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Automatic Generation of Quadrilateral Mesh From Triangular Mesh

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Abstract
Quad meshes, i.e. meshes composed entirely of quadrilaterals, are important data structures in computer graphics. Several applications in modelling, simulation, rendering, etc. are better suited for quad meshes than for triangle meshes. Hear the objective of study is to generate quad mesh from triangular mesh in a simpler way. The proposed method mainly includes two stages. In the 1st step quads are formed by merging two triangles by front advancing method. After the completion of the 1st step the resultant mesh is quad dominant mesh. It will have some isolated triangles inside the mesh. Then the isolated triangles are treated hear by dividing each isolated triangle into 3 quads. Which is very easy and less time consuming. After the application whole algorithm the resultant mesh is fully quad mesh.
Key words: Quad mesh, isolated triangles, Initial front

1. Introduction

Polygonal meshes are in importance since many years. Among those, triangles and quadrilaterals are the most common. Compared to the case of triangle meshes, simplification of quad meshes poses extra challenges, because quads are less adaptive and more delicate structures than triangles [3]. The main goal here is to obtain a mesh with good quality, i.e., having almost flat and square faces, and most vertices with regular valence four. Quality of approximation and adaptiveness are usually addressed only indirectly [5].
The constituents of a polygonal mesh are: vertices, edges and facets [Fig-1.1]. Vertices are just points in space; edges are straight-line segments bounded by pairs of vertices; and facets are polygons bounded by cycles of edges. Facets may share vertices and edges. [2]We consider primarily conforming meshes, in which any two faces may share either a single vertex, or an entire common edge. We also briefly discuss T-meshes, which are a special case of nonconforming meshes: in a T-mesh, there may exist some edge e of a face f that coincides with a chain of edges of two or more faces glued to f along e: internal vertices of such a chain are called T-joints of the mesh.

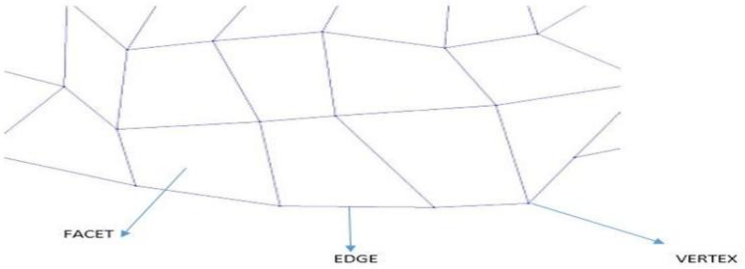

Fig-1.1 Quad mesh attributes

Need of Quad

- In higher order surface modeling semi regular quad meshes are very useful as base meshes for fitting tensor product spline and NURBS. [1]
- Superior performance in various applications like sheet metal forming and crash simulation, automation. [3,4]
- Semi regular quad meshes are the excellent match for texturing. [6,7]
- In fem it takes lesser computation time and gives better result. [3,4]
- In case of animation it is more convenient to manipulate. [5,6]

