Generative design of interlocking sequential assemblies

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Bracket-Arm Set
typical of Chinese medieval architecture

Hoshi Ryokan inn inaugurated in 719, Japan
Focus on the assembly node
design problem
a wicked problem, with fuzzy and competing goals

design knowledge
all geometrical interlocking designs can be generated

design exploration
the design space is explored through optimisation or user-feedback
Simplifying assumptions:

- Infinitesimal motions
- Polygonal/Polyhedral parts
2D - Theory
Cone of translational freedom
Half-planes of rotational freedom
Half-plane of translational freedom

Cones of rotational freedom
Cones of freedom
Non Directional Blocking Graph (NDBG)
2D - Implementation
2D

$x_1$

$x_2$

$x_3$
2D - rotation
2D - Results
Mechanical behaviour
Robustness to imperfection

\[ p_i^\epsilon \sim p_i + \mathcal{N}(0, \epsilon^2) \]
Interpolation
3D - Theory
Unit Dual Quaternions

\[ \hat{q} = \begin{bmatrix} \cos \frac{\hat{\theta}}{2}, \hat{u} \sin \frac{\hat{\theta}}{2} \end{bmatrix} \]

\[ \hat{\theta} = \theta_0 + \epsilon \theta_\epsilon \]

\[ \hat{u} = u_0 + \epsilon u_\epsilon \]

\[ \epsilon^2 = 0 \]
2D - Results
\[
\begin{pmatrix}
A_M \\
-x^T
\end{pmatrix} x \geq \begin{pmatrix} 0 \\ -||\bar{x}||^2 \end{pmatrix}
\]

Cone of freedom
Robustness to imperfection

\[ p_i^\epsilon \sim p_i + \mathcal{N}(0, \epsilon^2) \]
\[\forall f \in F \forall v \in V(f) \ m(v, \hat{q}) \cdot n_f \geq \alpha\]
Thank you