Yuwen Heng, PhD

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🏛 Education

University of Southampton	**Southampton, UK**
Doctor of Philosophy in Computer Science, Vision, Learning and Control Research Group	2020–Aug. 2023
University of Edinburgh	**Edinburgh, UK**
Master of Science in Data Science, Distinction	2019–2020
University of Edinburgh	**Edinburgh, UK**
Bachelor of Engineering with Honours in Electronics and Electrical Engineering, Second Class, Division 1	2015–2017
North China Electric Power University	**Beijing, China**
Bachelor of Engineering in Electrical Engineering and its Automation, GPA: 3.36	2013–2015

ℝᴳ Research Interest

Computer Vision and its Applications, particularly multi-modal material segmentation and panoramic depth estimation for immersive sound rendering, perception in autonomous driving (with a focus on sensor-fusion solutions), and the caption-based image retrieval method for data mining and corner-case generation.

🔧 Research Projects

Dense Material Segmentation for Scene-Aware Spatial Audio Rendering   Sep 2020–Now

- Research Description: This project aims to provide material labels for reconstructed 3D indoor scenes to synthesise spatial audio with multiple reflections and reverberation effects. Supervised by Dr. Hansung Kim and Dr. Srinandan Dasmahapatra at the University of Southampton.
- Research Background: Achieving accurate material segmentation for 3-channel RGB images is challenging due to the considerable variation in the appearance of a material. Moreover, the material datasets have sparse labels, where only a small region of the image is annotated. The sparse datasets present a significant challenge in recovering accurate material boundaries for lack of labelled samples near boundaries. To address these issues, multiple neural networks are proposed to enhance segmentation accuracy by incorporating material features along with contextual features related to objects and scenes.
- Research Achievements:
  1. Proposed and implemented a material labelling enhancement method based on semi-supervised learning (self-training).
  2. Introduced a semi-global contextual feature learning method utilising boundary loss.
  3. Designed a dynamic cross-resolution feature learning method based on transformer architecture.
  4. Developed a material feature learning method based on a camera model and hyperspectral image reconstruction.

  These contributions have resulted in achieving the highest accuracy of 88.34% on the test data. Furthermore, six papers have been published in conferences such as EUSIPCO, ICASSP, BMVC, and IEEE VR, and one chapter in the Springer CCIS journal. Additionally, one journal paper has been submitted to IEEE Trans. Image Process. and another conference paper has been submitted to AAAI.

Data Reduction for Supervised Training 📄 🐙   Feb 2020–Nov 2020

- This project is part of my MSc dissertation, supervised by Dr Cao Yang, at the Laboratory for Foundations of Computer Science (LFCS), University of Edinburgh.
- Surveyed existing data reduction techniques for machine learning, focusing on instance selection algorithms and non-uniform sampling algorithms. Implemented the algorithms with scikit-learn and TensorFlow in Python.
- Analytically and empirically evaluated the relative accuracy of training over reduced datasets and original datasets.
- Proposed a new workflow to adapt the algorithms to work with image datasets and convolutional neural networks (CNN) by extracting image features first with pre-trained network parameters.
- Designed a new instance selection algorithm to weight the instances based on classification difficulty and the decision boundary in extracted feature space.

📖 Publications

- Yihong Wu, Yuwen Heng, Mahesan Niranjan, and Hansung Kim. Depth estimation for a single omnidirectional image with reversed-gradient warming-up thresholds discriminator. In *2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2023
- Yuwen Heng, Srinandan Dasmahapatra, and Hansung Kim. Material recognition for immersive interactions in virtual/augmented reality. In *2023 IEEE conference on virtual reality and 3D user interfaces abstracts and workshops (VRW)*, pages 577–578. IEEE, 2023
- Yuwen Heng, Yihong Wu, Srinandan Dasmahapatra, and Hansung Kim. Enhancing material features using dynamic backward attention on cross-resolution patches. In *33rd British Machine Vision Conference 2022, BMVC 2022, London, UK, November 21-24, 2022*. BMVA Press, 2022a
- Yuwen Heng, Yihong Wu, Hansung Kim, and Srinandan Dasmahapatra. Cam-segnet: A context-aware dense material segmentation network for sparsely labelled datasets. In *17th International Conference on Computer Vision Theory and Applications (VISAPP)*, volume 5, pages 190–201, 2022b
- Alawadh Mona, Wu Yihong, Heng Yuwen, Niranjan Mahesan, and Kim Hansung. Room acoustic properties estimation from a single 360° photo. In *2022 30th European Signal Processing Conference (EUSIPCO)*. IEEE, 2022
- Yihong Wu, Yuwen Heng, Mahesan Niranjan, and Hansung Kim. Depth estimation from a single omnidirectional image using domain adaptation. In *European Conference on Visual Media Production (CVMP)*, pages 1–9, 2021

📝 Patents

Contributed to the development of 1 invention patent, 2 utility model patents, and 1 design patent.

💼 Work Experience

🐾 Baidu ACG   Shanghai, China
Internship in Computer Vision, Autonomous Driving   Dec 2021–Aug 2023

- Job Summary: Responsible for algorithm solution design, handling various business areas including autonomous driving simulation, data mining, automated annotation, automated quality assessment, and ground truth system. Also actively involved in innovative research in 3D point cloud detection and giant image retrieval model.
- Key Outputs of the Algorithm Team:
  1. Autonomous Driving Simulation: Developed a containerised simulation environment based on Carla and ROS using Docker. Integrated custom algorithms and loaded scenarios for autonomous driving simulation and evaluation. Collaborated with the platform development team to provide an early-stage autonomous driving simulation platform for external showcase in Baidu Cloud.
  2. Data Mining: Implemented data mining services based on 2D and 3D detection models, giant image retrieval models, and time-series vehicle sensor data. The service includes mining static scenes such as traffic lights, traffic participants, and barriers and dynamic scenes involving turns, cut-ins, cut-outs, and lane changes. The service shortened the data acquisition and annotation process.
  3. Automated Annotation: Utilised a large volume of annotated data within Baidu to train seven major models, including 3D detection and lane line recognition. These models were then validated by the internal annotation team, demonstrating an overall improvement of 30% in annotation efficiency.
  4. Automated Quality Assessment: Implemented an overfitting training approach to identify deviations from the overall annotation standards within labelled data. Successfully eliminated the need for one round of manual inspection process.
  5. Ground Truth System: Provided algorithmic support for Baidu Ground Truth System, including two application scenarios: cloud-based ground truth inference and on-vehicle ground truth visualisation. Main algorithms include 2D and 3D detection, lane line detection, multi-object tracking, trajectory reconstruction and prediction.

Beijing Overleap technology Limited   Beijing, China
AR Engineer   Jul 2017–May 2018

- Beijing Overleap was a start-up company founded by two of my classmates and me, aimed at developing cost-effective augmented reality (AR) hardware.
- Responsible for developing prototype AR software with the development toolkit, Vuforia in Java.

- Modified the render-related Java classes of Vuforia to apply affine translations to each frame so that the applications developed for mobile phones can run on our eyewear hardware without modifying the 3D resources and the application scene.
- Attended competitions and wrote the business plan to raise money for the company with my team. Successfully raised one million Chinese Yuan and built fully functional products for a science museum with 3D printed structures.

🏆 Awards

Overseas Students Pioneer Park; Creative Returnees Team	2017
2nd iCAN HongGuTan Cup VR/AR Innovation & Entrepreneurship Competition; Winning Team	2017
Hangzhou Overseas Returnees Innovation & Entrepreneurship Competition; Outstanding Young Returnees	2016