2. Method

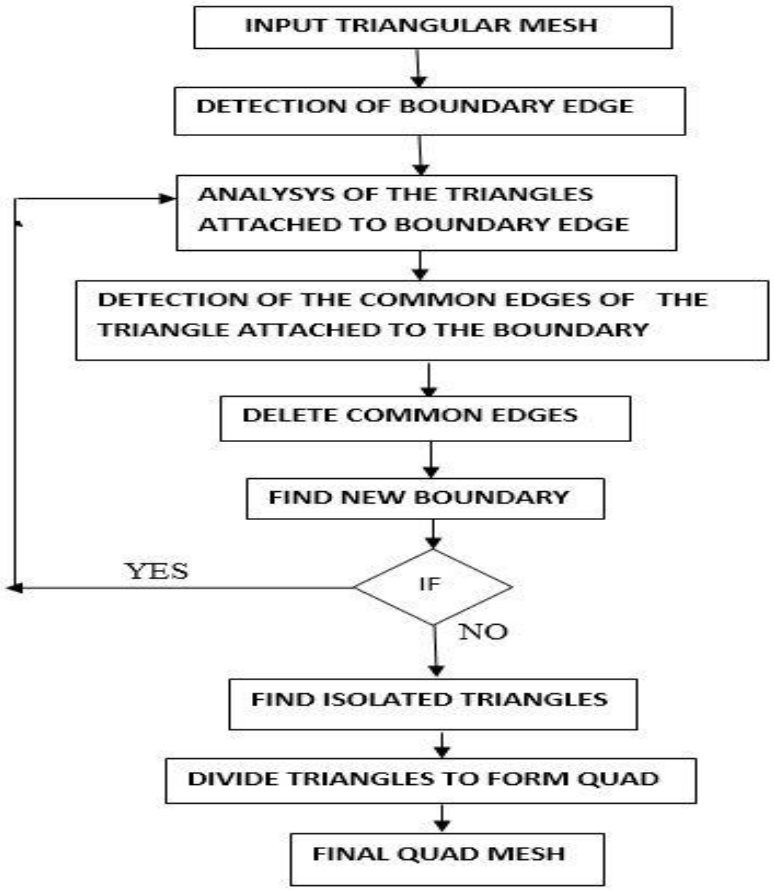

Fig-1.2 Flow Chart

2.1 Input triangular mesh

Hear triangular mesh [Fig-3.4, Fig-3.5] is taken as an input to the algorithm. The data base of the triangular mesh incudes the coordinates of the verities and their connectivity. Then edge data is extracted from this for the next step.

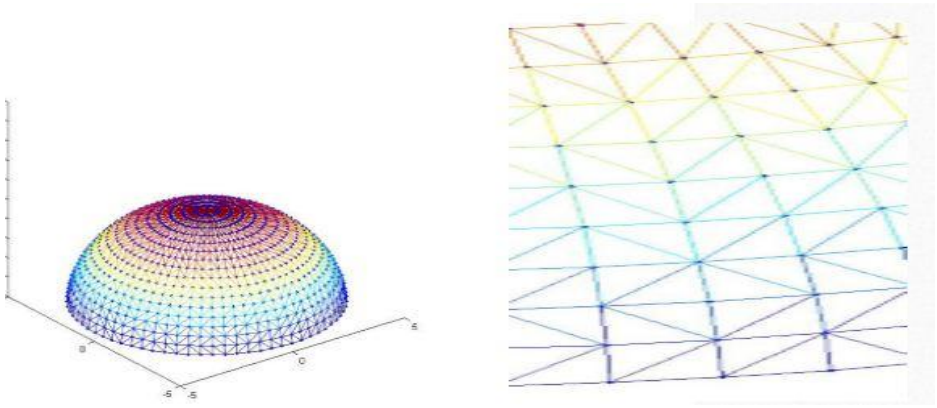

Fig-2.1 Triangular mesh on hemi sphere

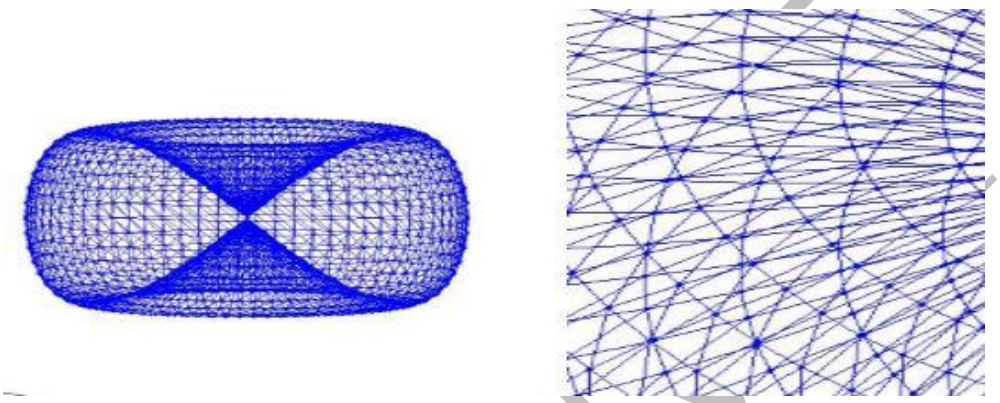

Fig-2.2 Triangular mesh on torus

2.2 Detection of Boundary Edge

The edges of the mesh will be analyzed and the edges which are not shared by any two triangles will be selected as the boundary edge. Then a boundary will be formed by connecting the edges. Then the vertices attached the boundary will be found and the triangles attached those vertices will be taken into consideration

