

# EXTRACTING SEMANTIC BUILDING MODELS FROM AERIAL STEREO IMAGES AND CONVERSION TO CITYGML

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Commission III, WG IV

**KEY WORDS:** 3D City model, CityGML, Data model

## ABSTRACT:

The collection of geographic data is of primary importance for the creation and maintenance of a GIS. Traditionally the acquisition of 3D information has been the task of photogrammetry using aerial stereo images. Digital photogrammetric systems employ sophisticated software to extract digital terrain models or to plot 3D objects. The demand for 3D city models leads to new applications and new standards. City Geography Mark-up Language (CityGML), a concept for modelling and exchange of 3D city and landscape models, defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantically and topological properties. It now is increasingly accepted, since it fulfils the prerequisites required e.g. for risk analysis, urban planning, and simulations. There is a need to include existing 3D information derived from photogrammetric processes in CityGML databases. In order to filling the gap, this paper reports on a framework transferring data plotted by Erdas LPS and Stereo Analyst for ArcGIS software to CityGML using Safe Software's Feature Manipulate Engine (FME)

## 1. INTRODUCTION

### 1.1 General Information

Virtual 3D city models gain more and more importance in science, government, and private industry. Several municipalities decide nowadays to build up 3D city models in order to clearly understand the cities' real situations. With the increasing number of more complex applications and objectives more sophisticated models are required not only based on geometric information, but on semantic information as well as on 3D topology, representing the meaning and functionality of urban objects. CityGML, an OGC standard for city and landscape modelling, is able to identify structures for the organization of urban information which can be used in a broad range of applications, e.g., for analysis in urban planning, disaster management, and environmental simulations.

Traditionally, acquisition of 3D objects is done by photogrammetric methods, using aerial stereo images. Leica Photogrammetry Suite (LPS) by Erdas for example, offers sophisticated tools for stereo feature collection. But there is a gap between the photogrammetric measurement and the storage of processed objects in CityGML which is filled by a student's master thesis completed at the Technische Universität Berlin.

## 2. 3D CITY MODELLING

### 2.1 3D City Models

3D City Models are digital representations of the Earth's surface and related objects belonging to urban areas. In order to get information about a city it is necessary to collect data from different sources. There are several methods of collecting the

data such as LIDAR, laser scanning, surveying measurements, aerial and satellite images...etc.

### 2.2 Semantic 3D City Models

Semantic 3D city models comprise besides the spatial and graphical aspects particularly the ontological structure including thematic classes, attributes, and their interrelationships. It follows structures that are given or can be observed in the real world. For example, a building can be decomposed into different building parts, if they have different roof types and their own entrances like a house and the garage (Kolbe,2009).

## 3. DATA MODELLING

Data modelling defines the relationships between data elements and structures. Data modelling techniques are used to model data in a standard, consistent, predictable manner in order to manage it as a resource (Carlis, 2001).

### 3.1 Building model in photogrammetric tools

The photogrammetric tools are combined with ERDAS Imagine – LPS and ArcGIS Stereo Analyst in the thesis work. The building data model of ERDAS which could not reach anywhere and it decided to build using UML diagram. Modelling the UML diagram of the ERDAS Imagine LPS module and ArcGIS Stereo Analyst is another task to follow on the project, while working on the photogrammetric methods. The UML diagram will help the user to follow the thesis work. It is representing the details of the workflow (Fig3.1).



#### 4. METHODOLOGY

To use technologies, which make the work possible are Digital Photogrammetric Workstations, Erdas Stereo Analyst, Stereo Analyst and Feature Assist for ArcGIS, FME and CityGML as an accepted data model for 3D GIS.

