Research on CAD-based Grid Generation Method for BIM Models (Postprint)

Authors: Ma Cheng (1); Lu Xiaolong (2); Wang Dejiang (1)

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Abstract

This paper analyzes DXF files generated from CAD drawing files to identify grid lines and grid annotations. Simultaneously, by employing Revit API development technology, it automatically generates corresponding grid lines and grid annotations in the Revit model based on the acquired CAD information, thereby reducing the current manual workload of constructing BIM models from CAD drawings.

Full Text

Research on Axis Grid Generation Method for BIM Models Based on CAD Drawings

Ma Cheng[1], Lu Xiaolong[2], Wang Dejiang[1]
[1]Department of Civil Engineering, Shanghai University, Shanghai 200072, China
[2]State Grid Shanghai Municipal Electric Power Company Economic and Technology Research Institute, Shanghai 20000, China

Abstract: This paper analyzes DXF files generated from CAD drawings to identify axis grids and their labels. Using Revit API development technology, it then automatically generates corresponding axis grids and labels in Revit models based on the extracted CAD information, thereby reducing the substantial manual workload currently required to build BIM models from CAD drawings.

Keywords: BIM; CAD; Secondary Development

BIM (Building Information Modeling) technology, which integrates various types of building information, is poised for widespread application in civil engineering design, construction, operation, and maintenance. Consequently, it has received significant promotion and adoption both in China and worldwide. The United States has continuously updated its national BIM standards, currently

in its third edition, while the UK government mandates BIM technology for all government procurement projects. In China, the Ministry of Housing and Urban-Rural Development and various provincial governments have successively issued development guidelines for construction informatization. However, due to the division of labor in the civil engineering industry and the fact that most designers are accustomed to CAD-based design, BIM model construction in China typically occurs after design institutes produce drawings, with BIM professionals manually building models from CAD drawings—a process that involves substantial workload. How to rapidly generate BIM models from CAD drawings is an urgent problem that needs to be addressed.

In BIM design software, Autodesk' s Revit series products dominate the civil building sector due to the widespread use of the company' s CAD software. Revit provides powerful API (Application Programming Interface) capabilities for secondary development, making it possible to enhance Revit functionality through programming.

This paper proposes reading DXF files exported from CAD to identify axis lines and their numbers, then using Revit secondary development technology to automatically generate BIM model grids and labels based on the CAD information. This approach provides a foundation for rapid modeling and reduces the manual cost of BIM model construction.

1. Development Tools and Drawing Standards

1.1 Development Tools

This research uses Visual Studio 2010 as the programming tool, with C# as the programming language and Revit 2014 as the software version. Revit' s secondary development utilizes the Revit SDK, which provides numerous Revit interfaces. During development, since the information read through secondary development is Revit' s internal data rather than interface-level information, the Revit Lookup plugin is used to view all properties of various family instances, as shown in Figure 1.

1.2 CAD Drawing Standards

To facilitate the identification of axis lines and numbering information in CAD drawings and ensure that the generated axes in Revit maintain consistency in length, spacing, and coordinates with those in CAD, the CAD drawings must be pre-modified according to established standards, with all axis lines placed on a single layer.

2. DXF Files

2.1 DXF File Structure

This paper adopts the method of reading DXF files exported from CAD to access drawing content. A DXF file consists of paired integer codes and associated values, which CAD refers to as group codes and group values respectively, each occupying one line. A complete DXF file comprises six sections: HEADER, CLASSES, TABLES, BLOCKS, ENTITIES, and OBJECTS. Each section begins with SECTION and ends with ENDSEC. The composition and meanings of some group codes are shown in the table below. This research focuses on the ENTITIES section, which contains various entities and any block references.

2.2 DXF File Reading

In CAD drawings, axis grids are composed of lines, circles, and text. As previously described, DXF files consist of group codes and group values. When CAD graphics are saved as DXF files, these graphics are represented by coordinate points, radii, and text heights. Different entities, such as circles and lines, require corresponding reading methods to store their distinct parameters. The program can determine data types through loops using entity names and layer names. The flowchart for reading DXF files is shown in Figure 3. Table 2 lists the meanings of some group values.

[Figure 2: see original paper] shows a DXF file snippet for a line entity, where group code 8 indicates the layer name (0 for the default layer), and group codes 10, 20, 30 and 11, 21, 31 represent the start and end point coordinates respectively. Since group codes and group values appear in pairs, programming identification of DXF files requires assigning them to two string variables, with the process shown in Figure 3.

3. BIM Model Grid Generation

3.1 Grid Generation

The class corresponding to axis grids in Revit is Grid, which inherits from Element. The grid creation function in Revit is NewGrid, which has two overloads for lines and curves respectively:

```
Document.Create.NewGrid(Arc)
Document.Create.NewGrid(Line)
```

Grids can be established by creating curves and lines separately, then substituting them as parameters into the NewGrid method. Using this approach, grids identical to those in CAD can be generated in Revit based on data read from DXF files. The methods for creating lines and curves are:

```
Line geomLine=Line.CreateBound(start,end)
Arc geomArc=Arc.Create(START,END,ZHONG)
```

3.2 Axis Numbering Modification

When generating grids in Revit, the automatic naming issue must be addressed. Revit automatically names created grids, with the first grid named "1" or "A" and subsequent grids incrementing sequentially. This automatic naming cannot meet the requirements for correspondence with CAD drawing numbers. The implementation method in this paper involves: finding circles that intersect with grid extension lines or tangents, reading the text within the circles, and assigning it to the grid. In Revit, grid names can be modified through the Grid.Name property. The flowchart for reading axis numbers is shown in Figure 5, and the complete process for creating grids is shown in Figure 6.

4. Research Example

To verify the proposed method, a building' s axis grid was imported into Revit. The CAD drawing (Figure 7) contains 6 vertical axes, 4 horizontal axes, and 1 curved axis, all in black with default line types.

The grids generated in Revit using an external command loaded via Add-in Manager are shown in the corresponding figure. Add-in Manager, an official Autodesk plugin for loading Revit plugins, allows code modification and reloading without restarting Revit. Since grids are generated directly from line endpoint coordinates, the insertion positions are guaranteed to be completely accurate.

The generated grids maintain complete consistency with those in the CAD drawing in terms of insertion position and numbering. However, line type and color issues were not considered in this study and will be addressed in future research. Axis grids are only the foundation; subsequent research will incorporate columns and beams to complete the import of entire frame structures.

Conclusion

This paper achieves recognition of axis grids and numbering from CAD drawings through DXF file reading and Revit secondary development technology, enabling the generation of axes and labels in Revit that are consistent with the CAD drawings. The study briefly describes the DXF data format and key technologies for identifying axis lines from DXF files, and details the method for using Revit secondary development technology to generate grids and numbering in Revit, solving the correspondence problem between BIM model axes and CAD drawings. The conclusions are as follows:

1. Using Revit secondary development technology to automatically generate BIM model grids is feasible.
2. The connection between CAD drawings and BIM models can be achieved through DXF as an intermediate file.

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Note: Figure translations are in progress. See original paper for figures.