IOCMA 2026 Conference

The 2nd International Online Conference on Mathematics and Applications

Figure 4 Some topological cleaning instances and examples

10–12 June 2026 | Online

MDPI

Semi-Constructive Method for 3D Solid Reconstruction from Orthographic Views

Gerardo Martín-Lorenzo[1], Jose Pablo Suárez-Rivero[1], Pedro Miguel González[1]

Departamento de Cartografía y Expresión Gráfica en la Ingeniería. Universidad de Las Palmas de Gran Canaria. Spain

INTRODUCTION & AIM

During more than fifty years, orthographic projection drawings have represented one of the dominant standards for graphical communication in engineering and industrial design, [1-3]. However, current CAD/CAM workflows are increasingly focused on three-dimensional modeling and the direct use of 3D geometries. Automatic 2D-to-3D reconstruction techniques, have gained strategic relevance, as they enable the recovery and reuse of a vast legacy of technical documentation originally created in bidimensional formats. Furthermore, the interest in this field remains significant because the reconstructed models can subsequently be integrated into advanced numerical simulation processes, including FEM and BEM analyses, as well as modern CAD/CAM and digital manufacturing applications. This paper presents a computational framework for reconstructing 3D polyhedral objects from orthographic. The proposed method integrates geometric processing, graph-based connectivity analysis, and topological validation to ensure structural consistency of the reconstructed model. The approach begins with the extraction and normalization of 2D segments from DXF files, followed by geometric refinement through collinearity merging and intersection-based subdivision. A 3D reconstruction stage generates candidate vertices by intersecting orthographic projections, and segments are classified according to their spatial orientation.

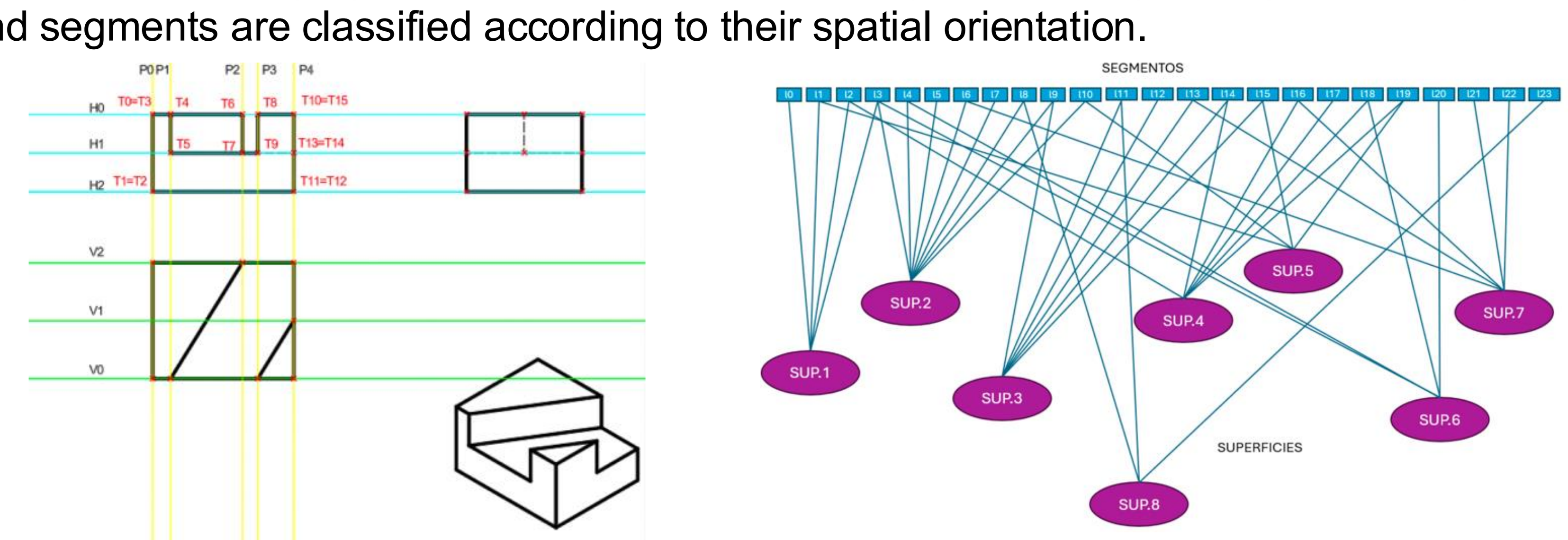

Figure 1. Scheme of a 2D to 3D reconstruction and topological decomposition

METHOD

Due to the complexity of the problem under consideration, there is no a universal approach capable of solving the reconstruction problem in a fully generic manner, [1-3]. Instead, it is necessary to progressively address the different particular cases presented by mechanical parts through specific solutions. For this reason, the study has gradually incorporated different case studies exhibiting particular geometric and topological characteristics that require distinct reconstruction strategies. Consequently, the analysis and subsequent development of solutions have been expanded incrementally in order to address these difficulties progressively and achieve the broadest possible framework capable of successfully reconstructing a large number of practical cases.

