CSE 555 Computational Geometry - Spring 2016

Project Report

Polygon Decomposition using Hertel Mehlhorn Algorithm

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Problem Statement:

To decompose a given polygon P into a small number of simple typically convex pieces.

Aim:

The purpose of this project is to implement Hertel-Mehlhorn heuristic for convex decomposition.

Algorithm:

Hertel-Mehlhorn heuristic is simple, efficient and always produces not more than four times the optimal number of convex pieces. It starts with a random triangulation of the polygon and then removes the diagonals that leaves only convex pieces. A vertex in a polygon is reflex if the angle made by it internally is greater than 180 degrees. All the diagonals that does not create a reflex vertex are said to be non-essential hence can be removed.

Data Structure:

Doubly Connected Edge List data structure is implemented to store the diagonals as half edges during triangulation and when Hertel-Mehlhorn heuristic is applied on this set of diagonals we obtain set of essential diagonals. This diagonals always results in convex pieces for the given polygon decomposition.

Platform:

Windows System, Java

User Interface:

Java Applet

Implementation Details:

Used java code provide by Joseph O'Rourke for Computational Geometry. Introduced a new option called polygon decomposition in the available operations and used existing ear clipping triangulation. Implemented DCEL and written a method for linear time hertel mehlhorn algorithm. Ear diagonals are stored in DCEL while performing triangulation then hertel mehlhorn alogorithm is applied on the DCEL to remove non-essential diagonals. Essential diagonals are then printed on the polygon showing polygon decomposition.

Classes Introduced:

cDCEL.java
cDCELHalfEdge.java
cDCELVertex.java

Usage:

Open command prompt pointing to the source code file directory

Run the applet using command: appletviewer CompGeom.html

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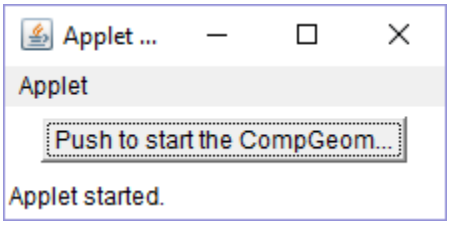
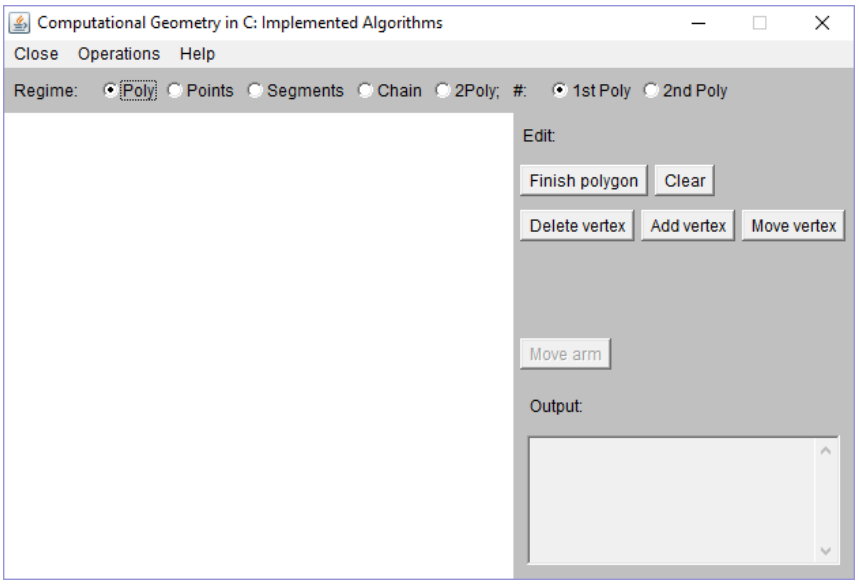
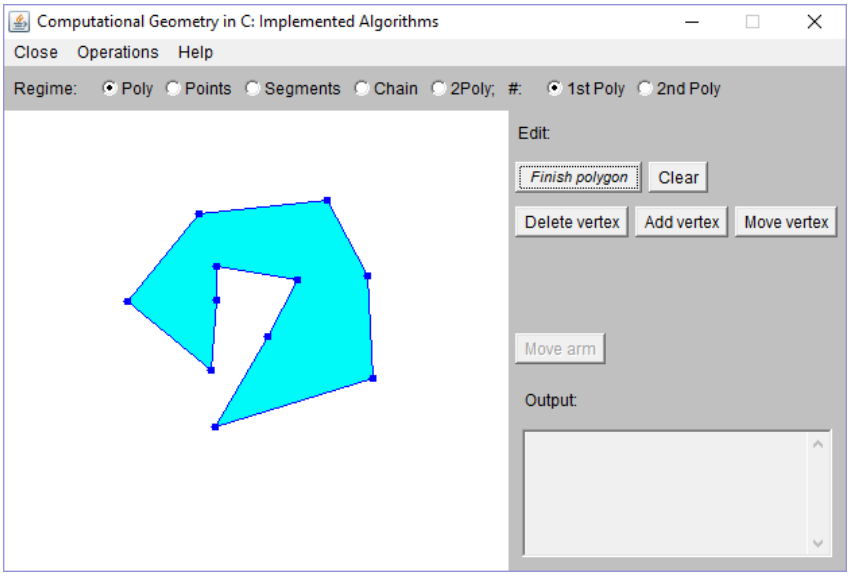
This shows up the applet as shown in the screenshot below:



