Geodesic Patterns

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Objective

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Discretize a given freeform surface into panels with the following properties:

1. Panels must be ***developable*** (Shelden 2002)
2. Panels should be of approximate ***equal width***
3. Panels should be ***as straight as possible***
4. Panels should ***bend by their weak axis*** to aproximate the surface.

Objective

Some text

Figure 1: Some figure

Background

Boat-building

The use of *sraight developable planks* is widely used in

traditional boat building

Some Algorithm

1: **for** $i = 1$ to N **do**
2: **for** $j = 1$ to JJJ **do**
3: $energy[i * JJJ + j] =$
$interpolate(AAA[i * JJJ + j], ZZZ)$
4: **end for**
5: **end for**

Algorithm 1: pseudocode for the calculation of

Developable hulls

Connected developable patches for boat hull design.

1. Common practice in naval engineering industry.

Figure 2: Developable hull model

Frank Ghery

This techniques have also been used in the architecture world, mainly by **Frank Ghery**.

His façades are usually a collection of connected developable surfaces.

Burj Khalifa

Latest architectural work following this techiques was:

Burj Khalifa by *Frank Ghery*

Burj Khalifa

It was designed as a collection of:

- **Developable surfaces**
  - *Which can be covered by equal width planks*
- **Surfaces of constant cuvrature**
  - *Which can be covered by repeating the same profile*

Burj Khalifa

Construction technique

Geodesic curves

A geodesic curve is the generalization of a *straight line* into *curved spaces*.

$$\nabla + \alpha^2 = \sqrt{8} * A$$

Geodesic curves

It could be easiy understood as:

The path that a bug follows on a surface if it only moves ***forward***

Straightest geodesics

In this research, we concentrate on the concept of ***straightest geodesics***.

Developable surfaces

Surfaces with ***0 gaussian curvature***. Meaning, they can be flattened onto a plane ***without distorsion***

Developable surfaces

Developable surfaces

- can be flattened
- can be generated by a single curve.

and

Geodesic curves

- are straight lines in a curved space.

Therefore

Therefore

We wish to generate panels using geodesic curves in order to achieve ***straight developable panels***

Developable surfaces

In other words:

We wish to cover a given freeform surface with a pattern of ***geodesic curves*** *with equal spacing.*

This can only be achieved if the provided surface is already *developable.*

A compromise exists between the curve spacing and the curve geodesic property

Algorithmic strategies

Obtaining Geodesic Patterns

There are three main methods for the obtaining succesfful geodesic patterns:

1. The parallel transport method
2. The evolution method
3. The piecewise geodesic vector-field method

The parallel transport method

Vector parallel transport

Parallel transport of a vector on a sphere

Implementation details

Parallel transport method over positive curvature surface

Results

Results

The evolution method

Implementation details

Results

The piecewise evolution method

Implementation details

Results

The level set method

Implementation details

Results

Modeling planks

Tangent developable method

Bi-Normal method

Comparisson

Optimization

Piecewise geodesic vector-fields

Developability of triangle meshes

Analysis

Conclusion

Thanks

MPDA
Master's degree
Parametric Design in Architecture

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Conclusion

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