Reconstruction from orthographic views starts from 2D drawings that may contain visible lines, hidden lines, dimensions, text, blocks, symbols, polylines, and small numerical variations. The reconstruction pipeline must address four main difficulties:

1. separating the useful geometry from auxiliary drawing elements;
2. identifying which entities belong to each orthographic view;
3. transforming 2D segments into consistent 3D correspondences;
4. removing redundancies, overlaps, unnecessary subdivisions, and isolated elements.

The method can be summarized as a nine-steps process as depicted in Figure 2.

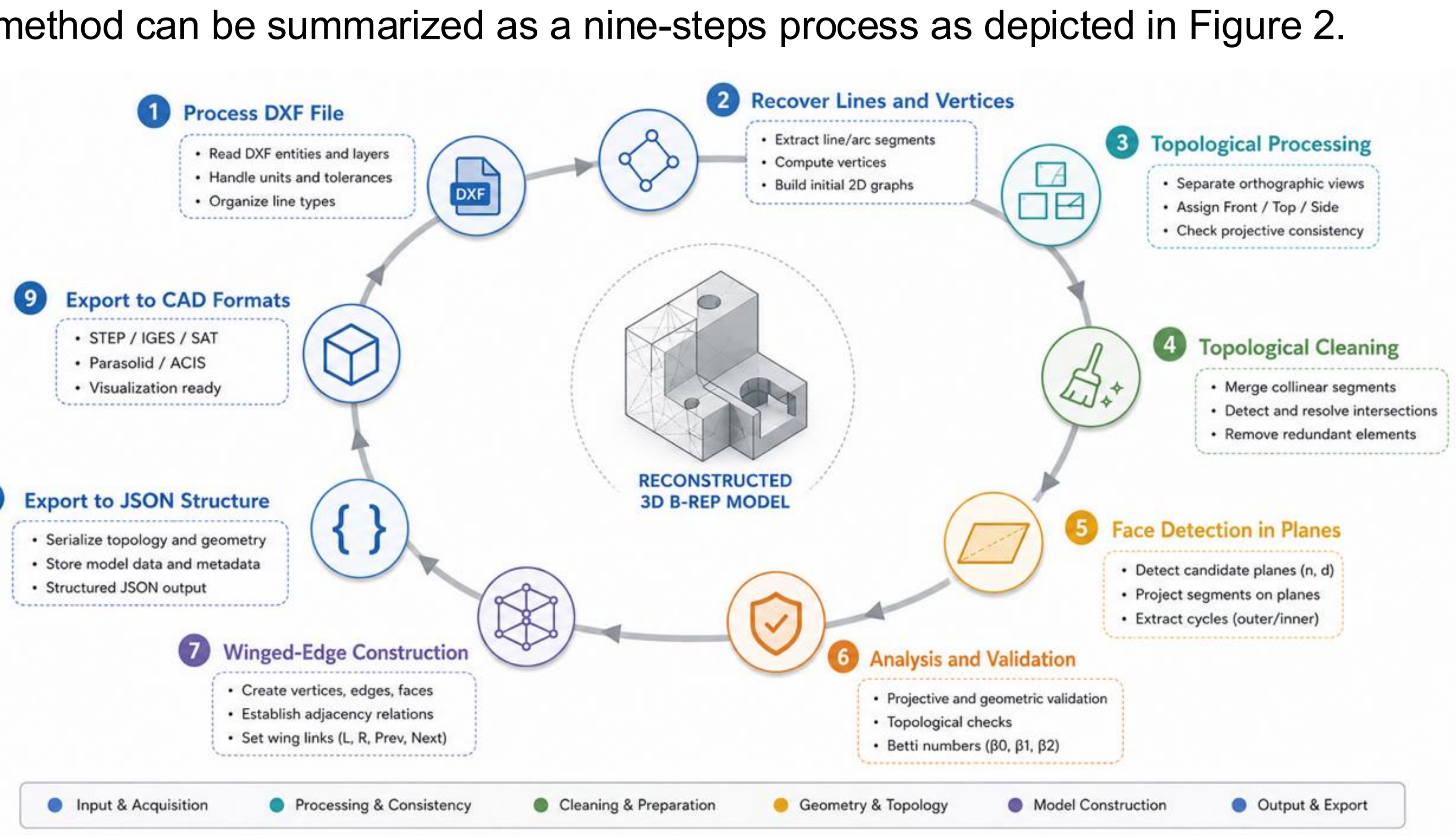

Figure 2. Overview of the 2D to 3D reconstruction pipeline

RESULTS & DISCUSSION

The proposed framework ensures not only geometric correctness but also topological consistency, which is critical for downstream applications in CAD and digital modeling. The method was evaluated on synthetic polyhedral models, including cubes and prisms. Results show:

