VIETNAM NATIONAL UNIVERSITY, HANOI
VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

INFORMATION ON DOCTORAL THESIS

1. Full name : PHAM HAI DANG 2. Sex: Male

3. Date of birth: 25-08-1991 4. Place of birth: Ha Noi

5. Admission decision number: 1200/CTSV Dated December 29, 2020

6. Changes in academic process: Adjust the thesis topic name according to Decision No. 1477/QĐ-ĐHCN dated July 11, 2025

7. Official thesis title: Research, Development of Modern Machine Learning Methods to Enhance Person Re-Identification Performance

8. Major: Information System 9. Code: 9480104

10. Supervisors:

Ass. Prof. Dr. Nguyen Ngoc Hoa – VNU University of Engineering and Technology.

Ass. Prof. Dr. Nguyen Ngoc Tu – Kennesaw State University.

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

11.1 Research Objectives and Subjects

In the context of rapid urbanization and the increasing depth of digital transformation, surveillance camera systems have become an indispensable tool for ensuring security, maintaining public order, and monitoring behavior in public spaces. However, as the number of cameras continues to grow, manual monitoring and analysis of visual data by humans is becoming increasingly impractical and inefficient. This reality highlights the urgent need for automated surveillance solutions, with person re-identification (ReID) emerging as a key problem—aimed at identifying and tracking individuals across multiple camera views. Effectively addressing this problem not only enhances timely response capabilities but also supports investigation processes and ensures security in large-scale surveillance systems. Stemming from these practical demands, this dissertation aims to research and develop modern machine learning methods to improve the performance of person re-identification, focusing on three specific approaches: supervised learning, unsupervised domain adaptation, and fully unsupervised learning.

Research Subjects: Images captured from surveillance cameras, specifically from benchmark datasets such as CUHK03, Market-1501, DukeMTMC-reID, MSMT17;

along with systems, models, methods, and deep learning algorithms applied to the person re-identification problem..

11.2 Research Methodology

- Theoretical Method: Study of foundational knowledge in deep learning and person re-identification, with a focus on techniques such as supervised learning, unsupervised learning, unsupervised domain adaptation, clustering algorithms, and pseudo-labeling, aimed at establishing a solid scientific basis for model development.
- Analysis and Synthesis: Collection and evaluation of existing research works, source code, and experimental results to identify current research trends and serve as a foundation for proposing improvements.
- Modeling: Formulation of the person re-identification problem as a system comprising input images, feature extraction modules, embedding space, and similarity measures, facilitating experimentation and implementation.
- Experimental Method: Implementation and evaluation on benchmark datasets (CUHK03, Market-1501, DukeMTMC-reID, MSMT17) using metrics such as Rank-1 accuracy and mean Average Precision (mAP), and comparison with state-of-the-art methods.

11.3 Research Contributions

- Under the supervised learning approach, the proposed SCM-ReID method employs supervised contrastive loss in combination with four commonly used loss functions (classification loss, triplet loss, center loss, and centroid triplet loss), enabling the model to learn more discriminative features and achieve better generalization.
- Under the unsupervised domain adaptation approach, the proposed IQAGA and DAPRH methods integrate several strategies: reducing the distribution gap between source and target domains using GAN and Domain-Invariant Mapping (DIM), assessing image quality to adjust training weights, combining local and global features to enhance representational capacity, and refining soft pseudo-labels based on cluster centroid distances to improve stability and accuracy.
- Under the unsupervised learning approach, the proposed ViTC-UReID method leverages the Vision Transformer (ViT) architecture as a replacement for CNN to enhance global feature representation. It also incorporates camera information to learn view-specific features, thereby improving the performance of unsupervised person re-identification.

12. Practical applicability, if any: The results of this dissertation bring many practical applications to intelligent surveillance systems. By linking the identity of the same individual across one or multiple cameras, the system can accurately trace movement history, support behavior analysis in spatio–temporal contexts, and integrate data from various observation sources into a comprehensive picture. This enables authorities to conduct more effective surveillance at airports, train stations, shopping centers, and other crowded public areas. In practice, in locations where this technology has been

deployed, person re-identification has played an important role in intelligent surveillance systems by enabling early detection of abnormal behaviors, reducing crime rates, and enhancing public safety.

13. Further research directions, if any: First, applying or flexibly combining novel loss functions can help optimize the feature space and enhance identity discrimination. Second, the quality of GAN-generated images can be improved through appropriate constraints, or replaced with more advanced data augmentation techniques such as diffusion models to increase data diversity. Third, evaluations should be extended across different backbone architectures and more diverse real-world datasets to verify model stability and generalization. Finally, more effective pseudo-label refinement strategies can be explored to further improve performance in unsupervised training.

14. Thesis-related publications:

1. Anh D. Nguyen, **Dang H. Pham**, and Hoa N. Nguyen, "GAN-based Data Augmentation and Pseudo-Label Refinement for Unsupervised Domain Adaptation Person Re-Identification", ICCCI 2023 - 15th International Conference on Computational Collective Intelligence. https://doi.org/10.1007/978-3-031-41456-5_45. (WoS, Scopus).
2. **Dang H. Pham**, Anh D. Nguyen, Long V. Vu and Hoa N. Nguyen, "IQAGA: Image Quality Assessment-Driven Learning with GAN-Based Dataset Augmentation for Cross-Domain Person Re-Identification", SOICT 2023 - 12th International Symposium on Information and Communication Technology. https://doi.org/10.1145/3628797.3628961. (WoS, Scopus).
3. **Dang H. Pham**, Anh D. Nguyen and Hoa N. Nguyen, "GAN-based Data Augmentation and Pseudo-Label Refinement with Holistic Features for Unsupervised Domain Adaptation Person Re-Identification", Journal of Knowledge-Based Systems, Elsevier.

   https://doi.org/10.1016/j.knosys.2024.111471. (SCI-E, Q1-Scopus).
4. **Dang H. Pham** and Hoa N. Nguyen "SCM-ReID: Enhancing Person Re-Identification by Supervised Contrastive-Metric Learning and Hybrid Loss Optimization", Journal of Electronic Imaging.

   https://doi.org/10.1117/1.JEI.34.4.043001. (SCI-E, Q3-Scopus)
5. **Dang H. Pham**, Tu N. Nguyen, Hoa N. Nguyen "ViTC-UReID: Enhancing Unsupervised Person ReID with Vision Transformer Image Encoder and Camera-Aware Proxy Learning", Journal of Computer Science and Cybernetics. (Accepted)