical value, opening opportunities for the development and application of positioning systems in areas such as navigation, warehouse management, and emergency rescue operations. The proposed solutions meet economic and technical objectives and have potential real-world applications in practical environments.

13. Further research directions, if any:

- Propose combining PDR techniques with models using Wi-Fi data to improve positioning prediction accuracy.
- Propose optimizing the hyperparameters for deep learning models using natural optimization algorithms for indoor positioning systems.
- Propose improving accuracy in step counting, combining step length estimation, and movement direction estimation to enhance positioning predictions using PDR.

14. Thesis-related publications:

[CT1] **Duong, H. T.**, Hoang, K. M., Pham, H. V., & Trinh, V. A. (2022), “High-Performance Stacked Ensemble Model for Stride Length Estimation with Potential Application in Indoor Positioning Systems”. *Journal of Communications*, 17(8). DOI:10.12720/jcm.17.8.652-660. (**Scopus, Q3**)

[CT2] **Duong, H.**, M. K. Hoang, A. V. Trinh, and T. Pham Thi Quynh, (2023), “High Accuracy Indoor Positioning Approach Using KNN and LSTM Algorithms”. *Journal of Military Science and Technology*, vol. 86, no. 86, pp. 48-55. DOI: <https://doi.org/10.54939/1859-1043.j.mst.86.2023.48-55>.

[CT3] **Duong, T. H.**, Trinh, A. V., & Hoang, M. K. (2023, October), “An Enhancement of Indoor Localization using PCA-aided LSTM Approach”, In *2023 International Conference on Advanced Technologies for Communications (ATC)* (pp. 512-516). *IEEE (Scopus)*.

[CT4] **Thi Hang Duong**, Anh Vu Trinh, and Manh Kha Hoang, (2023), “Efficient and Accurate Indoor Positioning System: A Hybrid Approach Integrating PCA, WKNN, and Linear Regression”, *Journal of Communications*, vol. 19, no. 1, pp. 37-43. (**Scopus, Q3**).

[CT5] **Hang Duong Thi**, Kha Hoang Manh, Vu Trinh Anh, Trang Pham Thi Quynh, Tuyen Nguyen Viet (2023), “Dimensionality Reduction with Truncated SVD and K nearest neighbour Regression for Indoor Localization”. *International Journal of Advanced Computer Science and Applications*, IJACSA Volume 14 Issue 10. (**ISI/Scopus, Q3**).

Date: August 12, 2024

Supervisor

Signature:

Signature:

Date: August 12, 2024

Phd Student

Signature:

Full name:

Assoc. Prof. Dr. Trinh Anh Vu

Full name:

Dr. Hoang Manh Kha

Full name:

Dương Thị Hằng