First of all the workflow is described using different colours and in different boxes referring the different programs which are used during the thesis work. Also on the workflow diagram the number refers to the steps which are in order on the thesis workflow. (Fig.4.1)

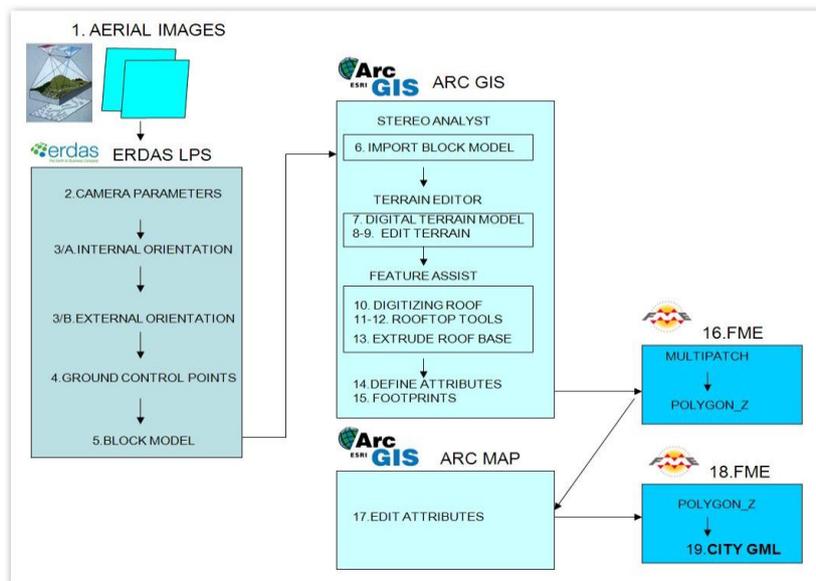


Figure 4.1: Workflow Diagram

During the workflow the following 19 steps which are listed below:

1. Adding Aerial Stereo images on ERDAS LPS and arranging to get 3D view
2. Defining the camera properties associated with the camera parameters
3. Orientation Parameters
  - A. Interior Orientation Parameters
  - B. Exterior Orientation Parameters
4. Adding the Ground Control Points on ERDAS LPS
5. Building a Block Model in ERDAS LPS
6. Import the Block Model in the Arc GIS Stereo Analyst
7. Adding a Digital Terrain Model in ArcGIS
8. Editing the Terrain using the Terrain Editor
9. Adding Terrain on Feature Assist
10. Digitizing the roof structure from Aerial stereo images in 3D view using Feature Assist for ArcGIS
11. Chosing the roof template in ArcGIS Stereo Analyst to digitize it
12. Digitizing the building installations and merging with the building roof
13. Extruding the roof structure with Extrude Roof Base based on the terrain model.
14. Giving the attributes of the building.
15. Footprints of the buildings from Multipatch Shape file
16. Converting from "Multipatch" to "Polygon z" on FME Workbench
17. Giving the attributes to the building's surface
18. Converting the building data from "Shape" to "CityGML" on FME Workbench
19. Displaying the CityGML data model in Land Explorer or Aristoteles

The result of the thesis work is a valid CityGML building model. In this paper work the aerial images were only the data which have been used within ERDAS LPS Program and the 3D city model have been created as a result.

#### 5. CONVERSION WITH FME

In this chapter, the main aim is filling the gap between photogrammetric tools and the CityGML data model has been solved by adding several transformers in the FME program. The conversion part is divided into two main part:

1. Conversion from ESRI *Multipatch* shape file format to ESRI *PolygonZ* shape file format with calculation of the building height. (Fig.5.1)

