

Exploration of mutation step sizes in the automated evolution of printable free-form 3D objects

Abstract

3D printing is a comparatively new technology that is becoming ever more attractive to everyday practitioners and hobbyists due to its low start-up cost as well as making significant advancements in its printing process as well resolution and material variety. Implementation of EAs in the field of 3D printing is still in its infancy since 3D printing itself is a relatively new technology that has only become main stream due to its significant decrease in acquisition cost in the past 2-3 years. In this study, an EA in the form of Evolutionary Programming (EP) is used to automatically evolve 3D objects generated by Gielis' Superformula. Objective: The focus of this study is to explore the mutation step size in hoping to create more diverse populations in the evolution of the generated 3D printable objects. In EP, the operator responsible for offspring generation is through the mutation process solely. Hence, the mutation step size has a direct and very significant impact on the diversity of the offspring generated. A fitness function was designed to evaluate the 3D objects and shapes generated by the Superformula. The parameters for the Superformula to generate 3D objects or shapes are m_1 , m_2 , $n_{(1,1)}$, $n_{(1,2)}$, $n_{(1,3)}$, $n_{(2,1)}$, $n_{(2,2)}$, and $n_{(2,3)}$. These parameters serve as a representation in EP and the mutation step size will affect the chances of these parameters' values to change. To carry out this study, ten different mutation step sizes ranging from 0.1 to 1.0 in increments of 0.1 were used and run for five times. Results: The results indicate that the most aesthetically-pleasing as well as machine-printable results were obtained using the smallest mutation size of 0.1. Conclusion: Optimal setting for mutation rate can successful generate 3D-printable shapes that are aesthetically-pleasing using the proposed Gielis Superformula-based methodology.