PRASHANT GUPTA

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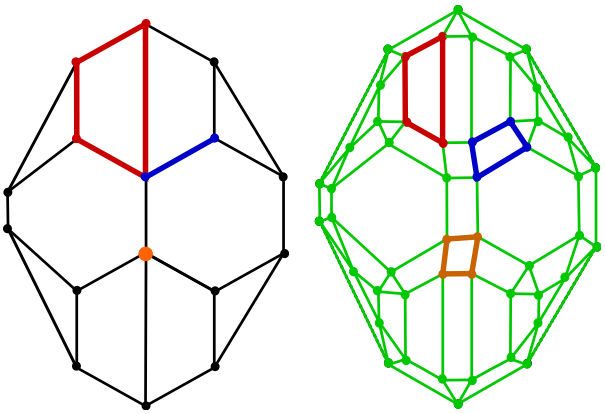
OBJECTIVE

Develop smart and robust algorithms to automate various tasks without compromising quality of end product.

PUBLICATIONS

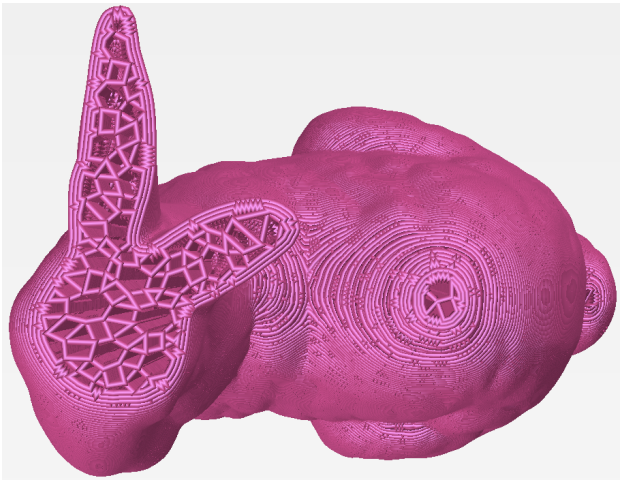
Euler Transformation of Polyhedral Complexes, 2018, Accepted in International Journal of Computational Geometry and Applications (IJCGA), 2021, arXiv: 1812.02412

Developed a provable mathematical model that transforms an arbitrary polyhedral complex in 2D or 3D to a new complex whose 1-skeleton has even degree. Model is based on combinatorial topology and computational geometry.



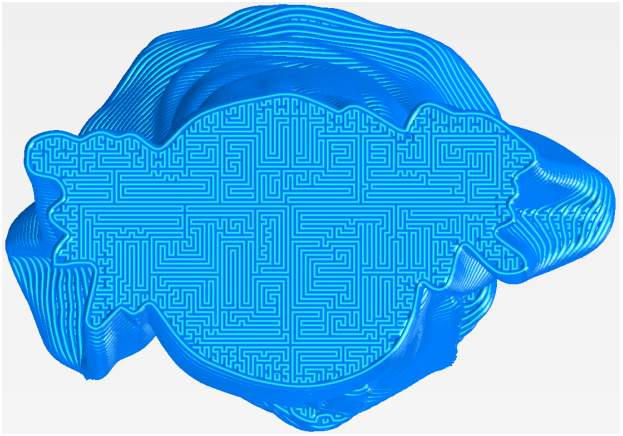
Continuous toolpath planning in a graphical framework for sparse infill additive manufacturing. Computer-Aided Design, 127:102880, SPM 2020, arXiv: 1908.07452

Developed a framework for continuous tool path planning of infill lattices in layer by layer 3D printing based on Euler transformation. Designed polynomial time algorithms to generate continuous tool paths. Based on combinatorial topology and graph algorithms. Framework is implemented in Python.



SFCDecomp: A Space-Filling Curve Based Domain Decomposition Method for Multicriteria Optimized Toolpath Planning in 3D Printing, 2020, submitted

Proved **NP-Completeness** of dense fill 3D printing problem. Developed an efficient framework for large instances of multicritria optimized 3D printing problem using graph decomposition based on space filling curves and Integer Programming. Typical instances include *Buddha* with 799,716 nodes over 169 layers and *Bunny* with 812,733 nodes over 360 layers. Based on discrete optimization and graph theory. Framework is implemented in Python using **CPLEX**. Improved mechanical strength of test sample up to 37%.



