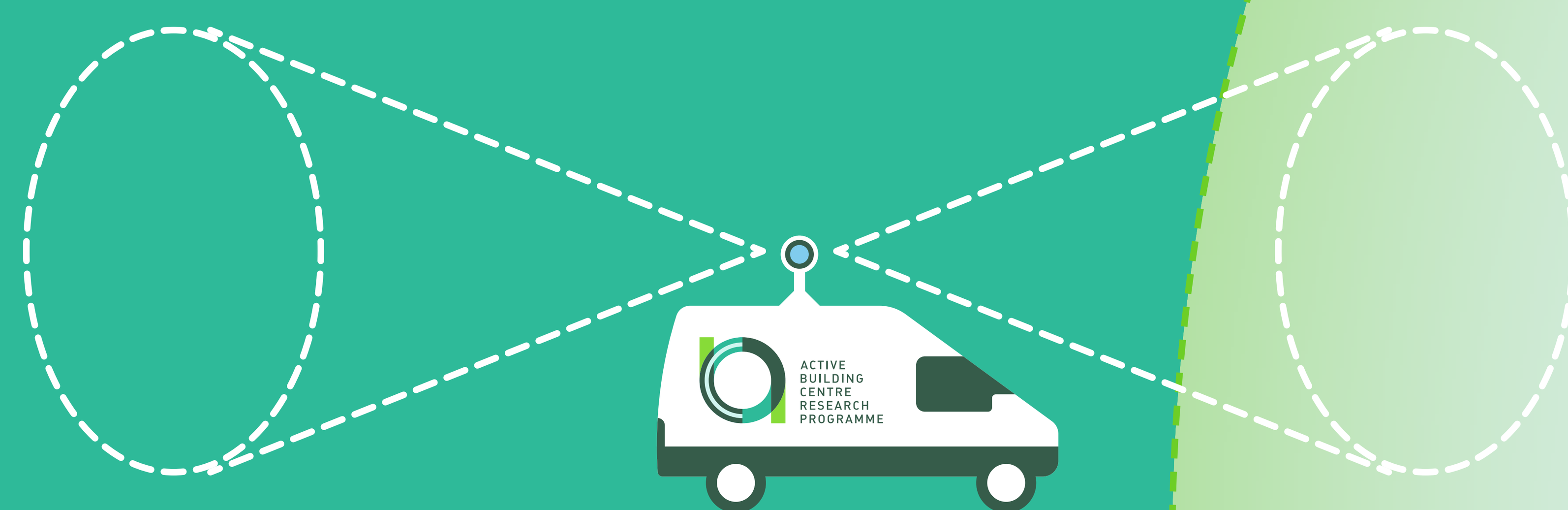
From Capture to Quantification Scalable Feature Extraction of Building Facades

Introduction

Building features, including the dimensions, envelope and characteristic details such as window layout, are essential properties for modelling the urban built environment. From building energy to stock models, understanding the layout of a building can improve reliability and certainty in modelling.

Multiview stereo is a technique to build three-dimensional reconstructions of scenes using a set of localised images capturing a scene at multiple angles. With a street-level mobile sensing vehicle, it is possible to capture high resolution 'views' of buildings and reconstruct these to create precise reconstructions.

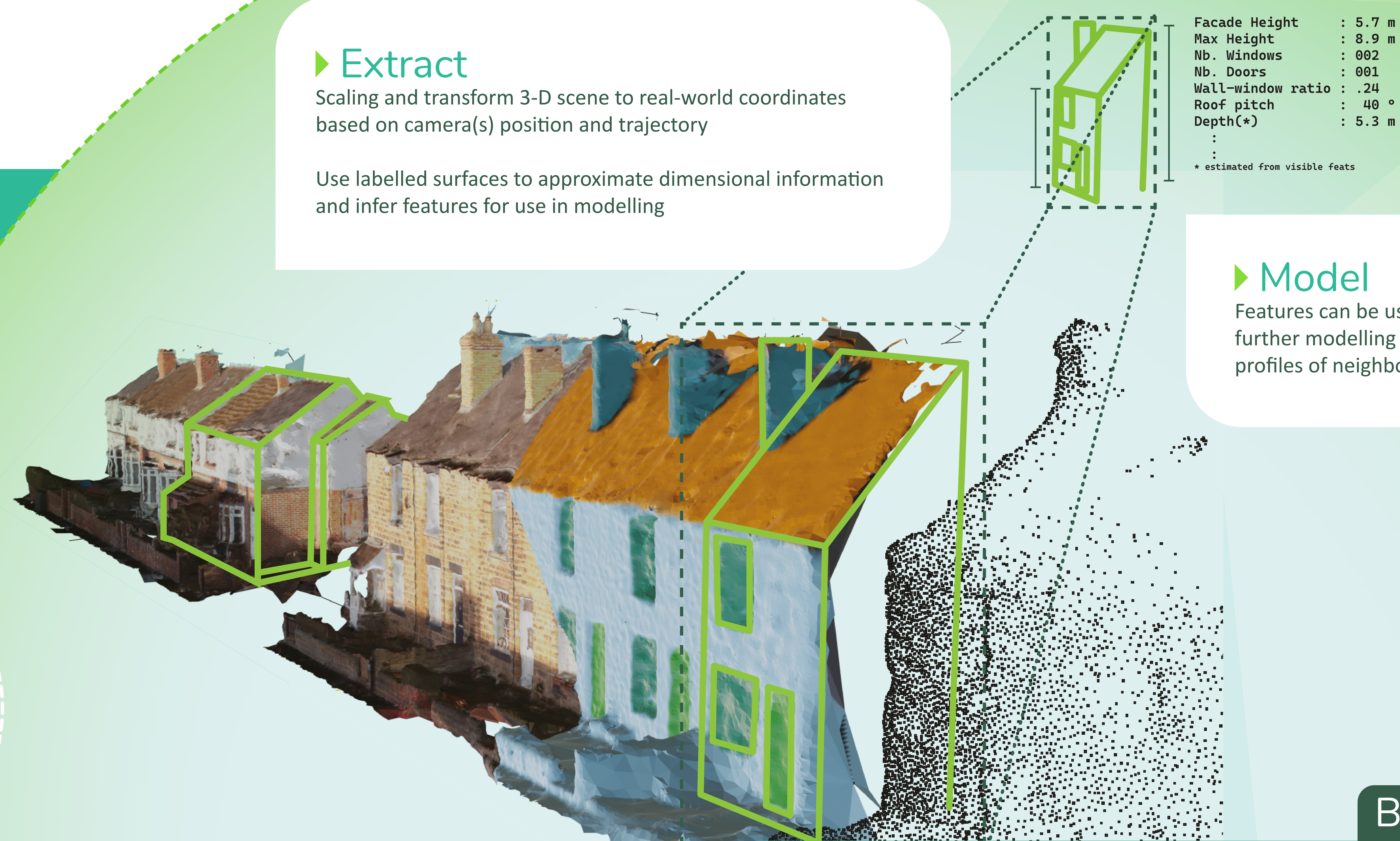
Annotating the facades at scale requires machine learning to predict features. Labels can be identified in the 2-D views and projected out. From these annotated labels, informative feature descriptors can be extracted.



