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# Geodesic Patterns

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# Objective

## Objective

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.

Notes: This are reveal notes

**Objective**

# 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 1:** 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**

**Conclusion**

**Thanks**

**References i**

Shelden, Dennis Robert. 2002. "Digital Surface Representation and the Constructibility of Gehry's Architecture." PhD thesis, Massachusetts Institute of Technology. http://hdl.handle.net/1721.1/16899.