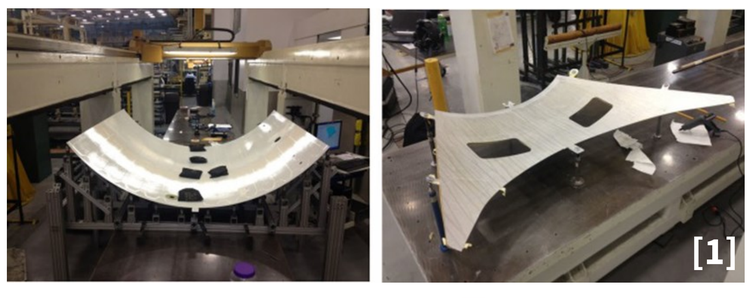
A new flexible part inspection method

Alex Bolyn, PhD candidate - Eric Béchet, Professor
Aerospace and Mechanical Engineering Department, University of Liège, Liège, Belgium
Contact : a.bolyn@uliege.be - eric.bechet@uliege.be

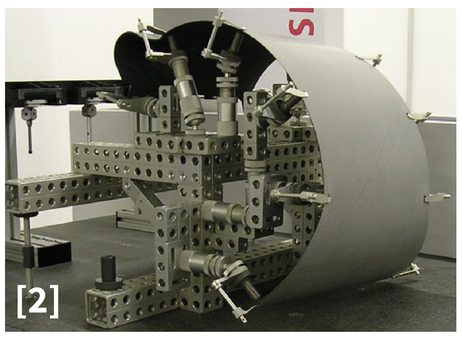
Introduction

▶ Flexible parts: pieces that have **different shapes** depending on its orientation and/or the supports used (metal sheets such as aircraft fuselage or car body parts)


[1]

▶ In production, inspections are necessary to check whether the parts comply with the requirements

▶ **Specific fixatures** are required for the inspection of flexible parts, making the inspection process very **time-consuming**


[2]

▶ There is **a need** to develop methods with **a shorter or automatic inspection process**

State of the art

Since about 2010 this problematic became a trend in research. Nowadays here are the two main categories:

▶ Comparison of the geometry with the 3D model

▶ Simulation of displacements from part to 3D model (e.g. using FEM) [1; 3]


[4]

Our idea

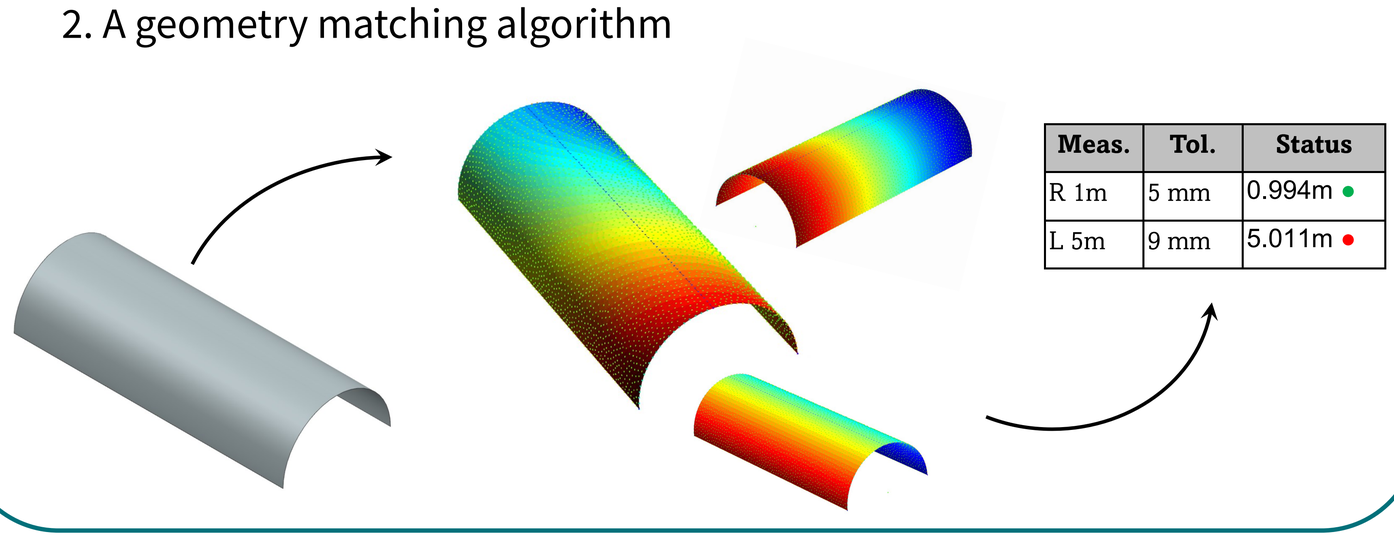
Based on the principle of **preserved distances** [5], a numerical method with:

▶ Measures realized directly on point cloud (3D scan)

▶ Multiple inspection cases handled (shape criteria, etc.)

