Prototype of an Intelligent GIS-to-BIM Converter (LKMap Data to IFC Data)

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Initial Situation: Underground utility networks/cadastres are usually managed in Geographic Information Systems (GIS) in 2D. These data are described in Switzerland by the schema and file format standard SIA 405-INTERLIS. The model of the standard that was focused on in this thesis was LKMap, a minimalistic data exchange approach that allows the coordination of the involved parties mainly through the geometries.

However, there is a high demand for these cadastres to be available in 3D. This would be of great benefit in Building Information Modeling (BIM). The cadastral data would allow BIM operators to visualize, plan, model and design the exact locations where utility infrastructures intersect with building elements of their model.

Following this need, this thesis aimed to provide a Command Line Interface (CLI) prototype that lets users convert 2D INTERLIS data to valid 3D data in IFC format, and that is standalone and Open Source.

Approach / Technology: The first step taken during this thesis was to split the goals of the project into four different strategies for solving the problem.

The first strategy aimed to create a CLI that requires the user to enter a LKMap INTERLIS data file (.xtf) and the corresponding model file (.ili) with a bounding box (bbox) argument to clip the data.

The concept defined to import the data was to convert the INTERLIS transfer data into a GeoPackage using ili2pg (ili2gpkg, written in Java) and then access this data using the Python GeoPandas library.

Since the imported data is in a 2D format, it was necessary to enhance it for proper 3D visualization. This led to the concept of Intelligent Defaults, which added the necessary properties to the existing data. The final step was to create IFC 4.3 files. This was to be achieved using the Python library IfcOpenShell.

Result: Three of the four solution strategies were successfully completed, resulting in a CLI prototype that allows the user to specify a GeoPackage, a coordinate range for the objects, and the name of the IFC file to generate. Running "convert-gpkg-to-ifc.py" with the above arguments results in a valid IFC 4.3 file that can be visualized with an external IFC viewer such as LexoCAD, Blender or BIMvision.

With data processing filters, the number of data objects is minimized by filtering out objects that do not intersect the bbox, objects are grouped into their LKObjekt types, and characteristic attributes are added to the corresponding object.

In addition, "Intelligent Defaults" enhance the provided data with location heights, element widths, color schemes, and scaling to set the origin of the coordinate system to the minimum values of the provided bbox, ensuring that the bottom left corner of the bbox is the (0,0,0) coordinate point.

Finally, using IfcOpenShell, IfcElementBuilders create the elements from the processed data and assign them to a generated IFC 4.3 file.
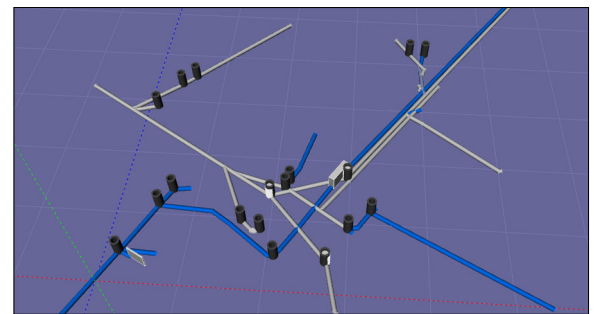
An excerpt of the 2D data from Rothenfluh. Sewage ducts displayed as LKPunkt (red) and pipes displayed as LKLinie
Own presentment
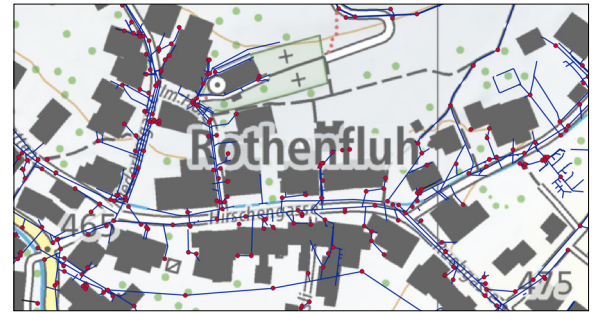
Waste water pipes (blue & grey) and manholes (black) exported as IFC 4.3 file by the prototype and visualized in LexoCAD
Own presentment

Original 2D view of the waste water utility elements in the QGIS viewer (Anwilerstr. 10, Rothenfluh BL)
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