2022 School of EECMS Summer Internship Application Form

Main Supervisor	Dr Sonny Pham
Is the main supervisor an ECR/MCR?	YES/NO
Other supervisors (if applicable)	Dr Susannah Soon Prof Tom Gedeon Yue Yao (ANU)
Project Title	Exploring deep learning using generated synthetic images via Unity simulations
Duration of project (select between 4 and eight weeks)	8 weeks
Project Description	Artificial Intelligence (AI) techniques in computer vision, image processing, data analytics etc., have seen phenomenal growth. Often, these rely on deep neural networks, requiring large datasets for their success. In particular, large, annotated datasets are required when using supervised learning e.g. Figure 1. [2, 3, 6, 7]. Whilst models can be trained with limited annotated data, the resulting performance can be reduced. Such consequences are more critical in specialised applications, such as defence and medical image analysis. In such domains, it is often hard to collect and annotate real data, and impractical to access comparable image datasets. Our project involves training autonomous vehicles to drive in a streetscape environment. Here, we extend successful vehicle identification work using synthetic imagery [10], by generating rich and effective synthetic image data using Unity simulations (e.g. Unity Simulation and the LGSVL Simulator) [8] and Unity's Computer Vision [9] capabilities. We would like to examine various approaches to generating synthetic imagery via Unity, this involves developing a digital twin of the environment, and examining the pipeline process of capturing tens of thousands of streetscape screenshots as training data to train the vehicles' autonomous behaviour. There are some existing synthetic image examples e.g. Figure 2 [1, 4, 5], however, the scale of the datasets, and image features are unsuitable for our specific scene characteristics. We expect that Unity generated synthetic data will enable us to fine-tune control the images captured: the level of detail and features; different weather and lighting conditions, and the quality of rendering. In addition, the workflow developed will allow us to automate training and testing easily with custom scripts. Given the current limited number of new training samples, this approach will allow us to augment the

simulation models to generate new synthetic data consistent with the real data. This approach will overcome the inherent limitations of other data augmentation approaches in that the output can be more diverse and desirable characteristics can be controlled more easily. We demonstrate the effectiveness of the proposal on semantic scene segmentation [6, 7].

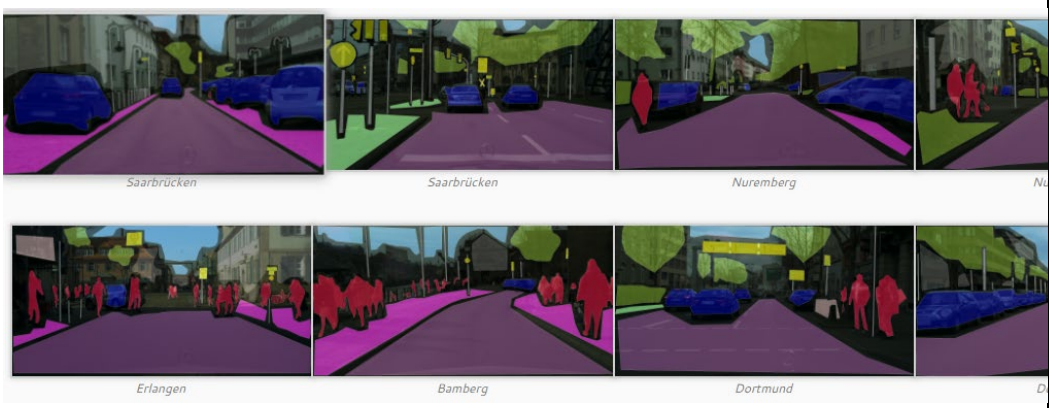

Figure 1. Example of annotated real imagery from the Cityscapes dataset.
Source: https://www.cityscapes-dataset.com/examples/#fine-annotations

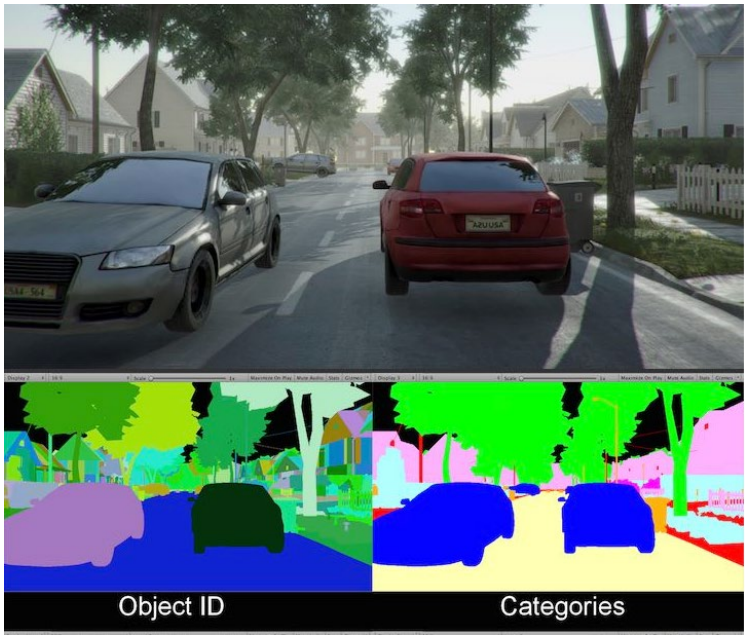

Figure 2. Example of some Unity generated imagery and annotations.
Source: https://blog.stratospark.com/generating-synthetic-data-image-segmentation-unity-pytorch-fastai.html

References

[1] AirSim simulator, https://microsoft.github.io/AirSim/

[2] Bowles, C., L. Chen, R. Guerrero, P. Bentley, R. Gunn, A. Hammers, D. Dickie, M. Hernández, J. Wardlaw, and D. Rueckert. Gan augmentation: Augmenting training data using generative adversarial networks. arXiv preprint arXiv:1810.10863, 2018.

[3] Cityscapes dataset, https://www.cityscapes-dataset.com/examples/#fine-annotations

[4] Smart Camera Outdoor, https://github.com/Unity-Technologies/Unity-Simulation-Smart-Camera-Outdoor

[5] Generating Synthetic Data for Image Segmentation with Unity and PyTorch/fastai https://blog.stratospark.com/generating-synthetic-data-image-segmentation-unity-pytorch-fastai.html

[6] Singha, T., D.-S. Pham, and A. Krishna. FANet: Feature Aggregation Network for Semantic Segmentation. In Proc. Digital Image Computing: Techniques and Applications (DICTA), pages 1–8. IEEE, 2020.

[7] Singha, T., D.-S. Pham, A. Krishna, and J. Dunstan. Efficient segmentation pyramid network. In Proc. International Conference on Neural Information Processing, pages 386–393. Springer, 2020.

[8] Unity Simulation and the LGSVL Simulator, https://unity.com/products/unity-simulation

[9] Unity Computer Vision, https://unity.com/products/computer-vision

[10] Yao, Y, Zheng, L., Yang, X, Naphade, M., Gedeon, T., Simulating Content Consistent Vehicle Datasets with Attribute Descent, European Conference on Computer Vision – ECCV 2020, pp 775-791.