University of Nottingham
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Dexterous manipulator using soft media for confined manufacturing operations

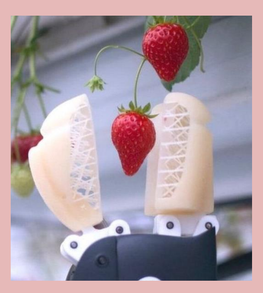
PhD student: Mohamed G. B. Atia
Email: Mohamed.Atia@Nottingham.ac.uk

Supervisors: Dr. AbdelKhalick Mohammad, Dr. Andres Gameros & Prof. Dragos Axinte

CHALLENGES

- One of the biggest challenges in automation industry is the automatic **manipulation** of **complex** and **fragile objects**.
- The main focus in academia is the design of soft grippers for general shapes, but the design for complex shapes to have a firm handling hasn't been addressed deeply.
- **Industrial** examples include biomedical devices, complex molds, fragile ceramic components, food, … etc.

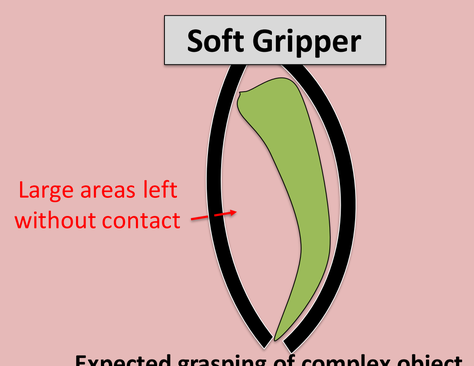
a) Using DEA actuator



b) Using DC motors actuation

c) Using pneumatic actuation

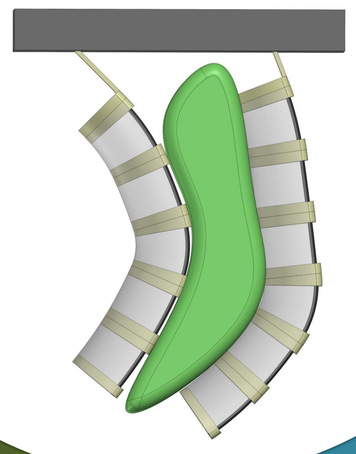
Varies soft grippers from the literature



Expected grasping of complex object using traditional soft gripper

AIM & OBJECTIVES

Develop a natural grasping-inspired dexterous soft manipulator in terms of design its principles, modeling, sensing, control and demonstration in near-industrial environment for complex object manipulation.

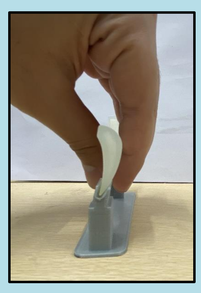


METHODOLOGY

Natural grasping

The dexterous gripper is inspired by the natural grasping technique that the human fingers holds the object by convoluting the curved sides to have a firm handling.

Complex object



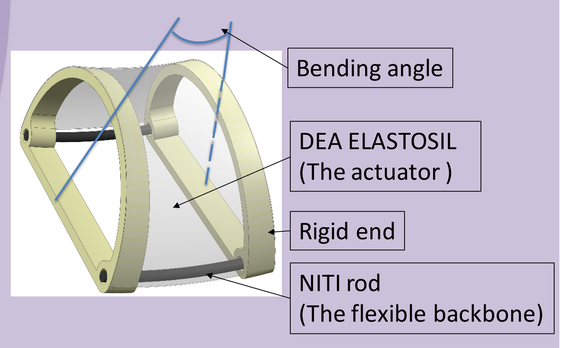
Human natural grasping

Inspired by human natural grasping

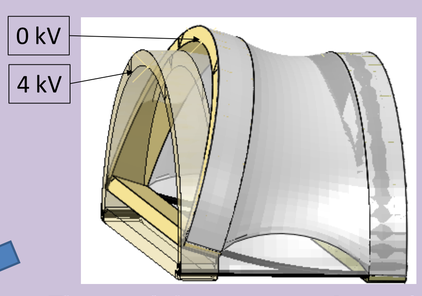
The reconfigurable modular finger

The dexterous gripper consists of **four reconfigurable modular fingers,** each which consists of several modular segments connected in series and can be assembled and dissembled easily manually like the LEGO.

The DEA is an actuator converts the electrostatic energy of high voltage to mechanical strain.



The modular segment structure

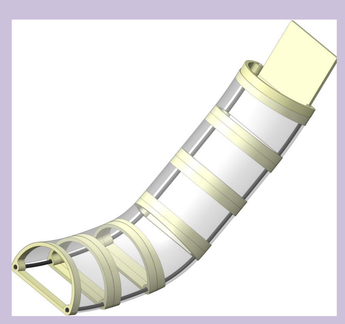


The modular segment Actuation

Several modular segments

Several segments

Assembling



The reconfigurable finger

Future work

➢ **Analytical model:**
- To predict the behavior of the fingers.

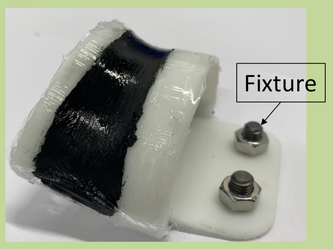
➢ **Collaborative control**
- To make accurate and safe manipulation.

➢ **Demonstration:**
- Demonstrate the system behavior in a near industry environment.

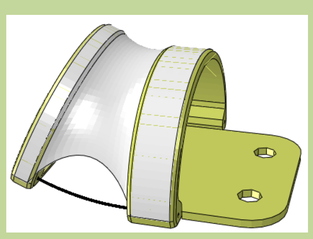
RESULTS

Shape optimization

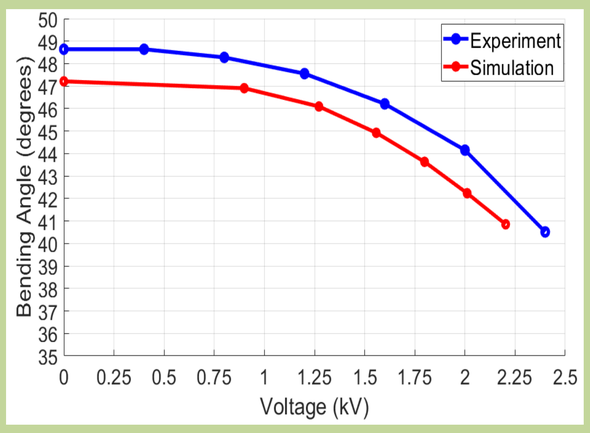
- An optimization of the parameters of each modular segment to have a curvature corresponding to the object.
- The Finite Element model is developed in the optimization.
- The FE model is validated and compared to the experiments.



The experiment



The FE model



A sample of the FE validation

Rolls-Royce University Technology Centre (UTC) in Manufacturing and On-Wing Technology