

Project Proposal: GeoRepair

COMP 438 W2025

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Motivation

When modelling for various purposes, unintentional mesh defects sometimes crop up, leading to later issues with textures, materials, animation rigs, and simulations. Often, by the time they are noticed, especially on complex meshes, it becomes difficult to fix without losing a lot of progress. For example, you might notice a defect when texture painting, weight painting, UV mapping, which will be interfered with when editing the model. The motivation for the GeoRepair program is to load a mesh and detect/repair any defects that might not be noticeable, before moving on to any texture painting, weight painting, UV mapping, etc..

Description

GeoRepair will use libigl for viewing the loaded mesh and some mesh processing functions. A mesh can be loaded, and then saved. While a mesh is loaded, the user can inspect it and use a variety of menu options to detect and repair defects (the actual defects that will be supported are listed in the objectives section). The user can also select some parts of the mesh and apply those menu options to the selection only.

Objectives

- (1) Load and save triangular meshes. Supported formats are: .obj, .off, .stl, .ply, .wrl, and .mesh.
- (2) Detect defects in the mesh using a variety of algorithms. Supported defects are:
 - Duplicate faces
 - Duplicate vertices
 - Isolated vertices
 - Null faces
 - Degenerate faces
 - Unpatched holes
 - Inverted normals
 - Non-smooth noise
 - Non-manifold edges
 - Invalid vertex/face values
 - Unconnected submeshes

- (3) Repair those defects using different methods. Some of the defects may also have some configuration parameters. For example:
- *Duplicate vertices* may have a certain acceptance threshold for when vertices are considered having same position.
 - *Inverted normals* would have two possible fixes: all normals pointing inward or all normals pointing outward.
 - *Unpatched holes* may have different patch methods, such as using a triangle fan, triangle strip, etc.
 - There are several different algorithms to repair *noise*, such as Laplacian smoothing, Taubin smoothing, and bilateral smoothing.
- (4) Analyze simple and complex meshes with defects, and test detection, repair, and program performance.
- (5) Implement undo/redo mechanism for repairs.