BuildingFootprint2RightAngles

When mapping building footprints, either working for an authoritative agency or in OpenStreetMap (OSM), many factors will affect the accuracy of the result. Since the accuracy of right angles and parallel structures is generally the rule for actual buildings, it is reasonable to favor these criteria over the representation of data, within certain tolerance limits. This procedure was developed to orthogonalize building footprints made available by Canadian government agencies, in order to import them in OSM since they had a compatible license. A description of the algorithm is detailed below.

Concepts Behind Orthogonalizing Buildings Footprint

Not all buildings are orthogonal since some architectural features may deviate from this rule. Let start with a simple example: a building having a right triangle footprint (figure 1).

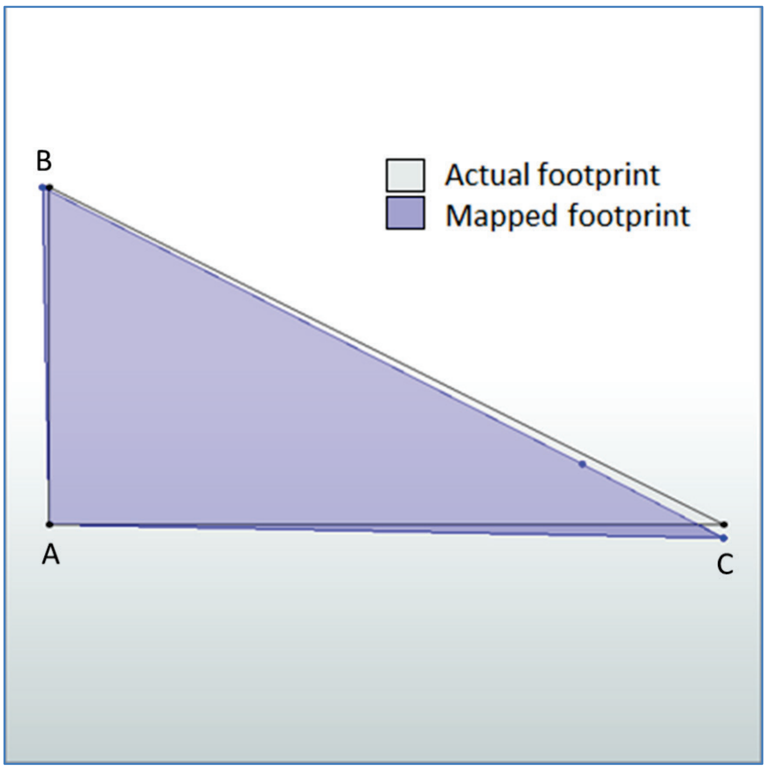


Figure 1 Right angle building

There are differences between actual and mapped footprints. The segments AB and AC show inaccuracies which make angle A not orthogonal. At the same time, angles B and C must not be orthogonalized since they represent the actual structure of the building. One must then consider there is a threshold around right angles below which the angles could be orthogonalized (figure 2).

