Automatic creation of navigation network from IFC models

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Content

- 1. Related work
- 2. Goal of the research
- 3. Steps to be completed
- 4. Progress
1. Related work (1)

use BIM’s floor plan with Revit API (Wei Yan, 2010)
1. Related work (2)

C# + Revit API + Matlab for 2D path-finding with A-MAT-VG
(Albert Y. Chen and Ting Huang, Oct, 2015)
1. Related work (3)

Transform IFC to GTN (Geometric Topology Network) in 2D path-finding with S-MAT

(S. Taneja, B. Akinci, J.H. Garrett, 2011)

Figure 6. a) Voronoi diagram of the polygon, b) Modified medial axis of the polygon.
1. Related work (4)

a) extracting both geometric and semantic information
b) discretizing and mapping the extracted information into a planar grid,
c) path-finding
(Ya-Hong Lin etc., 2012)
1. Related work (5)

1. Related work (6)

1. Related work (6)

(Aftab A. K. et al., Zhihang Y., Thomas H. K., Nov. 2014)

Room-door-room-door Network
1. Related work (6)

1. Related work (7)

multi-step indoor navigation network deviation process from IFC:
- a) semantic cleaning;
- b) walkable features extraction;
- c) Multi-Storey 2D Mapping;
- d) automatically generate network with S-MAT.

(S. J. Tang, Q. Zhu, W.W.WANG etc. 2015)
Question

Above mentioned method get indoor navigation network **indirectly** from IFC by transforming to CityGML or 2D mapping. 

**Why not create automatically it from IFC directly?**
A little simple example:

not considering important useful IfcObjects such as stairs, elevator, obstacles (IfcFurnishingElement, IFurniture) and other IfcObjects.

(P. Boguslawski, L. Mahdjoubi, V. Zverovich., Sept.2015)
2. Goal of the research

This research will concentrate on an approach for 3D indoor navigation considering obstacles. Two major problems will be addressed:

1) creating a spatial schema for IndoorGML (introducing adaptations for obstacles if needed)
2) automatic generation of this model from 3D semantic-rich models Building Information models (i.e. IFC).

The goal of the research is to investigate automatic procedures for network derivation for different users and their activities.
Work Plan (Jun, 2015-Jun, 2016)

Phase 0: preparation
- a. Studying IFC standard
- b. Studying PostGIS
- c. Studying Blender/AutoCAD (i.e. software for visualisation)

Phase I: conceptual design
- a. Spatial Schema for DBMS
- b. Selecting IFC objects to be used for IndoorGML
- c. Mapping between IFC and IndoorGML
- d. Strategy to derive connectivity graph and network

Phase II: implementation
- a. Creating tables
- b. Developing IFC reader/importer in the DBMS
- c. Developing IFC DBMS exporter
- d. Visualization of geometry and network.

Phase III: Tests
- a. Use at least 3 different data sets.
- b. Adapt schema and visualization approach if needed
- c. Report the results in a paper.

Phase IV: Different users and activities
- a. Define profiles
- b. Define tasks
- c. Adapt the workflow to be able to create network with respect to a profile
- d. Report the results in a paper.
UML diagram with IFC objects used for IndoorGML

- **IfcBuilding**
  - buildingStoreys: 1
  - buildingParts: 1

- **IfcBuildingStorey**
  - belongingStory: 0..2

- **CellSpace**
  - BoundedBy: 0..1

- **NonNavigableSpace**
  - TransitionSpace

- **NavigableSpace**
  - TransferSpace

- **FixedNonNavigableSpace**

- **RemovableNonNavigableSpace**

- **IfcFurnishingElement**
  - (Chair, Table, Desk, Bed, FileCabinet, Shelf, Sofa)

- **IfcFurniture**

- **IfcWall**

- **IfcBeam**

- **IfcColumn**

- **IfcStair**

- **IfcRamp**

- **IfcT ramp**

- **IfcDoor**

- **IfcWindow**

- **IfcTransportElement**
  - (Elevator, Escalator, MovingWallWay, Craneway, LiftingGear)

- **Route**
  - nodes: 0..*
  - edges: 0..*

- **RouteNode**
  - State: 2
  - Transition

- **RouteSegment**

- **State**
  - duality: 0..1

- **Transition**
  - duality: 0..1

- **CellSpaceBoundary**
  - Route
  - RouteNode
  - RouteSegment
  - State
  - Transition

- **RelatedBuildingElement**

- **BoundedBy**
  - 0..1

- **0..2**

- **BuildingStoreys**

- **BuildingParts**

- **0..1**

- **edges**

- **0..***

- **nodes**

- **0..1**

- **duality**

- **0..1**

- **duality**

- **0..***

- **edges**

- **nodes**

- **0..***

- **edges**

- **nodes**

- **0..***
Strategy to derive connectivity graph

1. Useful IFC file collection
2. Extract geometrical and semanical information
3. Compute centroids of IfcObjects useful to Indoor navigation
4. Create the connectivity graph
5. Path-finding (A* or Dijkstra)
6. 3D Visualozation
Challenge the future
"Room-to-door-to-room" Doors and Rooms are nodes
Challenge the future
Connectivity graph and network

But it’s incorrect or ideal! Since the lines is only connected naturally with retrieved Centroids not using semantical information.
We can get the relationships between IfcSpace and other IfcObjects such as IfcDoor, IfcWindow, IfcWall, IfcSlab with IfcRelSpaceBoundary.
We can get the relationships between IfcSpace and IfcDoor or IfcWindow or IfcWall or IfcSlab with IfcRelSpaceBoundary.
But other important IfcObjects having relationships with IfcSpace can not be retrieved:

- IfcStair
- IfcFurnishingElement
- Elevator

It is the work for next step!
Thank you!