Conversion of an IFC-model to a lod2-3 3D-GIS building model

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Abstract

In this study an IFC-model of a single family house was converted to a lod2-3 multisurface building model according to the Swedish geodata specification *Samverkan Svensk Geoprocess Byggnad Version 3.0* which is based on CityGML; hence, the method can be applied to convert an Ifc-model to a CityGML building model.
Keywords: IFC, CityGML, Samverkan Svensk Geoprocess

1 Introduction

Conversion of Building Information Models (BIM) to 3D-GIS can facilitate urban planning processes by providing 3D-models of buildings to be integrated with geographical data. Less detailed building models (lod1-lod2) of existing buildings can be derived from lidar data and photogrammetry in combination with building footprints from urban planning maps (e.g. Donkers et al. 2016). For higher levels of details, and for planned constructions, BIM-models (usually in IFC-format) can be converted to 3D-GIS (usually following the CityGML standard).

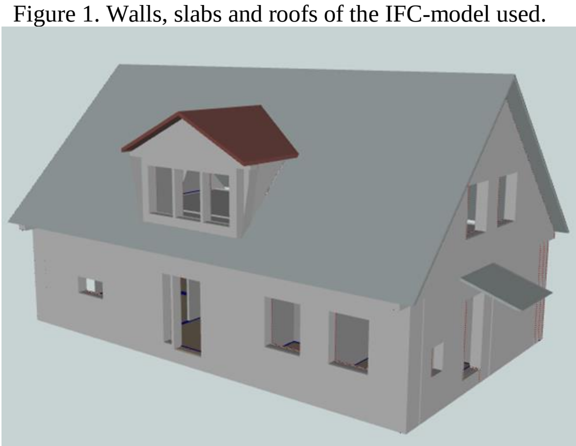
There are studies that mainly focus on the semantic mapping between IFC-models and CityGML (e.g. El-Mekawy et al. 2012; Isikdag & Zlatanova 2009). However, to create a valid CityGML building model, the solid geometries of the IFC-model must be converted to surface representation. Geiger et al. (2015) developed a method to convert IFC-models to lod2 CityGML building models by extruding the footprint of buildings and clipping these extruded models with roof surfaces. Lod3 models were created from the lod2 models by clipping holes for openings and adding windows and doors. Donkers et al. (2016) developed a method to convert an IFC-model to a lod3 CityGML building model with the aid of morphological operators in 3D.

In this study, an IFC-model of a single family house was converted to a lod2-3 building model with a multisurface geometry according to *Svensk Geoprocess Byggnad Version 3.0* (*SGP Building*) (Lantmäteriet 2018a). SGP Building is based on *Inspire* and *CityGML*; hence, the method can be applied to transform IFC-models also to Inspire and CityGML.

2 Method

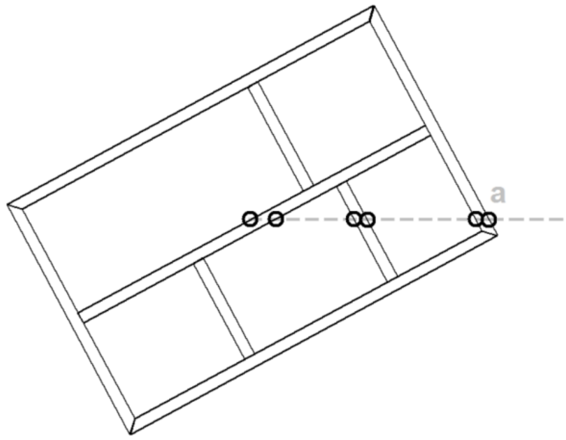
The conversion was based on walls (*IfcWall, IfcWallStandardCase*), slab (*IfcSlab belonging to floor*) and roof (*IfcRoof, IfcSlab belonging to roof*) from the IFC-model (Figure 1).

Figure 1. Walls, slabs and roofs of the IFC-model used.