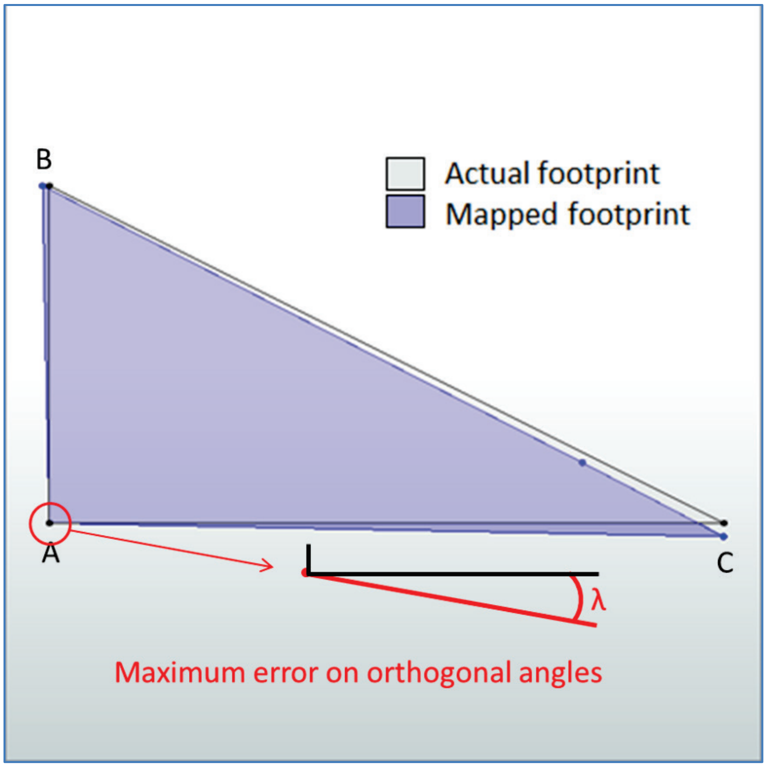
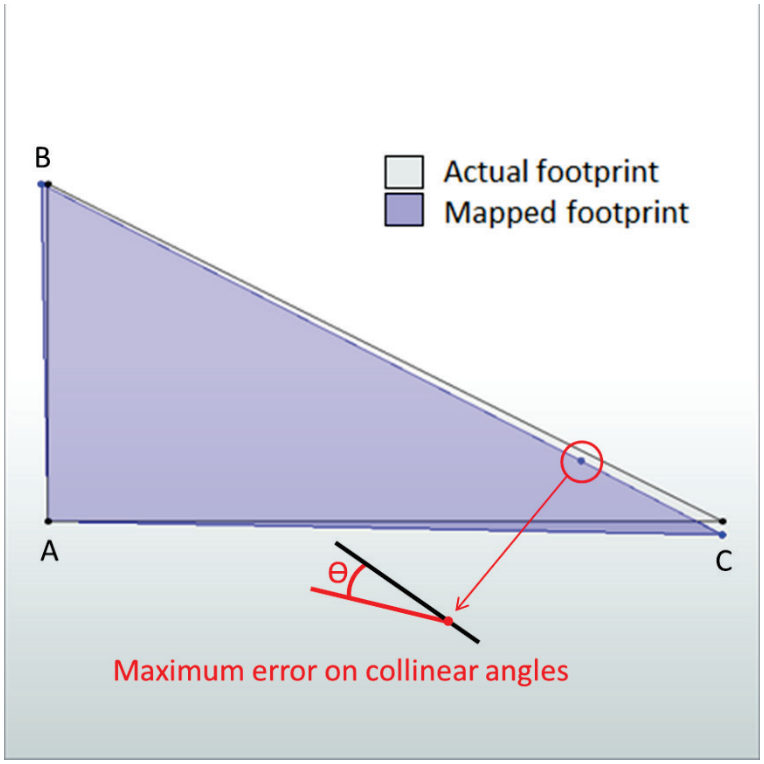


Figure 2 Angle inaccuracy threshold

Over that threshold (maximum error on orthogonal angles) an angle does not result from a random error but represents an architectural feature of a building, and consequently should not be orthogonalized.

Another characteristic of mapped footprint is the existence of unnecessary vertices (nodes) which alter the



Each angle of a footprint must be analyzed in order to identify building sections that can be orthogonalized (BAC) and those who should not (BC).

Another

Each line segment is analyzed to build its equation (Ax+By+C=0) where A=-dy, B=+dx, C= (-A*cx) + (B*cy). Here, cx,cy is the coordinate of the center of the segment, and dx,dy are the slope components of a segment of length=1.

All contiguous line segments that are linked through right angles (90o ±λ) define an orthogonal section of the footprint. A bunch of line segments that are either orthogonal or parallel to each other.

in a section New segment orientations are estimated using a weighted average of their orientations using segment lengths. It results in two orthogonal orientations that are applied to each line segments equation (A'x B'y C=0) of a processed building section. I also look at the equation intercept (C) to have aligned segments really aligned within a given tolerance. The application shows good results with an intercept tolerance of 0.5 metres. The final line equation (A'x B'y C'=0) of each line segment is used to compute the new location of section's corners (x, y).

Building sections that do not meet orthogonalization requirements are left unchanged. After processing, a tag note='Orthogonalized (Complete)' or note='Orthogonalized (Partial)' is added to each building, describing if all corners could have been processed or not.

Collinear Vertices Filtering

Filtering collinear vertices using a maximum distance from a theoretical line (e.g. Douglas-Peucker) tends to remove significant vertices when buildings have small detailed segments. Instead, the application uses the angle between adjacent line segments to decide if a vertex has to be removed. The application shows good results using a threshold of 5 (OSM) or 2.5 (Import data) degrees.

Topological Errors

Changing building geometries may result in topological error with adjacent buildings (errors that may have existed previously). In these cases a fixme='Topological errors' is added to the feature.

Post-Processing

Once the building processed, the import process participants must be advised to look at the note and fixme tags to properly introduce the new geometries.