

3D Urban Tree Modelling for Environmental Studies

Like Gobeawan

26 July 2022

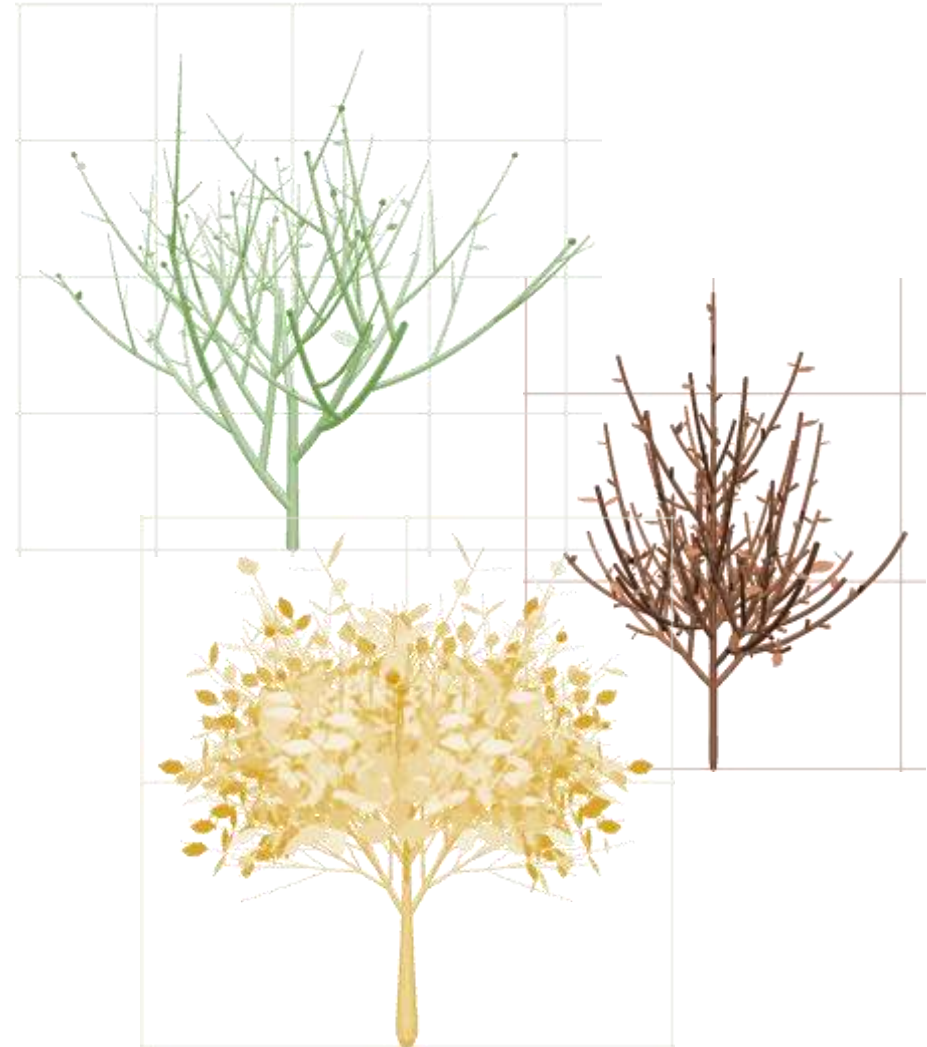
3D Urban Tree Modelling

Motivation

Challenges

Approach

Use cases



Motivation for 3D Urban Tree Modelling

Digital twin city : static urban furniture + organic vegetation (millions of trees and other greeneries)