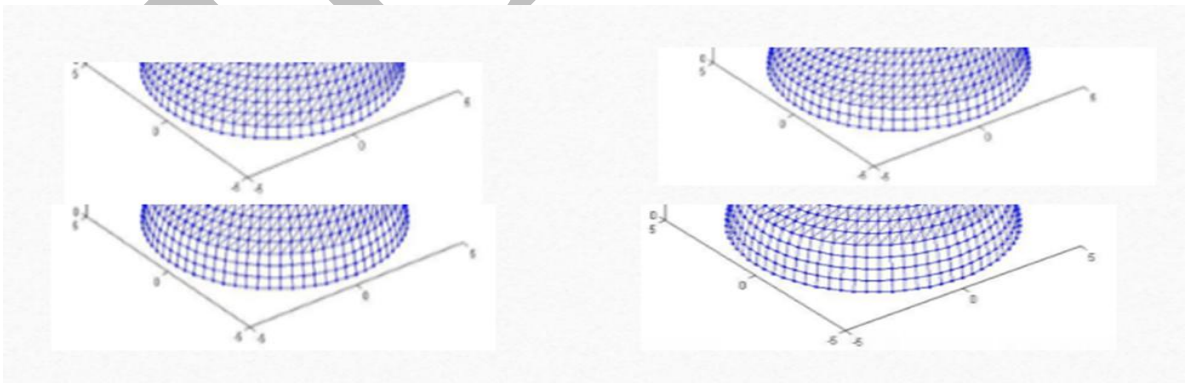

Fig-2.3 Move of boundary edges

2.3 Detection of Common Edges

The triangles attached to the boundary are analyzed and common edges are detected for the pairs of the triangles.

2.4 Delete Common Edges

The common edges are deleted to form quads.

2.5 Find New Boundary

In this step new boundary edges will be found. Hear new boundary edges are found. Hear the boundary edges are the common edges of triangle and quadrangle. Then these edges are joined to form new boundary.

2.6 Find Isolated Triangle

Then the algorithm will search for the isolated triangles which are not attached to any other triangle.

2.7 Divide Triangles to Form Quad

In this step the isolated triangles are formed by dividing the triangle into 3 quads by joining the incentre of the triangle with the midpoint of the edges of the triangle. [Fig-2.4]

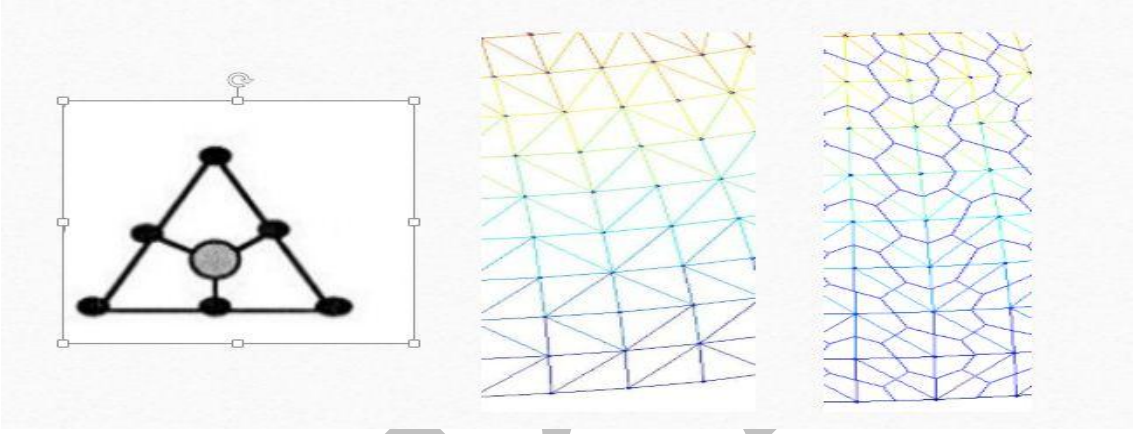

Fig-2.4 Division of Triangles to form Quad

1. Result and Discussions.

Mesh in which all the elements are quad. This is the final output of the algorithm

