UNIVERSITY OF ZAGREB
FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING
DIGITAL IMAGE PROCESSING AND ANALYSIS

VPR VISUAL PLACE RECOGNITION

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VISUAL PLACE RECOGNITION

- various domains of application
- using visual information
- role of deep learning and computer vision
- CNN models and specialized VPR models

OVERVIEW OF METHODS

ResNet

- „residual” connections
- output directly passed to the next layer

NetVLAD

- efficient aggregation of local descriptors into a powerful global image representation

DenseNet

- connecting each layer to all previous layers
- richer set of features

TransVPR

- transformer architecture
- frequent changes in visual information

RELATED WORK

- comparation of neural networks and transformers
- transformers proved to be much better
  - mechanism to process all parts of the input data simultaneously
- sequence matching
- sequential descriptors
- global descriptors

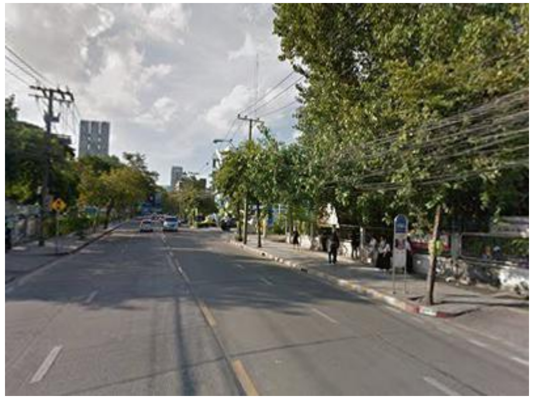
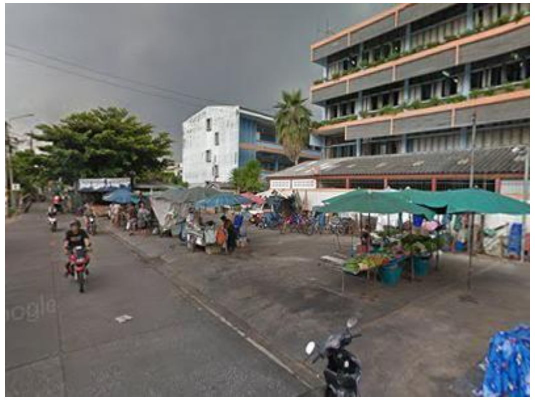
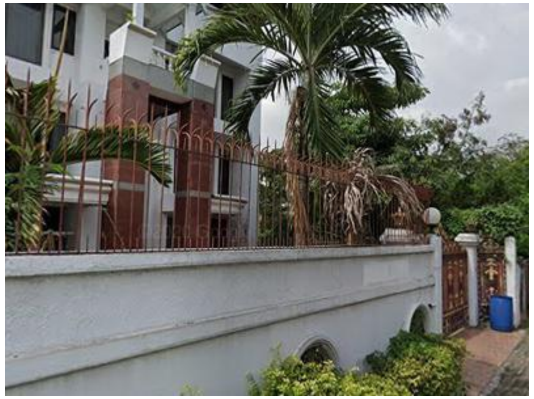
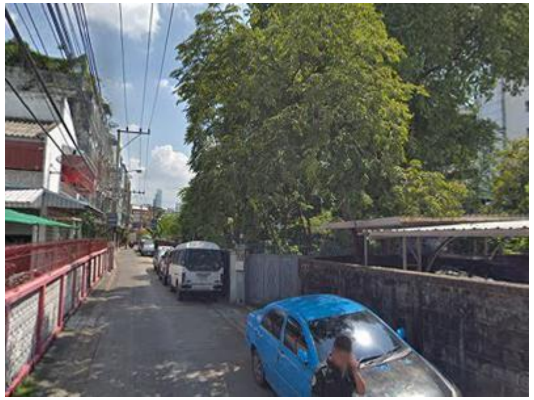
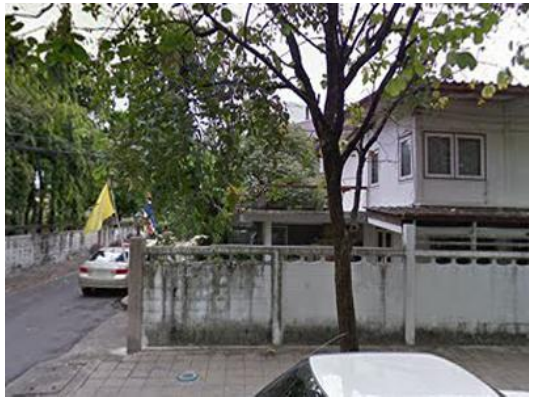
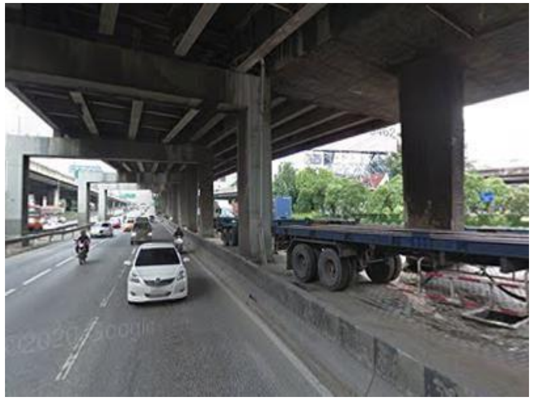
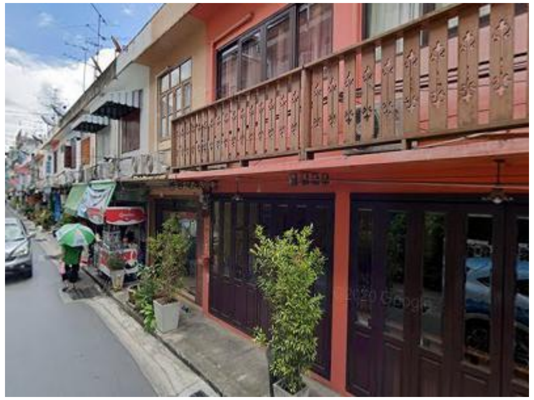
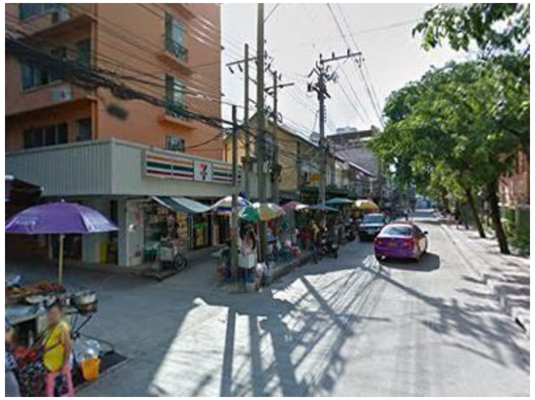
USED MATERIALS AND METHODS

