From 2D to 3D: How to inflate shapes via machine learning

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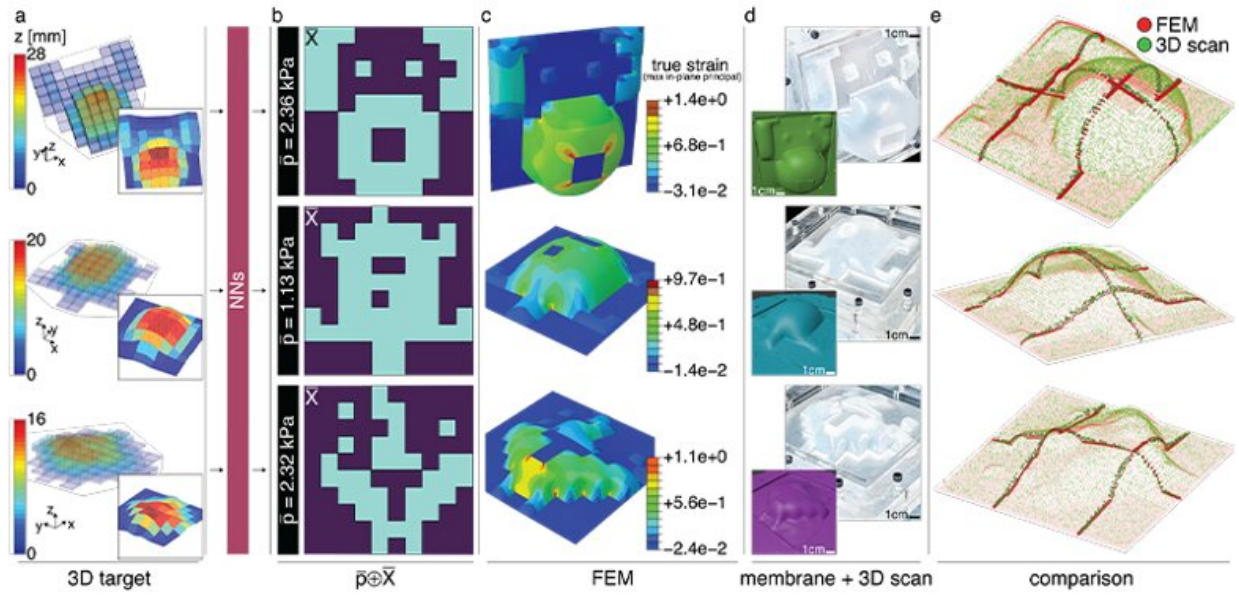

Machine learning helps unraveling the complex non-linear mapping between 3D inflated bulges and their material distribution when flat. Credit: King's College London

Research by King's Lecturer in Engineering, Dr. Antonio Forte, is investigating ways of working with soft robots to allow them to morph from two to three dimensions. This paves the way for devices that can be programmed to inflate to a precisely customized shape that will meet a

specific need. The research is published by *Advanced Functional Materials*.

Until now machine learning methods have been mainly used for image recognition and language processing. More recently they have emerged as powerful tools to solve mechanics problems. The work of Antonio and his colleagues shows that these tools can be extended to study the nonlinear mechanics of inflatable systems.

The research involved building multimaterial membranes made of soft or stiff square pixels. The researchers present algorithms to generate three classes of soft membranes, where the pixels cluster in different ways, creating various deformed inflated shapes. They design and optimize a model that learns how the mutual position of each pixel in the grid contributes to the global mechanics of the system.

Commenting on the findings, Antonio says, "We show how our platform has potential to design patient-specific devices for mechanotherapy and beyond. Before this research we didn't know how to use machine learning to unravel nonlinear mappings in inflatable systems. It turns out that they are very powerful for these purposes. The work has potential in many areas, for example in treating tissues around scars to promote healing."

The success of the research so far has led the team to consider further developments, for example, morphing three dimensional shapes into new three dimensional forms.

More information: Antonio Elia Forte et al, Inverse Design of Inflatable Soft Membranes Through Machine Learning, *Advanced Functional Materials* (2022). DOI: 10.1002/adfm.202111610

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