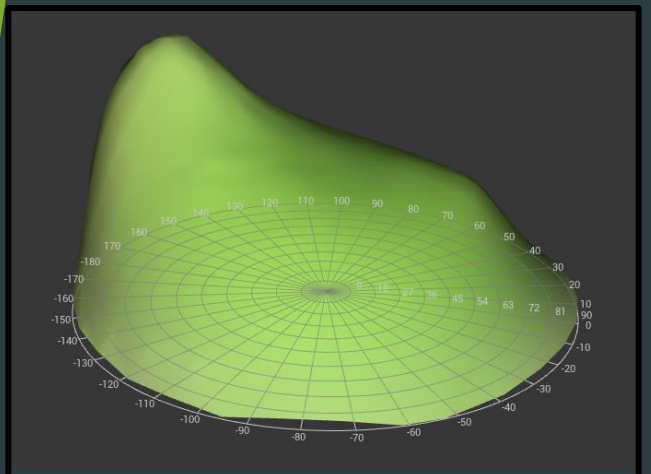
Author: Gino Tramontina Contact: G.E.Tramontina@student.tudelft.nl TU Delft Responsible Professor: Ricardo Marroquim Supervisor: Yang Chen

1: Background

A Bidirectional Reflectance Distribution Function (BRDF) describes how much light is reflected given an incoming and outgoing direction.

BRDFs are used in computer graphics applications to simulate how a material reflects light.

Creating a measured BRDF is timeconsuming and costly due to specialized equipment.



BRDF of green acrylic felt for one diriction of incoming light [1]

REFERENCES

[1] Jakob, W. and Dupuy, J. (2018) *Material database: RGL, Realistic Graphics Lab.* Available at: https://rgl.epfl.ch/materials

[2] Olinde, Rodriques. Des lois geométriques qui régissent les déplacements d'un systéme solide dans l'espace, et de la variation des coordonneés provenant de ces déplacements considérés indépendamment des causes qui peuvent les produire. *Journal de Mathematiques Pures et Appliquees*, 5:380–440, 1840.

[3] Karl Pearson F.R.S. Liii. on lines and planes of closest fit to systems of points in space. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 2(11):559–572, 1901.

2: Research Questions

How can we approximate a full, 3D BRDF for a material from one slice (in-plane BRDF)?

- How to create a simple BRDF?
- How can simple BRDFs be combined?
- How can an in-plane BRDF be divided into sub-curves to be used to create the full BRDF?
- How can a curve be rotated around a non-vertical axis?
- What method can be used to find non-vertical axes of rotation?

3: Methodology

Approximate a full BRDF trough solids of revolution

Steps to take to create the algorithm:

- Create simple BRDFs trough single solids of revolution.
- Combine solids of revolution to create more complex BRDFs through normalization and sorting.
- Divide slice into sub-curves based on the curves acceleration to create solids to be combined into a single BRDF
- Rotate points around a non-vertical axis using Rodriques' rotation formula [2].
- Find non-vertical axes of rotation through Principal Component Analysis (PCA) [3].

5: Conclusion

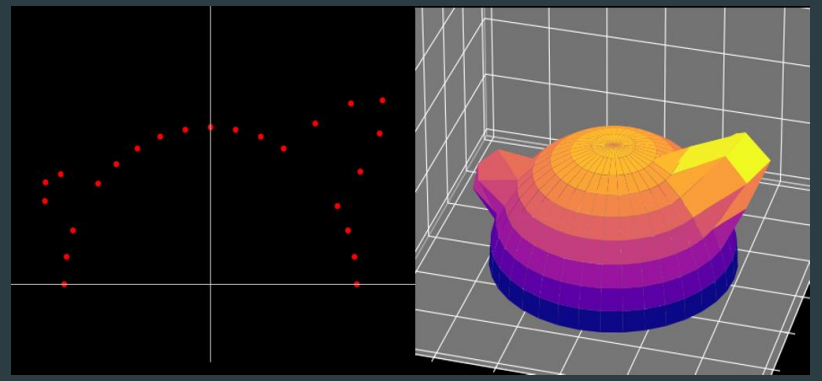
Using solids of revolution, in conjuction with Rodriques' rotation formula and PCA, one can approximate many types of full, isotropic, 3D BRDFs from a slice.

4: Results

The algorithm:

1. Divide the slice into sub-curves.
2. Find the axis of rotation for each sub-curve using PCA.
3. Rotate the sub-curves around their axes using Rodriques' rotation formula.
4. Normalize the directions of the data and sort it.
5. Combine the separate solids of revolution.
6. Remove data with overlapping directions.

Example BRDF:



An in-plane BRDF (left) and the respective approximated, full BRDF (right).

6: Limitations

- The algorithm can only approximate BRDFs for isotropic materials and does not work for anisotropic materials.
- Analytical BRDFs cannot be approximated using this algorithm, which only works for measured BRDFs.
- Other data is not considered when making approximations for a piece of data.