Applying Conformal Geometric Algebra Algorithms to 3-D Survey Plan Boundary Topology Problems

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Key words: Digital cadastre; Geoinformation/GI; Land management; 3-D Cadastre; CGA; Topology

SUMMARY

This paper reports on applying Conformal Geometric Algebra algorithms and operational techniques, along with 3-D point-point distance evaluations and geometric concepts such as collinearity and coplanarity to test data modelling processes that are designed for the purpose of classifying various geometrical and topological relationships between 3-D spatial objects. This paper reports on how these computational processes can be applied to the boundaries of two 3-D cadastral units registered to a survey plan for the purpose of solving 3-D cadastral boundary problems related to survey plan validation, specifically for verifying that adjacent units have the correct shared boundaries as intended on the plan prior to registration.

The approach to classifying relationships between two 3-D cadastral units A and B was to first evaluate the relationships between all boundary components in unit A with all boundary components in unit B. These relationships were then combined and interpreted together to describe the relationships between two 3-D cadastral units A and B. Six sets of data flow processing algorithms were developed to determine the relationship classifications that occur between the point-point, line-point, line-line, plane-point, plane-line, and plane-plane boundary component pair sets between the cadastral units. These algorithms were coded as MATLAB functions.

Experiments were conducted using simulated datasets and then using cadastral datasets that were derived from a condominium survey plan registered in Alberta, Canada. All examples tested consisted of cube-like 3-D cadastral units that were each represented by their standard geometric boundary primitives, being points, lines, and planes. Point coordinates for each cadastral unit boundary were derived using a coordinate system that was local to the condominium building. The relationships between all sets of 3-D cadastral units were known a priori to running the experiments and relationship classification results were validated manually to check if the implementation

program produced the correct results.

The results show how the computational processes developed using Conformal Geometric Algebra along with 3-D point-point distance evaluations can be applied to a practical 3-D boundary problem example in the land surveying field, specifically towards shared boundary validation between two adjacent 3-D cadastral units. Results show how relationship classifications between 3-D cadastral units that have shared boundary points, lines and planes can be verified using data flow processes prior to registering a survey plan. These processes could be leveraged by land surveyors and land administration professionals when analyzing 3-D survey plan boundaries.