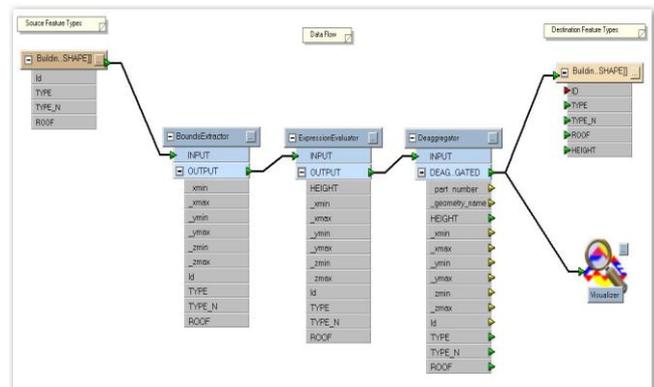


Figure 5.1: Conversion from ESRI Multipatch to ESRI PolygonZ shape file

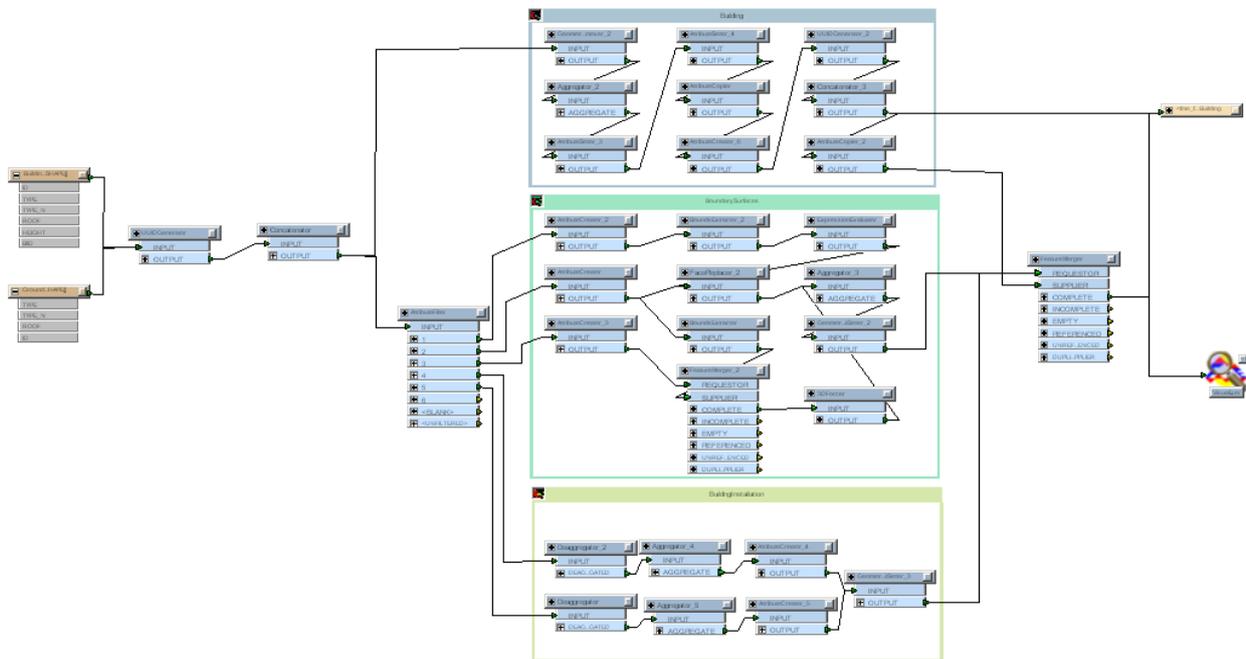


Figure 5.2: Conversion from ESRI PolygonZ shape file to CityGML data model

2. Conversion from ESRI PolygonZ Shape file to CityGML data model which is the main conversion task of the thesis work. Also the conversion is divided into three parts which are called bookmark in FME (Fig.5.2),
  - a. *Building bookmark* which includes general information about buildings and necessary attributes in order to have correct CityGML dataset.
  - b. *Boundary Surface bookmark* which includes the buildings surface informations, necessary attributes as well as extra attribute such as roof height.
  - c. *Building Installations bookmark* which includes the building installation necessary attributes in order to open properly in the CityGML data model.

Each Transformer needs necessary input data and should be in the right position in the FME workbench. Finally, the conversion has reached the destination data as CityGML, which is XML based format.

## 6. CONCLUSION

To sum up, the gap between photogrammetric methods and CityGML has been filled with a FME Workbench. Furthermore, the building model of photogrammetric methods has been created and also the building model of CityGML is minimized from the specification document depending on the requirements of the thesis work.. Also those building data models are compared with CityGML building model. The differences and similarities of those models have also defined and also they mapped eachother with using UML diagram.

## 7. REFERENCES

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