Clicking 'Push to start the CompGeom' shows up the screen shown below



Draw the polygon using mouse actions and click finish polygon button as shown in the below screen



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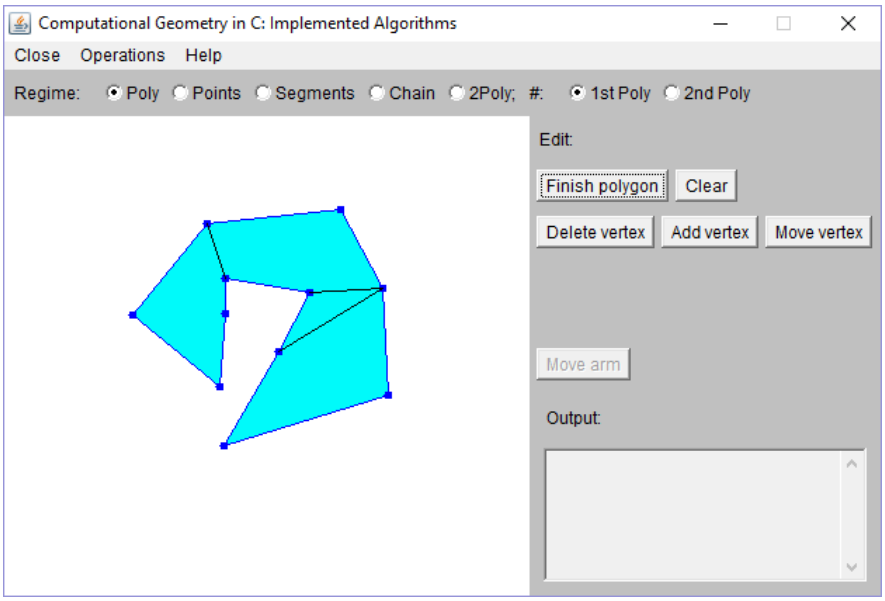
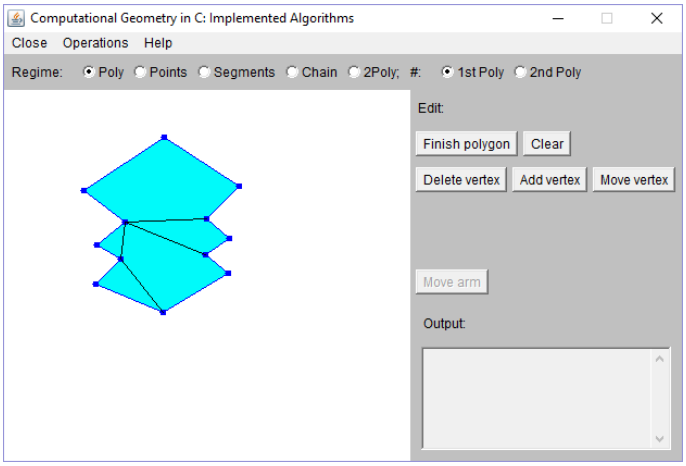
Click operations and choose operation ‘Polygon Decomposition’ last one in the list and the resultant screen is shown below



Test Cases:

Since polygon decomposition varies with different triangulations and various deletion order tested for a generic family of polygons and the result is near to optimal. One such example is shown in the below screen shot



Optimal convex pieces are 3 whereas this implementation resulted in 5 pieces.

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References:

- http://cs.smith.edu/~orourke/books/ftp.html
- http://dyn4j.googlecode.com/svn/!svn/bc/159/trunk/src/org/dyn4j/geometry/decompose/DoublyConnectedEdgeList.java