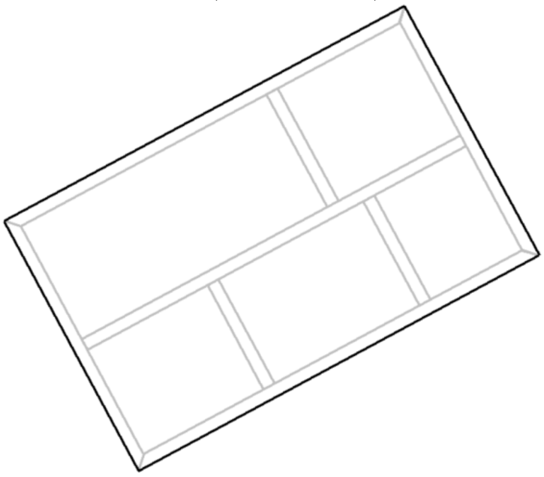
The walls of the outer shell of the building were extracted with a modified version of a ray casting method by Ying et al. (2017). The walls were flattened from 3D to 2D so that each wall element was represented with four lines, here referred to as *wall segments*. A line, starting from the centroid of the footprint of the ground floor, and reaching outside the building, was created and the points of intersection between that line and all wall segments were found (Figure 2).

Figure 2. Simplified figure showing wall segments (solid black lines), the line created to find the intersection points (dashed grey line) and the intersection points (black circles) with the wall segments.



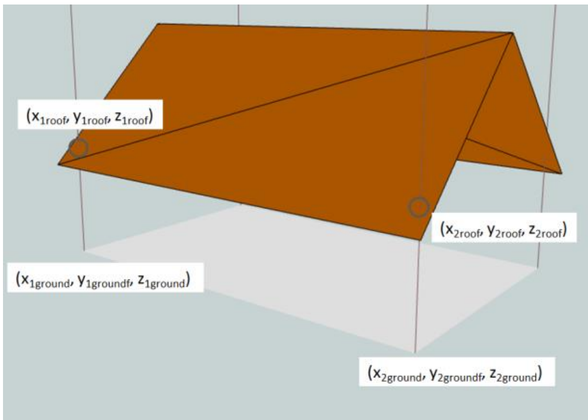
The wall segment with the outermost point of intersection (*a* in Figure 2) was identified as an outer wall and used as the starting segment. The method then proceeded by finding the wall segment with the smallest angle in relation to the last identified outer wall segment in clockwise direction until all outer wall segments of the building were identified (Figure 3).

Figure 3. Simplified figure of outer walls of the building in 2D (solid black lines).



Since IFC-models often have geometrical and topological errors (e.g. Donkers et al. 2016) the upper part of the walls were found with a methods that ensures that the wall surfaces are connected to the roof surfaces: The coordinates of the start and end points of the outer wall segments were first extracted. The upper roof surfaces were then triangulated and an interpolation was conducted to find the z-coordinates for the corners of the walls (Figure 4). Wall surfaces were created based on the upper (x_{1roof}, y_{1roof}, z_{1roof}; x_{2roof}, y_{2roof}, z_{2roof}) and lower ($x_{1ground}$, $y_{1ground}$, $z_{1ground}$; $x_{2ground}$, $y_{2ground}$, $z_{2ground}$) wall segments. Finally, the overhangs of the roof surfaces were removed.

Figure 4. Triangulated roof surfaces and the end points (x_{1roof}, y_{1roof}, z_{1roof}; x_{2roof}, y_{2roof}, z_{2roof}) of the upper edge of one wall surface.

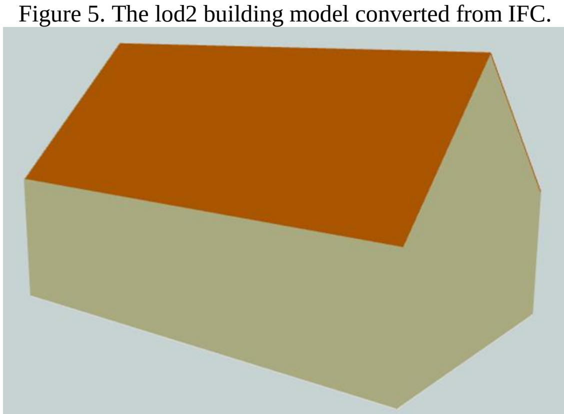


An FME script from Lantmäteriet, released under a BSD-license (Lantmäteriet 2018b), was modified to save the model according to SGP Building 3.0 and additional attributes were derived from the geometry of the building: The highest height of the roof (swe: *takets högsta punkt (nock)*) and the height of the base of the roof (swe: *takfot*).

3 Results and future work

The final lod2 model is shown in Figure 5. To create a lod3 building model the outer wall segments in 2D (Figure 3) are joined with the 3D-geometries of the original wall surfaces and windows and doors are added as grand-children of the walls in the IFC-model. The final step to simplify the geometry of the doors and walls is currently not finalized.

Figure 5. The lod2 building model converted from IFC.



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