- The integration of topological constraints significantly reduces ambiguity in reconstruction, Fig 3. However, the method assumes complete and consistent input views.
- Performance is influenced by the number of segments and intersection complexity, but remains acceptable for moderate-sized CAD models. Future work includes handling curved geometries and integrating machine learning techniques for ambiguity resolution.

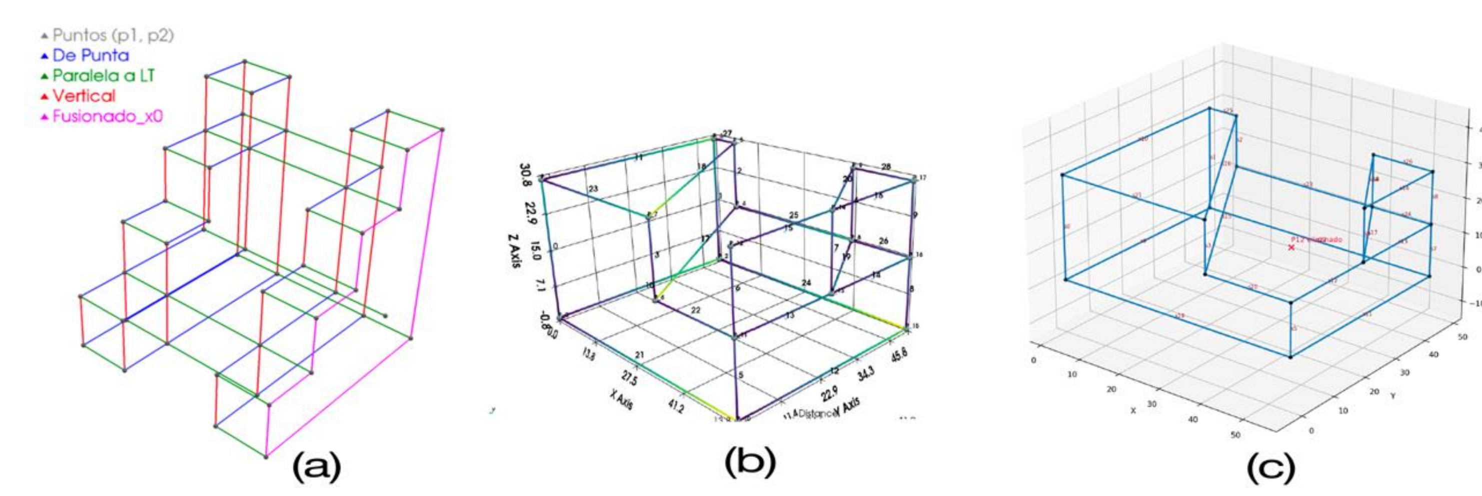

Figure 3 Some topological cleaning instances and examples

Betti analysis is applied as a topological validation tool for the reconstruction process. Its main usefulness is twofold. First, when applied to the 1D graph of segments, it allows verification of whether the reconstructed linear structure is connected and determines the number of independent cycles it contains. This is particularly useful for detecting undesired fragmentations or linear redundancies after the geometric reconstruction stage. In addition, it enables evaluation of whether the surface structure is topologically consistent, or not.