1. DATASET
2. IMPLEMENTED SOLUTION
3. RESULTS

DATASET – GSV-CITIES

- *Neurocomputing 2022: GSV-Cities: Toward Appropriate Supervised Visual Place Recognition*
- 530 000 images from over 62 000 different locations
- common image dataset problems:
    - geographical coverage
    - precision of reference dana
    - perceptual diversity

GSV-CITIES – BANKOK

IMPLEMENTED SOLUTION

1. DATA PREPARATION
2. SELECTION OF OPTIMAL HYPERPARAMETERS
3. MODEL DEFINITION
4. MODEL TRAINING
5. MODEL EVALUATION

1.

DATA PREPARATION

- CustomImageDataset
- image transformations:
    - resizing to 224x224 pixels
    - random horizontal flipping
    - normalization
    - conversion to tensors

2.

SELECTION OF OPTIMAL HYPERPARAMETERS

- different learning rates
- different optimization algorithms (SGD and Adam)
- different batch sizes
- 5% of the data

3. MODEL DEFINITION

- pre-trained ResNet18 model

4. MODEL TRAINING

- cross-validation and EarlyStopping
- 50 epochs

5. MODEL EVALUATION

- overall loss and accuracy on training, validation and test sets

RESULTS

TRAINING	VALIDATION	TEST
LOSS	LOSS	LOSS
0.0308	**0.2678**	**0.2693**
ACCURACY	ACCURACY	ACCURACY
99.20%	**91.49%**	**91.53%**

CONCLUSION

- significant enhancement of VPR system capabilities
- high efficiency demonstrated on the GSV-Cities dataset
- potential for better results with further research and refinement of transformer-based models
- wide range of possible applications of VPR

VPR
VISUAL PLACE RECOGNITION

THANK YOU!
FOR YOUR ATTENTION

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LITERATURE

[1] R. Mereu, G. Trivigno, G. Berton, C. Masone, B. Caputo, "**Learning Sequential Descriptors for Sequence-based Visual Place Recognition**", 2022.

[2] S. Sundar Kannan, B. Min, "**PlaceFormer: Transformer-based Visual Place Recognition using Multi-Scale Patch Selection and Fusion**", 2024.

[3] A. Ali-bey, B. Chaib-draa, P. Giguère "**GSV-CITIES: Toward Appropriate Supervised Visual Place Recognition**"