# GRAMMAR-BASED BUILDING MODELLING USING MOBILE LASER SCANNING DATA

Z. Zhang [a], J. Li [b*, c], Y.Yu [a], H. Guan [c], C. Wang [a]

[a] Fujian Key Laboratory of Sensing and Computing for Smart Cities (Xiamen University), School of Information Science and Engineering, Xiamen University, 422 Siming Road South, Xiamen, FJ 361005, China - zhangzongliang@nwsuaf.edu.cn, allennessy.yu@gmail.com, cwang@xmu.edu.cn

[b] MOE Key Laboratory of Underwater Acoustic Communication and Marine Information Technology, Xiamen University, 422 Siming Road South, Xiamen, FJ 361005, China - junli@xmu.edu.cn

[c] Department of Geography and Environmental Management, University of Waterloo, 200 University Avenue West, Waterloo, ON N2L 3G1, Canada - junli@uwaterloo.ca, h6guan@uwaterloo.ca

**Commission I, ICWG I/Va**

**KEY WORDS:** Building Modelling, Parsing Expression Grammar, Point Cloud, Markov chain Monte Carlo

**ABSTRACT:**

The paper presents a grammar-based approach for building modelling using 3D point clouds acquired by a mobile laser scanning (MLS) system. Scanned point clouds are usually incomplete, noisy and uneven. Due to this, it’s difficult to directly model buildings from scanned point clouds. It’s possible to use grammar to represent the hierarchical structure of each building. In our approach, we employ Markov chain Monte Carlo (MCMC) algorithm to find the optimal model from the MLS point clouds. The idea behind our modelling approach can be formalized as follows:

$$\arg\min_{M} \; d(M,T)$$

where M is one of the derivation models according to the user defined building grammar, T is the input point cloud and d is the similarity measure between derivation model and point cloud. Three tasks must be done in order to solve this problem.

The first task is to define the grammar. We use parsing expression grammar (PEG) to define our grammar manually. A PEG, a type of analytic formal grammar, describes a formal language in terms of a set of rules for recognizing strings in the language.

The second task is to measure the similarity between derivation model and input point cloud. Actually, there are several similarity measure algorithms which highly depend on model rendering approach and pre-processing of the input point cloud. One of the measurement algorithms is to render the model as a mesh and then compute the

* Corresponding author: junli@xmu.edu.cn.

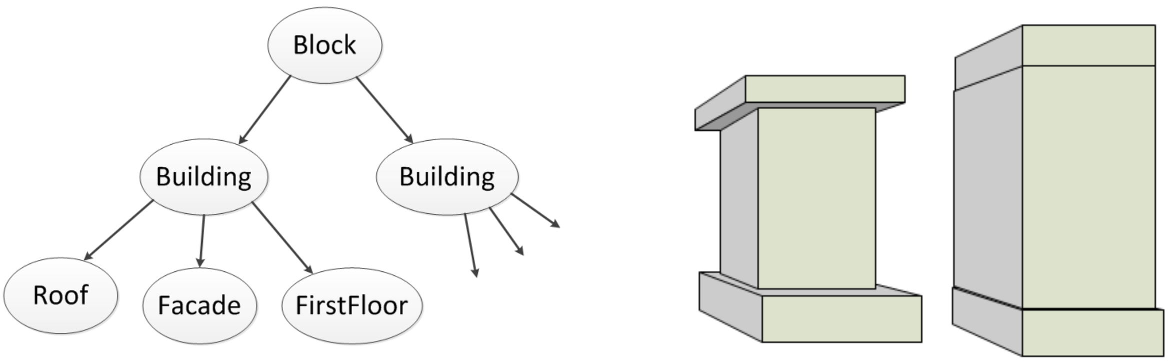
similarity between this mesh and the input point cloud. However, computing the similarity between a mesh and a point cloud is time consuming. To reduce the computation complexity, we render the derivation model to a point cloud too. In other words, we uniformly resample the model mesh to obtain a model point cloud. As a result, we can compute the similarity by comparing model point cloud and input point cloud. By pre-organizing the input point cloud into some data structure, such as k-d tree, we can compute the similarity in a quick fashion.

Finally, given the grammar and similarity measure, the third task is to find the model that fits best the input point cloud. Due to the huge space of models, it's not suitable to use traditional optimization method to solve this problem. Our solution is to employ reversible jump Markov chain Monte Carlo technique to harness optimization problem by sampling. Figure 1 shows (a) a building grammar, (b) the input point cloud. Figure 2 shows (a) the expected output derivation model and (b) the expected model after rendered. Figure 3 is the flowchart of the proposed grammar-based building modelling approach.

Block $\rightarrow$ Building. Block
Block $\rightarrow$ $\varepsilon$
Building $\rightarrow$ Roof. Façade. FirstFloor

(a) (b)

Figure 1: (a) Input grammar, (b) Input point cloud




(a) (b)

Figure 2: (a) Output derivation model, (b) Rendered model

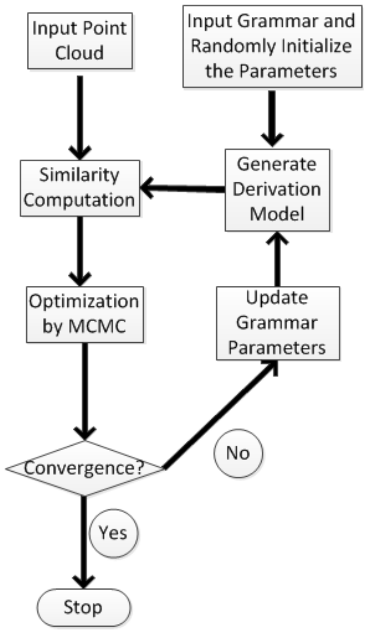



Figure 3: Flowchart of the grammar-based building modelling approach