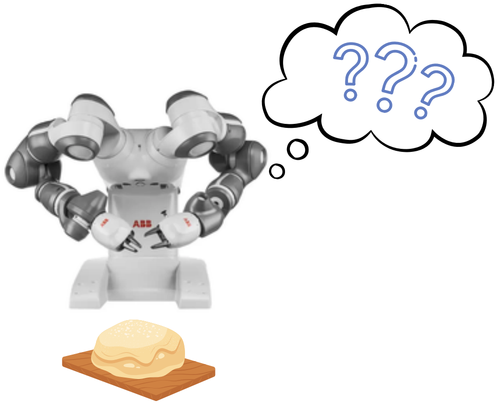
# Illustrative example

Think of pizza dough. A cook takes a ball of dough, manipulates it and deforms it into an almost perfect flat circle. To achieve this, she adjusts the pressure and the movement of her hands, observes how the dough responds to each movement, and continually checks that the shape of the dough is approaching the circular shape that she wants to obtain.

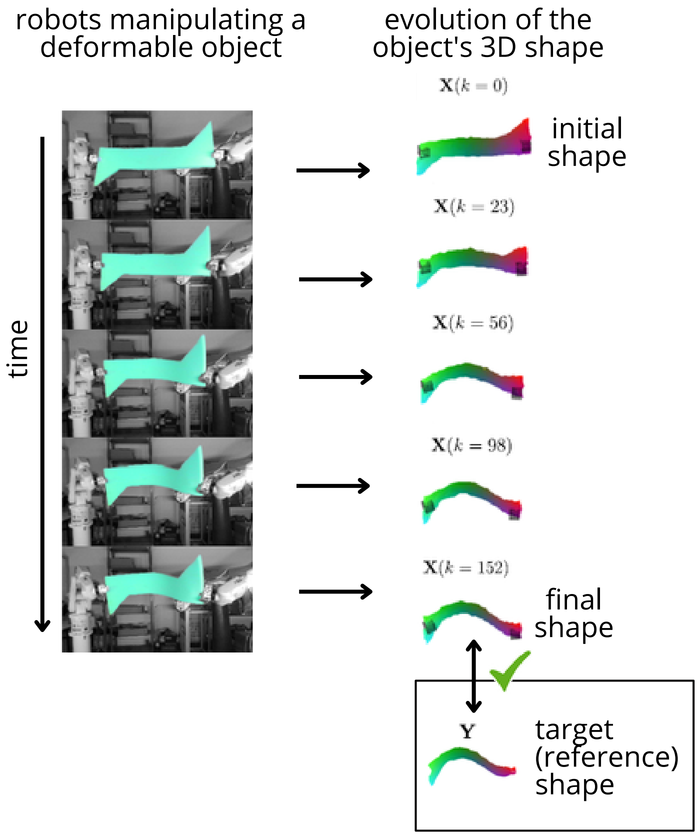
A robot, on the other hand, lacks human sensory capacity, as well as the knowledge and intuition required to understand how the dough behaves. Therefore, the robot needs a system that *tells* it exactly what movements and actions to perform. This PhD thesis focuses on the development of a system capable of *telling* the robot how to move in order to achieve precise control of the shape of deformable objects.




# One of our experiments
**(find more with this QR)**

Controlling the shape of a piece of foam using two robotic arms:

1. **Perception:** our system analyses images from an RGB-D camera to identify and capture the 3D shape of the deformable object.
2. **Shape comparison:** our system automatically compares the current geometry of the object with the reference shape we want to obtain.
3. **Control actions:** our control method generates actions for the robots to guide the object towards the desired shape through their movements.




ENG

My PhD thesis in a nutshell:

# Shape control of deformable objects

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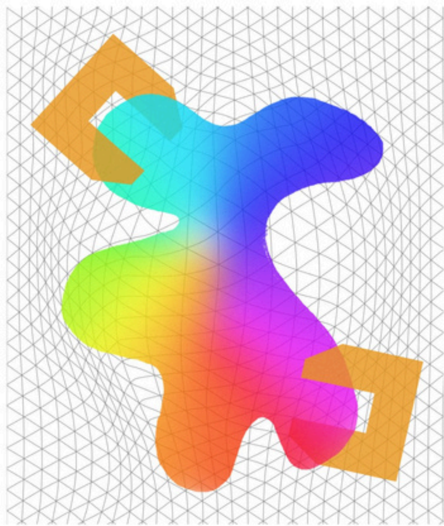

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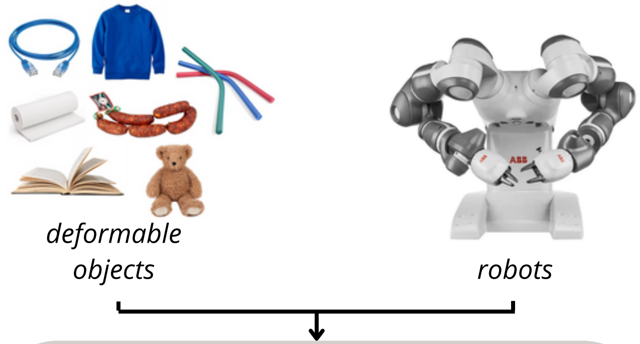
# Motivation for this thesis

What do folding a T-shirt, plugging in a mobile phone charger, and performing surgery have in common? In these tasks, the fabric, cable, or human tissue change shape when we manipulate them, i.e., they are **deformable**.

Robots are capable of manipulating rigid objects, such as boxes or metal parts, with millimetre precision. However, **robotic manipulation** of **deformable objects** poses many new challenges. Overcoming these challenges can open up a wide range of new applications for robotics.

# Problem addressed




**Shape control**: enabling robots to autonomously and precisely manipulate a deformable object from its initial shape towards a target shape.

# The 3 fundamental objectives of this PhD thesis

## 1. Perception of deformable objects

Our goal is to equip the control system with the ability to visually detect and identify the object it manipulates. It's essential to continuously track the object's location and shape. To achieve this, we use RGB-D (3D) cameras and apply *computer vision* techniques to analyse the images they produce.


## 2. Accurate shape comparison

Humans excel at making comparisons. Imagine a sculptor who gradually shapes a piece by continuously **comparing** it to a **reference** photograph. In the same way, the shape control system must precisely measure and assess whether the deformable object is moving *closer* to or *further* from the desired **reference** shape.

## 3. Generation of shape control actions

After **perceiving** the object's current shape and **comparing** it to the **reference** shape, the robot must be directed on what movements or actions to take. The control system must precisely understand how the robot's movements influence the object in order to generate actions that effectively control its shape.