This algorithm would need :

1. A precise geodesic computation algorithm
2. A geometry matching algorithm

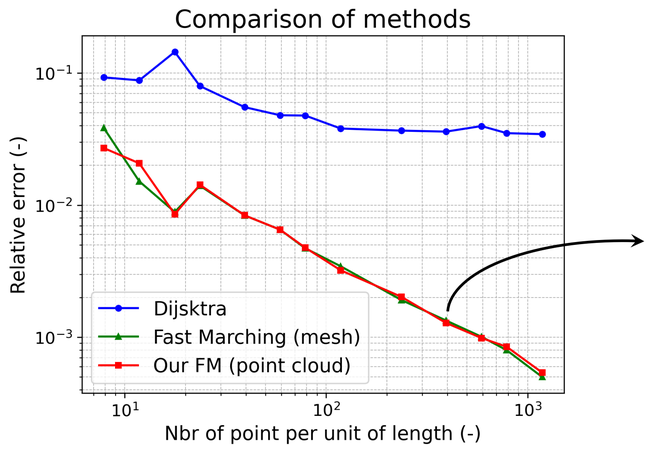


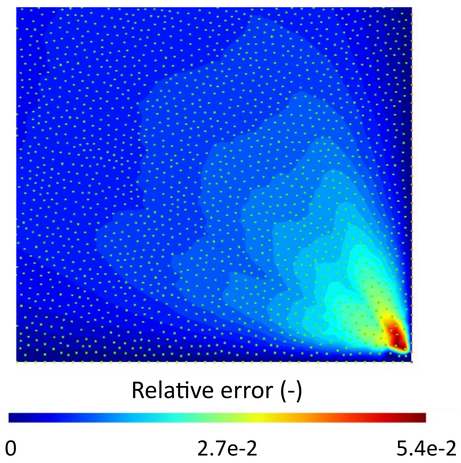
Algorithms

An algorithm for **geodesic computation** (fast marching algorithm) was **adapted to point clouds**, without the need for a valid mesh.

▶ Similar precision as the original (mesh based version)

▶ 1st order approximation is not enough

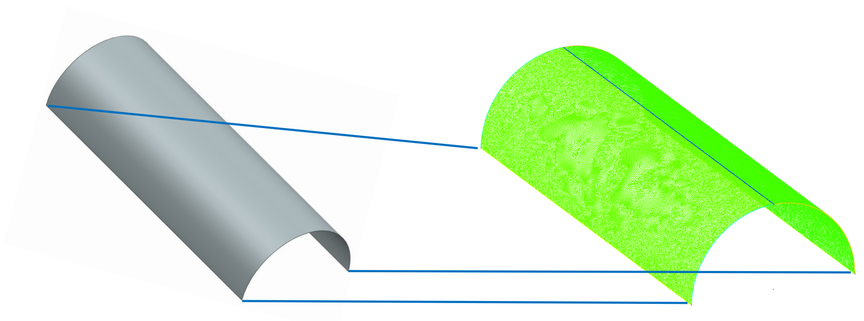




An algorithm to **match the geometry** between the model (blueprint or 3D) and the 3D scan.

▶ Automate the inspection process (finding key points)

▶ Similar homemade code available



References

[1] "Adapting the coherent point drift algorithm to the fixtureless dimensional inspection of compliant parts", A. Aidibe, A. Tahan, Int. Journal Advance Manufacturing Technology 79, 2015, pp.831-841.

[2] "Measurement of nonrigid freeform surfaces by coordinate measuring machine", R. Ascione, W. Polini, Int. Journal Advance Manufacturing Technology 51, 2010, pp. 1055-1067.

[3] "Nonrigid geometric metrology using generalized numerical inspection fixtures", H. Radvar-Esfahlan, A. Tahan, Precis. Eng. 36, 2012, pp.1-19.

[4] "The fixtureless inspection of flexible parts based on semi-geodesic distance", K. Babanezhad, G. Foucault, V. Sabri, et al. Precision Engineering 59, 2019, pp. 174-184.

[5] "On bending invariant signatures for surfaces", A. Elad, R. Kimmel, IEEE Transactions on pattern analysis and machine intelligence 25 n°10, 2003.