Representative tree models in digital twin city

environmental simulations, city planning, agriculture, education, entertainment,



Picture courtesy of Dassault Systemes for Virtual Singapore

Challenges in 3D Urban Tree Modelling

Tree – organic (dynamic & growth), variety, interaction with environment

How to generate tree models to represent actual trees in virtual cities

→ Address challenges of

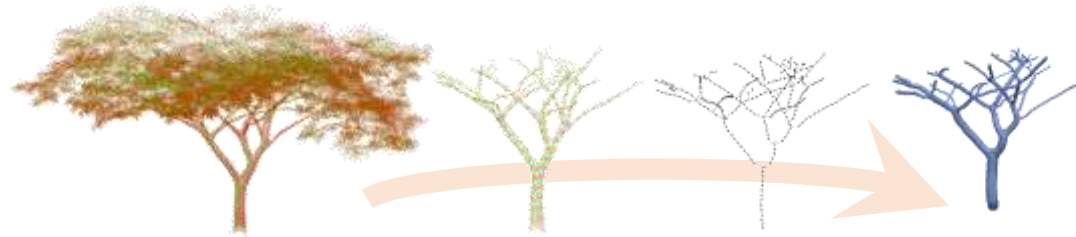
1. **species**-level representation/similarity
2. **dynamic** tree growth
3. automated large scale generation (**scalability**) and maintenance
4. **extension** to new additional species



Picture courtesy of Dassault Systemes for Virtual Singapore

3D Urban Tree Modelling Approach

Remote Sensing



Domain Knowledge



3D Modelling



L. Gobcawan, E. S. Lin, A. Tandon, A. T. K. Yee, V. H. S. Khoo, S. N. Teo, Y. Su, C. W. Lim, S. T. Wong, D. J. Wise, P. Cheng, S. C. Liew, X. Huang, Q. H. Li, L. S. Teo, G. S. Fekete, and M. T. Poto, "Modeling trees for Virtual Singapore: From data acquisition to CityGML models," *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. XLII-4/W10, pp. 55-62, 2018

L. Gobcawan, D. J. Wise, S. T. Wong, A. T. K. Yee, C. W. Lim, and Y. Su, "Tree species modelling for digital twin cities," *Transactions on Computational Science XXXVIII*, pp. 17-35, 2021

Use Cases of 3D Urban Tree Modelling

Tree management

Environmental simulations

Green building designs

Social economic impact studies



Picture courtesy of Dassault Systemes for Virtual Singapore

Tree Management

Tree inventory

Tree inspection (for health & safety)

Biodiversity

Tree maintenance (grooming & pruning)

Interactions with environment (neighboring vegetation, building structures, street traffic, human activities, etc.)



Pictures courtesy of NParks

Tree Models for Environmental Simulations

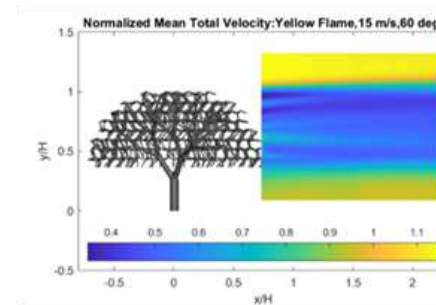
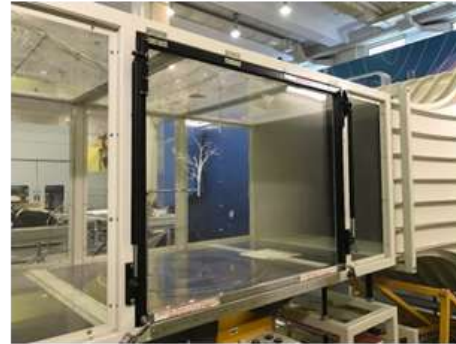
Wind-tree interaction (tree wind load prediction)

Tree fall risk

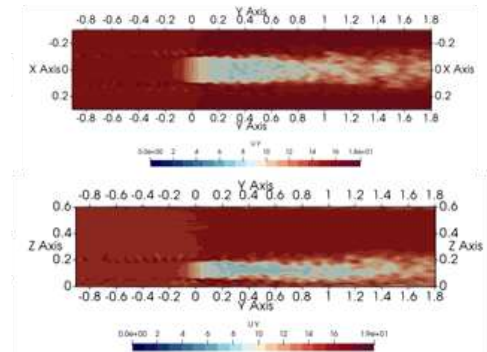
Shading, air cooling

Air pollutions

Wind tunnel analysis
on fractal-Tree model



CFD Wind Load Prediction
at Urban landscape



W. L. Chan, Y. Cui, S. S. Jadhav, B. C. Khoo, H. P. Lee, C. W. C. Lim, L. Gobcawan, D. Wise, Z. Ge, H. J. Poh, E. Lin, and D. C. Burcham, "Experimental study of wind load on tree using scaled fractal tree model," in *The Eighth International Symposium on Physics of Fluids*, Jun 2019

