CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1410

Project Title

Dimensional Isomorphisms of the Eulerian Sequence: A Computer Inspired Analysis

Abstract

Objectives

In his monograph "Solutio facilis problematum quorumdam geometricorum difficillimorum," the Swiss mathematician Leonhard Euler first publicized the concept of the Euler Line, which connects the circumcenter, centroid, and orthocenter of any triangle. Curious to explore this line in other geometrical configurations, we began with the Eulerian Sequence, a subset of polygons postulated to contain the Euler Line. Inductive and extensive reasoning yielded several isomorphisms between this sequence and three-dimensional figures. Our project focuses on generalizing this sequence to describe a set of polyhedrons that contain the Euler Line in addition to exploring their properties.

Methods

We utilize multiple computer simulations to gather observations and make conjectures, primarily using Java and MATLAB software to plot the special points and the set of polyhedrons with the Euler Line. Inspired by our simulations, we proved our conjectures of Eulerian Polyhedrons through various multivariate techniques.

Results

Using a proof by induction, we were able to develop explicit and recursive descriptions for the number of faces, edges, and vertices for any Eulerian Polyhedron. Through topological and analytical techniques, we located the centroid, Monge point, and circumcenter of a general Eulerian Polyhedron, and using differential geometry to express the volume and surface area of each Eulerian Polyhedron. Lastly, examining the end behavior of our formulas showed that Eulerian Polyhedrons would converge not to a sphere but to a Steinmetz solid.

Conclusions

In our project, we define the criteria for any Eulerian Polyhedron while also validating its algebraic and geometric properties. We also explore and develop barycentric descriptions of Eulerian Polyhedrons. Ultimately, our computer simulations remain a critical inspiration for our analyses and applications, and we hope to use our computer simulations in the future to approach problems in other fields that may benefit from computer inspiration.

Summary Statement

Our project focuses on generalizing the Eulerian Sequence to describe a subset of polyhedrons that contain the Euler Line in addition to exploring their properties.

Help Received

None. While we have received no outside help, we plan on contacting a professor in the near future and publishing our results.