Extract

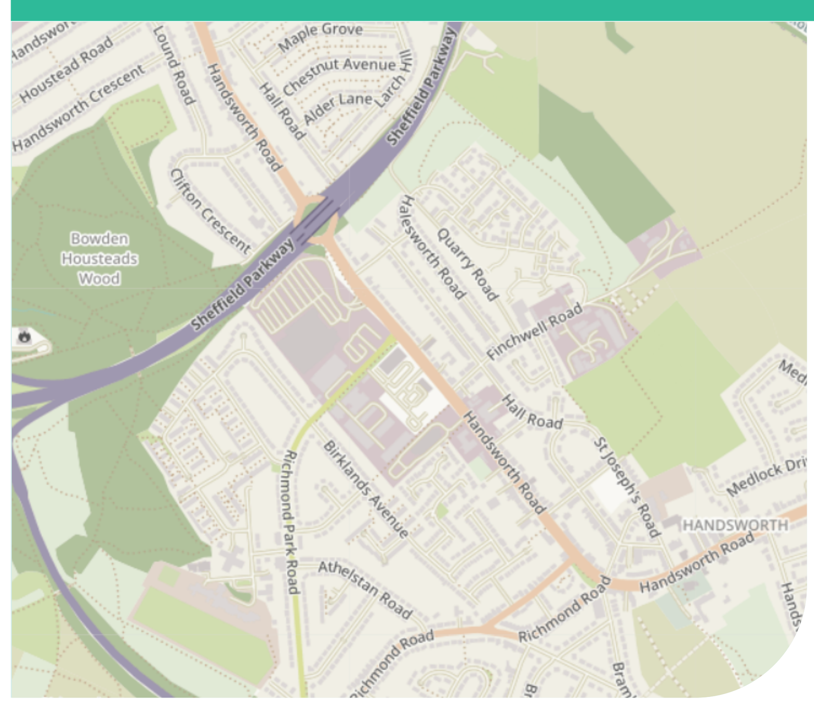
Scaling and transform 3-D scene to real-world coordinates based on camera(s) position and trajectory

Use labelled surfaces to approximate dimensional information and infer features for use in modelling



Model

Features can be used in further modelling for building profiles of neighbourhoods



Select

Choice of neighbourhood based on requirements, e.g. property archtypes, neighbourhood classification

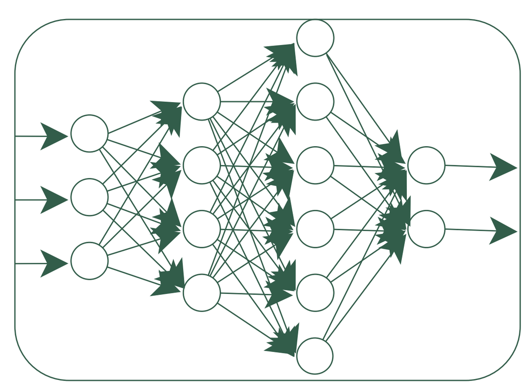
Capture

Drive-by capture of street-level buildings
- MARVel (high resolution)
- Google Street View (low resolution)

Project

Reconstruct 3-D scene geometry with structure-from-motion and multiview stereo to build representation of scene

Use pixel-matching and projection geometries to project label masks to 3-D geometry



Annotate

Label images with manual annotations and trained deep learning models

Beyond

The accuracy of reconstructions is dependent on that of the localisation tools (IMU/GNSS), variations of the camera, and uncertainties in the labelling.

Capture on a multi-sensing rig allow for capture of complementary LiDAR data to build depth maps that correspond to the reconstructions point clouds. Incorporating this information could be used to improve quality and certainty by:

- correcting point clouds based on LiDAR geometry

- applying multifidelity learning to train a LiDAR annotation model using projected labels

Beyond visual annotation, incorporation of multi-sensor data, e.g. thermal and hyperspectral, can build up a detailed representation of houses and neighbourhoods towards a digital twin.

Wil Ward, Menglin Dai • University Of Sheffield

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

The University Of Sheffield.

UK Research and Innovation

INDUSTRIAL STRATEGY