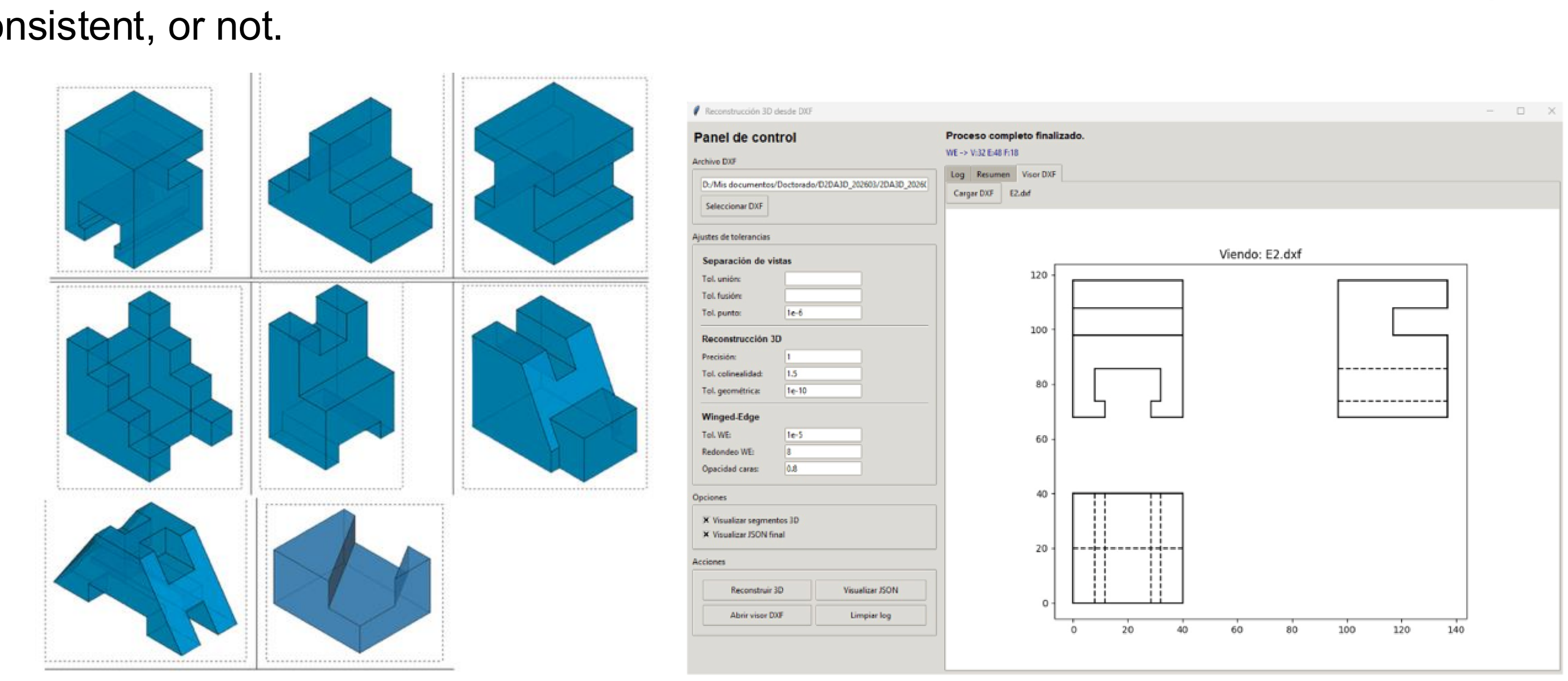

Figure 4 Screenshots of the computer app and some instances of processed parts.

CONCLUSION

We have showed the main features in the ongoing research of a PhD Doctoral Thesis, addressing the problem of 2D to 3D geometric reconstruction. Experimental results on polyhedral CAD parts demonstrate that the proposed pipeline produces geometrically accurate and topologically consistent models. The integration of topological validation significantly reduces reconstruction ambiguities and improves robustness. Figure 4 shows some screenshots of the computer app and some instances of processed parts. In a near future, we plan to improve the processing and cleaning of the input parts, and also open to other cases of more engineering complexity.

FUTURE WORK / REFERENCES

In a near future, we plan to improve the processing and cleaning of the input parts, and also open to other cases of more engineering complexity.

[1] Idesawa M. A system to generate a solid figure from three view. Bulletin of JSME;16(92):216-225, (1973)

[2] Wesley MA, Markowsky G. Fleshing out projections. IBM Journal of Research and Development.25(6):229-258, (1981)

[3] Sakurai H, Gossard DC. Solid model input through orthographic views. ACM SIGGRAPH Computer Graphics; 17(3):243-252 (1983