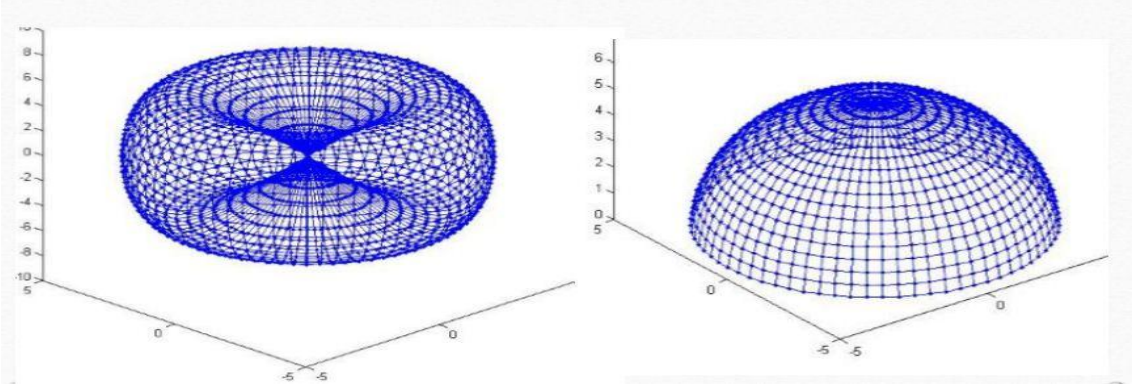

Fig-3.1 Quad mesh on hemisphereere and tours for uniform data

The algorithm is applied on both uniform and scattered triangular meshes. In both the cases quad mesh is resulted successfully. This method is simple and it takes less time for the operation.

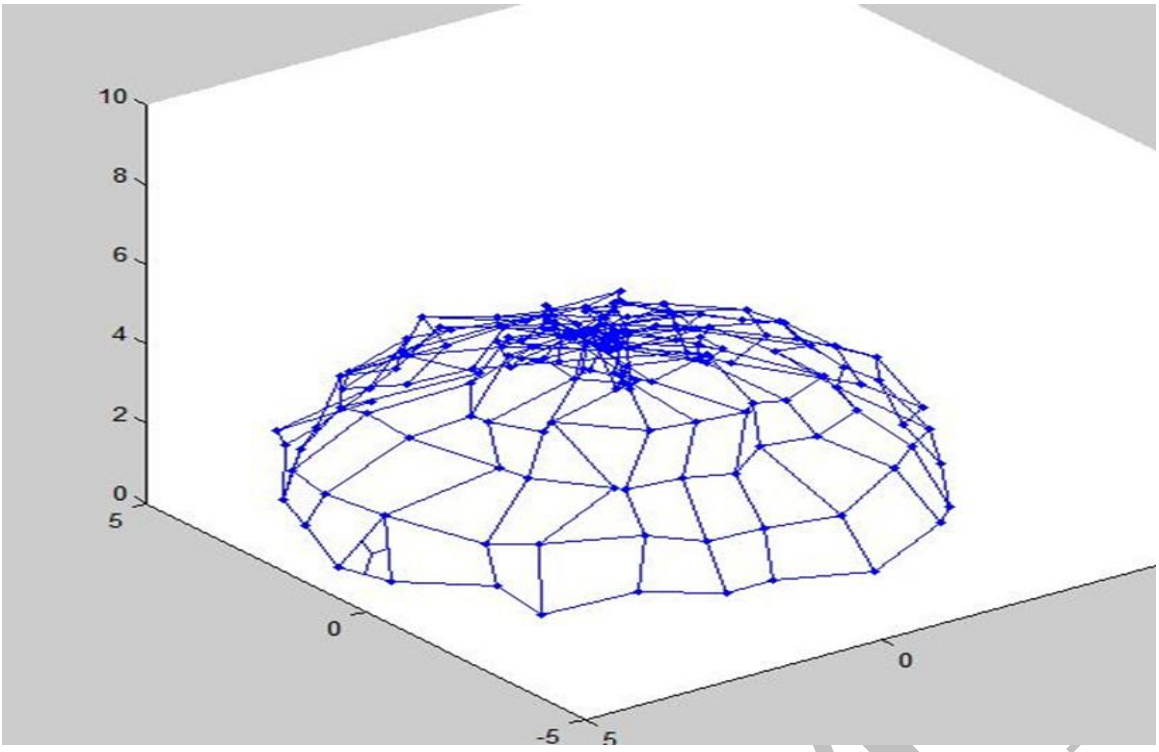

Fig-3.2 Fully Quad Mesh

After the completion of the 1st step the resultant mesh is quad dominant mesh. In this case isolated triangles are very less. Then the isolated triangle is treated hear by dividing each isolated triangle into 3 quads. Which is very easy and less time consuming. After the application whole algorithm the resultant mesh is fully quad mesh. [Fig-3.2].

2. Conclusion

The resulting mesh by this method is ideal in case of uniform triangular mesh. It is reducing the number of elements which is very helpful in applications like surface generation and FEM analysis. But in case of non-uniform and complicated input mesh this process will create a quad dominant mesh rather than fully quad mesh and then the isolated triangles are divided to form quads. In the existing algorithm the isolated triangles are treated with some types of edge flipping operations but in the proposed algorithm the isolated triangles are divided to form quads in order to make it faster and simpler.

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