Steadied Lattice Structures

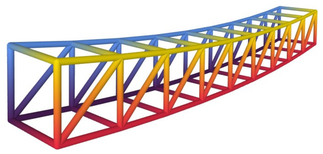
Ashish Gupta, Jarek Rossignac
School of Interactive Computing, College of Computing

Problem: Given two ball clouds C_0 and C_n, where no total similarity transform T exists such that $C_n = T(C_0)$, and is therefore not possible to compute a ***steady*** interpolating pattern, i.e. $C_{i+1} = T^{1/n}(C_i)$, of ball clouds, compute a ***steadied*** (i.e. nearly steady) interpolating pattern of ball clouds.

Motivation

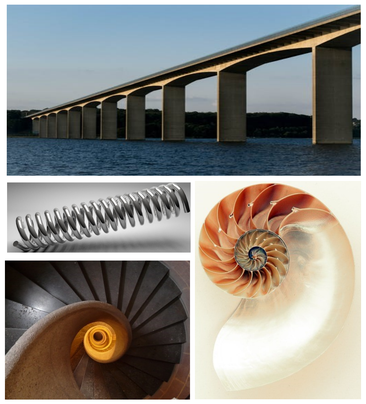
Design of Lattices with uniformly graded geometry, presumably leading to

- Improved aesthetics
- Uniformly varying mechanical properties
- Accelerated querying
- Accelerated performance testing



Steady Patterns

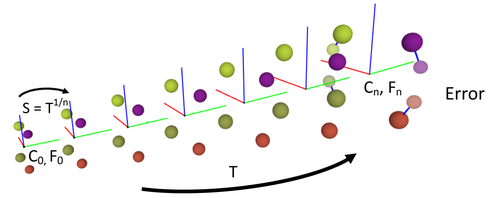
- Given a starting shape S_0 and an affine transform T. A sequence of shapes $S_{i+1}=TS_i$, forms a steady pattern of shapes.
- Examples - spiral, helix, swirl

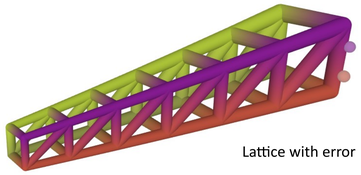


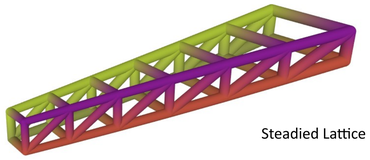
Proposed solution

Compute steadied lattice

- Compute a similarity transform T that registers C_0 to C_n, minimizing the least square error.
- Associate a frame F_0 with C_0 and compute a **steady similarity pattern** ($S=T^{1/n}$) of frames and corresponding ball cloud.
- Balls in C_n and $S^n(C_0)$ won't match (see blue lines in last cloud)
- Distribute corrections of the errors between C_0 and $S^n(C_0)$ by composting S with an incremental correction X, which moves and scales the balls individually in the local frame.
- Motion of balls in local frame can be simple LERP or SAMBA [1].




Lattice with error

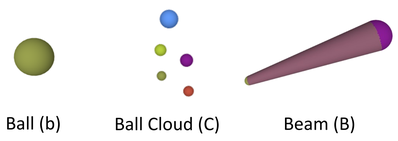

Steadied Lattice

[1] *Rossignac, J., Luffel, M., & Vinacua, À. (2012, June). SAMBA: Steadied choreographies. In Proceedings of the Eighth Annual Symposium on Computational Aesthetics in Graphics, Visualization, and Imaging (pp. 1-9). Eurographics Association.*

Problem formulation

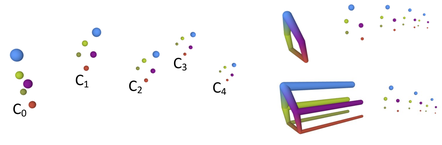
Lattice Primitives

- Ball (b) – center (c) and radius (r)
- Ball cloud (C) – a set of disjoint balls, same or different r
- Beam (B) - Beams is a cone connecting tangentially to the two



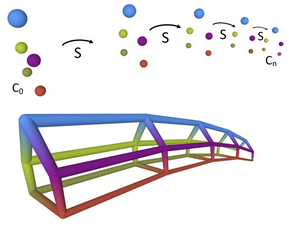
Lattice representation

- Pattern of ball cloud connected by beams
- Beams connect balls within a cloud or across the clouds



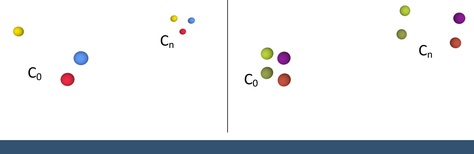
Similarity Steady Lattice (SSL)

- A sequence of ball clouds, such that $C_{i+1} = S(C_i)$, — where S is a similarity transform— and the associated beams.
- Either C_0 and S is given and the structure is created incrementally OR
- C_0 and C_n is given , such that $C_n = T(C_0)$ where T is the total similarity transform, then the incremental similarity transform can be computed as $S=T^{1/n}$.



Steadied Lattice (SL)

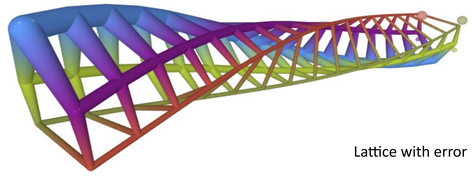
- Given the ball clouds C_0 and C_n where no total similarity transform T exists such that $C_n = T(C_0)$, compute a ***steadied*** (i.e. nearly steady) interpolating pattern of ball clouds

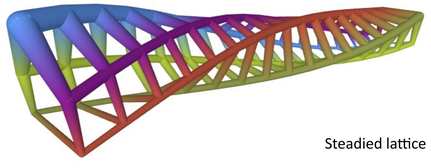


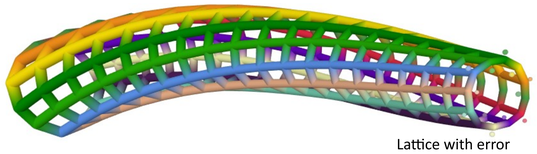
Results

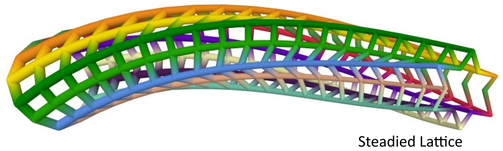
Lattice structures before and after error compensation. Observe that:

- The pattern is interpolating, i.e. error corrected $S(C_0)$ matches exactly with the last cloud C_n.
- Ball size and therefore also the beam thickness changes smoothly.
- Shape of the ball cloud and therefore the angle between beams change smoothly.


Lattice with error

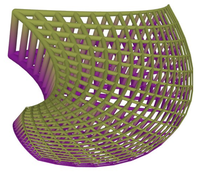

Steadied lattice

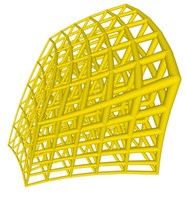

Lattice with error


Steadied Lattice

Ongoing

- Define steadiness measure, then evaluate and compare lattice structures for steadiness.
- Lattice structures defined by more than two ball clouds.





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