MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Singapore-NZ Data Science Workshop:
Summary of 3D Spatio-Temporal Theme discussion
(3D data for environmental applications (urban and agricultural))
30-31 October, 2019

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This report aims to capture the ideas that were generated during the 2-day Singapore-NZ Data Science Workshop in the 3D Data theme. On Day 1 we collected high level ideas and on Day 2, we described possible projects. There were rich discussions, and the findings have been summarised here.

Wednesday 30 October

General discussion:
The session began with introductions around the table, followed by general discussion and sharing about the mutual interests in 3D data which quickly coalesced around 3D Data related to trees, as follows:

- Tree information:
  - Species
  - Health (non-destructive sensors)
  - Leaf area
  - Growth prediction
  - Planting strategy (incl. next generation building planning)
  - Wind interaction
  - Age (incl. max age)
  - Size (incl. spatial model)
  - Tree roots
  - Sensors: camera, LiDAR, hyperspectral (incl. geometry, airborne, safety data)
- Terrain
  - Above ground mapping
    - Under canopy
    - Remote sensing (airborne above canopy)
    - Radar
    - Visualisation (VR, web/mobile)
    - Digital twins
    - Floods
    - Environmental conditions (e.g. temperature, etc)
    - Pollution
  - Underground mapping/study
    - 3D mapping (roots, etc)
    - Interpolating sparse data (incl. radial basis functions)
    - Soil moisture/temperature/etc
    - Water flows
- Smart sensors
  - Spatial
    - Indoor localisation
    - Animals
    - Insects
  - Environmental sensors
    - Water flow
    - Air flow
    - Pressure, etc
  - Traffic and urban planning
    - 3D mapping
    - Mobility

  - Crowd sourced data (e.g. using mobile phones)
- Human well being
  - Environment
  - Social
  - Economic
  - Knowledge/Data/ML (multi-mode, spatial/temporal)
- Useful/trustworthy results
  - Explainable
  - Rigorous in data science (bias/uncertainty modelling)
  - Policy – risk - perception

Post-its:
The objectives of the brainstorming session were then discussed and everyone invited to brainstorm ideas written on post-it notes for the whiteboard. These post-it notes were organised into various clusters, followed by group discussions to fine-tune the clusters and classify each cluster with an appropriate research topic. This led to the overall structure of the various 3D data research sub-streams as below:

- Virtual Singapore (3 yrs initially)
  - Trees
    - Not yet reconstructed
    - Singapore Land Authority
    - National Park
    - Non-destructive modelling
    - Predictive size/pruning
    - Health monitoring
    - Predictive size/pruning
    - Air quality, temp, humidity, haze
    - Age/replace
    - Update every 2-3 yrs
    - Dynamic (people/vehicles)
  - Buildings
    - Correctly spaced for wind (taking into account nearby trees)
    - Shadows
    - Building-green ratios (plan pre-plant years before build)
  - Animals – species detection
  - Cloud penetrating imaging
  - Flood flow (water flow and flood modelling & reservoir location)
  - Forest fires (estimating forest fires in other nearby countries)
  - Big data simulation
    - Modelling petabyte models (compare with initial sparse simulation using simple fast CNN)
    - HP computing
  - Sensor networking (Country wide sensor network – e.g. each lamp post, underground optic fibre, cameras, etc)
  - Novel sensor research
    - incl. detecting mosquitos (disease vector spread)

- Underground sensors (fibre optic sensors underground for temp, moisture, flow, etc)
- CNN based 3D geometric algorithms for 3D DS research
- Interpolation research (e.g. radial basis functions) – especially for sparse underground sensor data

Thursday 31 October

The second day was focused on generating three example project ideas.

First, the group brainstormed various application domains that are of mutual interest to SG and NZ and initially came up with three projects:

1. Spatial & temporal modelling of trees
2. Modelling and managing petabytes of tree data
3. Integrated ML/physics-based/data-based models of trees to determine health

However, further discussion highlighted the need for the following related underlying foundational research:

- Merging and processing multiple data sources of diverse sample rate and resolution
- Virtualisation of the environment
- Innovative sensors
- Edge computing
- Hyperspectral processing
- Health of vegetation (incl. trees) – current and predicted
- Soil properties – sensing study
- Hydro modelling
- Hazard modelling
- Vegetation & selection and its effect on the environment
- Accurate interpolation of data (e.g. sparse underground sensor data)
- Vegetation selection & planning and its interaction with the environment
- Fauna movement