Z. Ge, H. J. Poh, D. Wise, C. W. C. Lim, L. Gobcawan, J. Lou, W. L. Chan, B. C. Khoo, H. P. Lee, E. Lin, D. C. Burcham, and J. X. Peng, "Drag force prediction with cfd full closure model simulation on scaled fractal tree in wind tunnel," in *The Eighth International Symposium on Physics of Fluids*, Jun 2019

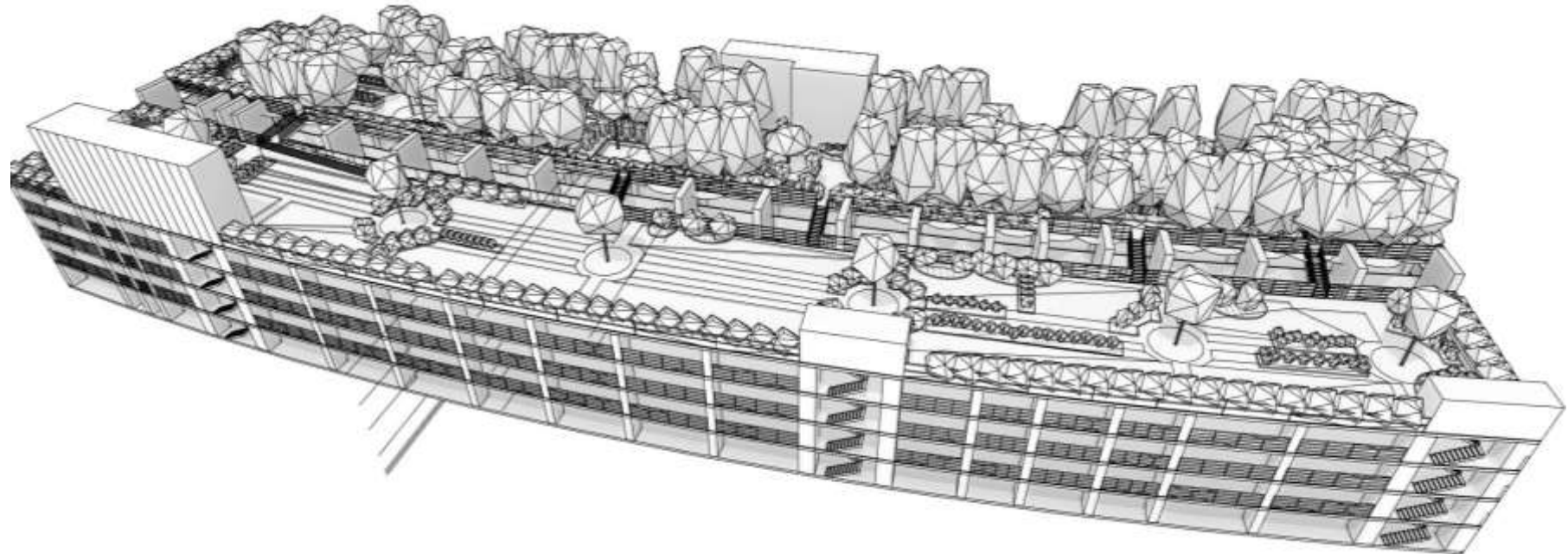
H. J. Poh, C. W. C. Lim, Z. Ge, D. Wise, L. Gobcawan, J. Lou, W. L. Chan, E. Yong, B. C. Khoo, H. P. Lee, E. Lin, D. C. Burcham, K. W. Li, I. Lee, and S. C. Chang, "Fractal tree geometry reconstruction and meshing: From point cloud model to tree aerodynamic simulation," in *The Eighth International Symposium on Physics of Fluids*, Jun 2019

