2024-25 HIVE Summer Internship Project

UrbanLens:Real-Time 3D LiDAR Visualization for Smart City Infrastructure Monitoring & Urban Planning
45SAE_EECMS_3DLidarViz

Primary Academic Supervisor
Nur Al Hasan Haldar

Project Background
Currently, 55% of the global population resides in urban areas, and this figure is projected to rise to 68% by 2050. According to United Nations projections, this massive shift toward urbanization, along with global population growth, could result in an additional 2.5 billion people living in urban areas by mid-century. This rapid urbanization presents significant challenges for city planners and authorities, as they struggle with the need to expand and maintain urban infrastructure while ensuring sustainability and safety.

As cities grow in size and complexity, traditional methods of monitoring infrastructure, managing traffic, and planning urban developments become inadequate. There is a growing need for data-driven tools that can provide real-time insights into a city's infrastructure health, traffic flows, and environmental conditions. In this context, LiDAR (Light Detection and Ranging) technology has emerged as a critical tool for smart city applications. LiDAR's ability to generate highly accurate 3D spatial data enables city officials to monitor urban environments with unprecedented precision. This technology is also invaluable for monitoring infrastructure such as bridges, roads, and buildings, detecting potential structural issues early, and preventing costly failures. Additionally, LiDAR's capability to capture real-time traffic patterns allows for more efficient management of urban mobility, helping cities optimize traffic flow and reduce congestion. Combining with AI-enhanced analytics, LiDAR systems can predict infrastructure failures and traffic problems before they occur, providing cities with the tools they need to manage growth effectively and sustainably.

By the end of the project, students will have gained invaluable experience in the application of LiDAR technology for urban infrastructure, developed skills in 3D visualization and AI-based analytics, and contributed to a real-world solution with the potential for scalability across smart city.

Project Description, Expected Outputs, Possible Stretch Goals

The aim of this internship project is to develop a real-time 3D visualization platform using LiDAR data for monitoring urban infrastructure and managing city resources more effectively. The platform will utilize the Curtin HIVE visualization capabilities to produce high-resolution, real-time models of Perth's infrastructure and traffic systems, providing stakeholders with the tools to monitor the city's infrastructure health, optimize traffic flow, and plan future urban development projects. Students will work with a team of researchers and developers to collect, process, and visualize LiDAR data, integrating it into a highly interactive 3D model of Perth's CBD.

Expected Outputs:

1. A functional 3D model dashboard of Perth's CBD that integrates LiDAR data to monitor the real-time condition of urban infrastructure.
2. A user-friendly interface where city planners and engineers can interact with the 3D model and monitor real-time data, helping them make informed decisions.
3. A visualization system that monitors traffic patterns and assists in traffic signal adjustments to reduce congestion and optimize public transportation routes.

Possible Stretch Goals:

1. Add sensors to track air quality, water levels, or green space development, enabling real-time environmental monitoring for sustainable urban development.
2. Develop a mobile app that allows city planners and officials to access the platform remotely
3. Expand the platform's capabilities to monitor multiple cities simultaneously
4. Implement features that track crowd density and movement patterns during large events.

Links to background reading and any relevant recent work in the field

[1] Ortega, S., Santana, J. M., Wendel, J., Trujillo, A., & Murshed, S. M. (2021). Generating 3D city models from open LiDAR point clouds: Advancing towards smart city applications. Open Source Geospatial Science for Urban Studies: The Value of Open Geospatial Data, 97-116.
[2] Mortaheb, R., & Jankowski, P. (2023). Smart city re-imagined: City planning and GeoAI in the age of big data. Journal of Urban Management, 12(1), 4-15.
[3] TTan et al. (2020). Toronto-3D: A Large-scale Mobile LiDAR Dataset for Semantic Segmentation of Urban Roadways. (Source Code: https://github.com/WeikaiTan/Toronto-3D)
[4] Video link: LiDAR Technology brings efficiency and safety to urban planning (https://www.youtube.com/watch?v=na9hJ9HjI5U)

What type of visualisation will the student develop or produce?

The student will create highly detailed 3D models of urban environments, including roads, bridges, and buildings, using LiDAR-generated point cloud data. These models will offer real-time, up-to-date visual representations of the city. The platform will integrate predictive AI-driven analytics to forecast traffic conditions, helping city planners make data-driven decisions.

How will the visualisation contribute to your research outcomes?

The visualization will provide a powerful tool for data-driven decision-making in urban planning. It will contribute to research outcomes by offering real-time data for analysing traffic efficiency, predicting infrastructure failures, and visualizing environmental impacts, supporting smarter urban development strategies.

If the project is successful, where would you consider publishing the results?

The project outcomes will be aimed for publication in a Q1 journal, with a focus on journals such as Remote Sensing of Environment, Sensors, IEEE Transactions on Geoscience and Remote Sensing, or other highly ranked conferences and venues that align with research in LiDAR applications, AI-driven urban planning, and smart city infrastructure.

Draft Project Timeline:

Week 1

• Full-day HIVE induction to familiarize the student with the HIVE's visualization and research tools. • Project induction with the supervisor to discuss project goals, expectations, and methodologies. • Developing a detailed project plan with the HIVE team and academic supervisors. • Conduct a literature review and understand the project's scope.

Week 2

• Start the collection of LiDAR data relevant to Perth's CBD infrastructure, roads, and traffic systems. • Begin cleaning and preparing the data for use in the 3D visualization platform.

Week 3

• Continue processing and integrating LiDAR data into initial models for the 3D visualization. • Develop the base 3D model of Perth's infrastructure and urban layout. • Start exploring options for traffic flow integration and urban infrastructure visualization.

Week 4

• Complete an initial version of the 3D model, including real-time traffic patterns. • Begin integrating AI-driven predictive analytics for infrastructure monitoring (traffic congestion). • Meet with supervisor to review progress.

Week 5

• Refine the 3D models and traffic data visualizations based on feedback from supervisors and team members. • Continue enhancing the predictive algorithms for infrastructure and traffic management.

Week 6

• Perform initial testing of the platform, ensuring real-time data integration is working smoothly. • Optimize the user interface for the infrastructure monitoring dashboard. • Finalize key features for real-time visualization.

Week 7

• Focus on adding interactive features to the platform for urban planners to engage with the data intuitively. • Begin environmental monitoring integration (e.g., adding air quality).

Week 8
• Continue testing and refining the user interface and real-time 3D visualization. • Prepare a prototype of the platform for review by the academic and HIVE team. • Begin preparing documentation for the final report.

Week 9
• Report Writing and Presentation Preparation. • Finalize and polish the platform for the upcoming showcase presentation.

Week 10
• Final Presentation Showcase • Submit the final report detailing the project development, technical challenges, solutions.

Student Experience and Supervision:

How often will you meet with the student over the 10-week period?

Once per week, if needed twice.

Your work desk location and the location of student desk

My Office: Building 314, Room 332B, | Student desk could be at HIVE Staff Office: Building 201, Room 212| Bentley Campus, or Online

<u>Student Attributes:</u>

Please indicate any preference for student's academic discipline or field of study

Computer Science, Data Science

What competencies are required to start this project

Beginner - 2D image and/or video software (e.g. Adobe Suite, Sony Vegas)
Beginner - 3D modelling software (e.g. Blender, 3ds Max)
Intermediate - Unity Programming (C# coding, animation syntax, debugging, problem-solving)
Beginner - Data structures, analytics, statistical modelling

Do you have any other student attributes you think are important to the project?

Problem-Solving Skills, Python Programming