Future Scope:

- Improve quality of the print by computing minimum cost tool path. Cost of the edge in the graph can be modeled using **simulation tools, e.g., finite element analysis,** based on various mechanical parameters such as temperature, stress, etc.
- Optimize Euler transformed mesh using **topology optimization** based on various mechanical factors.
- SFCDecomp can be extended to **hybrid manufacturing problems**.
- SFCDecomp is **embarrassingly parallelizable.**
- Graphical framework enables seamless use of **machine learning techniques**.

EXPERIENCE

Research Intern (ASTRO) May–Aug 2018, Jun–Dec 2017
Oak Ridge National Laboratory (ORNL) *Knoxville, TN*

- Created a new formulation for tool path (the path followed by the printer head as it extrudes material) planning to optimize 3D print quality and to reduce printing time and cost. Implemented in **Python** and **C++**.
- Created a novel geometric subdivision approach, Euler transformation (ET). It transforms any mesh into a new one that guarantees a continuous tool path. Reduced print time and improved print quality on test example.
- Tested and integrated hexagonal mesh library, and developed ET module in **C++** for ORNL slicing software.

Graduate Researcher May 2016–present
Washington State University *Pullman, WA*

- Developed and characterized mathematical aspects of the additive manufacturing (AM) problem, and designed efficient algorithms with provable guarantees of performance and quality for tool path planning.
- Created a novel topological data analysis (TDA) filtration approach for high-dimensional data visualization and summarization to understand complex features. Implemented framework in **Python** using **SciPy**. Identified significant thin features in point cloud not observable in standard TDA.

Graduate Researcher Jan 2015–May 2016
Washington State University *Richland, WA*
Developed a C++ module in lammps from scratch for nanoscale fluids using discretized Navier Stokes Equation, works for both shared and distributed memory systems.

Finite Element Analysis intern May–Aug 2013
NEi Software (now part of Autodesk) *Westminster, CA*
Integrated and tested the nonlinear optimization solver IPOPT on NEi Nastran software that gives better performance in terms of checkerboard and symmetry of design when forces are symmetric in topology optimization.

CAE Engineer Aug 2011–Jun 2012
Mechartes Researchers *India*
Simplifying and analyzing 3D models using finite element analysis. Optimizing design to be economical and reliable based on analysis and conveying it to the client.

Manufacturing intern Jun–Dec 2009
Yamaha Motors *India*

TEACHING EXPERIENCE

Instructor Aug 2016–Dec 2019
Washington State University *Pullman, WA*

Taught 3 freshman / sophomore level mathematics classes (Basic Mathematics, Algebra, Trigonometry) to non-math majors. Responsibilities included creating class lectures, preparing and grading assignments and exams, and holding office hours. Classes have up to 100 students.

Lab Instructor Jan 2015–May 2016
Washington State University *Pullman, WA*
Taught Calculus-I, II labs. Responsibilities included grading lab assignments and homeworks and exams and holding office hours. Labs have upto 45 students.

PROJECTS

Text Classification using Convolution Neural Networks (CNN): Implemented CNN for sentimental analysis of text data in Python using TensorFlow and evaluated on Movie Review Dataset on Kaggle, ranked in top 20% (post competition).

Letter recognition using Artificial Neural networks (ANN): Implemented a scalable binary classification algorithm in Matlab using ANN with one hidden layer on UCI dataset of English letters with accuracy of 93.9% compared to original paper with 80% accuracy.

Topological Complexity of Robot Motion Planning (Blog Post): Introductory blog on topological complexity of robot motion planning.

EDUCATION

Ph.D. in Applied Mathematics, Washington State University 2015–present
Relevant Coursework: Non-Linear optimization I and II, Network Optimization, Advanced Matrix Computations, Integer and Combinatorial Optimization, Structured Prediction, Artificial Neural Networks, Deep Learning, Bayesian Analysis, Distributed Systems Concept And Programming, System Programming, Algebraic Topology, Computational Topology, General Topology.

M.S in Mechanical Engineering (Simulation), University of Colorado, Boulder 2012–2014
Relevant Coursework: Numerical Methods, Applied Mathematics I and II, Markov Processes, Finite Element Method (FEM), Continuum Mechanics, Introduction To Fluid Dynamics, Reacting Flow, Computational Fluid Dynamics, Turbulent Flow.

B.Tech in Mechanical Engineering (Machine Tools), YMCA Institute Of Engineering, India 2006–2010

TECHNICAL SKILLS

NumPy, Pandas, Cplex, LPsolve, SciPy, TensorFlow

REFERENCES

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