Tree Models for Green Building Designs

BIM (Building Information Modeling) for vegetation in building designs

GnPR (green plot ratio) calculation

Virtual landscaping



L. Gobeawan, S. E. Lin, X. Liu, S. T. Wong, C. W. Lim, Y. F. L. Gaw, N. H. Wong, P. Y. Tan, C. L. Tan, and Y. He, "IFC-centric vegetation modelling for BIM," *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. VIII-4/W2-2021, pp. 91–98, 2021

S. E. Lin, L. Gobeawan, X. Liu, C. W. Lim, Y. He, C. L. Tan, P. Y. Tan, N. H. Wong, and A. T. K. Yee, "Deriving green plot ratio (GnPR) from a building information modelling (BIM) vegetation library," *Journal of Landscape Architecture*, vol. 7-2022, To appear (Jun 2022)

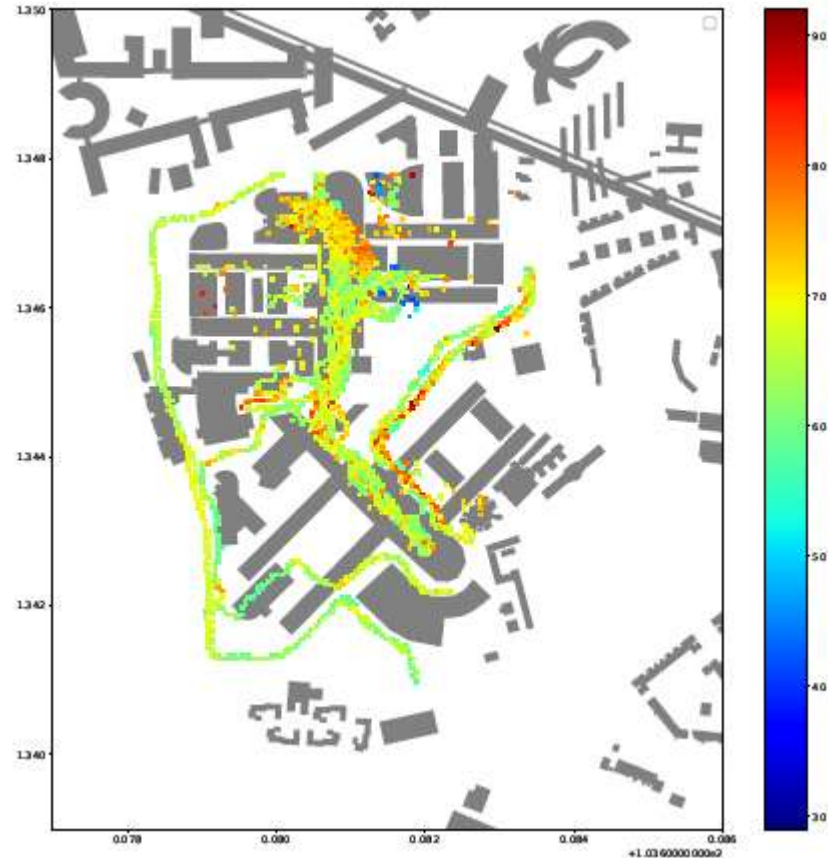
S. E. Lin, Y. He, L. Gobeawan, X. Liu, C. W. Lim, C. L. Tan, P. Y. Tan, N. H. Wong, and A. T. K. Yee, "The linking of microclimatic simulations and planting design using a species-level building information modelling (BIM) vegetation library," *Journal of Landscape Architecture*, vol. 7-2022, To appear (Jun 2022)

Tree Models for Social Economic Impact Studies

Study on trees and urban noise absorption

Tree and soil (landslide) studies

Air pollutions



Y. J. Lim, S. Yean, B. S. Lee, and P. Edwards, "What could ambient noise around campus tell us? a study on campus crowd noise," *Procedia Computer Science*, vol. 201, pp. 390–397, 2022. The 13th International Conference on Ambient Systems, Networks and Technologies (ANT) / The 5th International Conference on Emerging Data and Industry 4.0 (EDI40)

Work in Progress, Future Works

Automation with Data Science & AI

Tree interactions with environments

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Acknowledgments

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Nanyang Technological University





THANK YOU

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