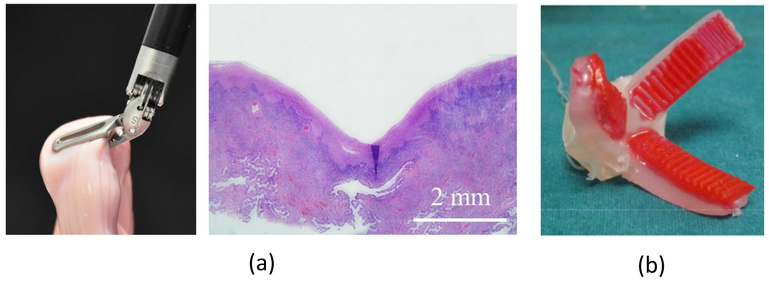
Low-contact Grasping and Manipulation of Flexible Objects

Roman Mykhailyshyn, Ann Majewicz Fey, Texas Robotics, The University of Texas at Austin.
roman.mykhailyshyn@austin.utexas.edu; ann.majewiczfey@utexas.edu

Soft Tissue in Medical Applications

Grasping systems continue to interact with tissues with significant force during surgery. High tissue grasping forces lead to the destruction of endothelial and smooth muscle cells, increasing the risk of irreversible tissue change, and increasing the appearance of adhesions after surgery.



(a) (b)

Fig. 1 Mechanical gripping devices for medical applications: (a) - Ex vivo clutching tests on porcine uterus with tissue damage results dVRK gripper; (b) - Soft three-fingered gripper.

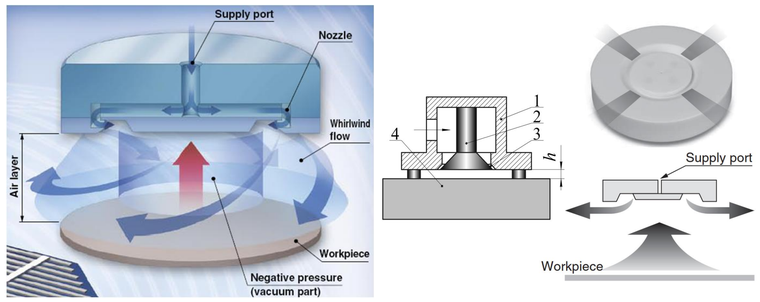
Thus, the research goal of this proposal is **to develop grasping systems providing minimal gripping contact with tissues and an optimized manipulation process in robotics medical applications**. This proposal has three specific objectives:

(1) Develop small jet grippers devices capable of non-contact and low-contact grasping tissue;

(2) Optimize the design and performance of the gripping device of varying surface properties, as well as develop control strategies in dynamic control applications;

(3) Develop a robotic testbed for running bowel, and actively closing a large wound, using a optimal control framework.

Low-contact Jet Grasping Technology



(a) (b)

Fig. 2 The two most common jet gripping technologies: (a) - Vortex grasping process; (b) - Bernoulli grasping process

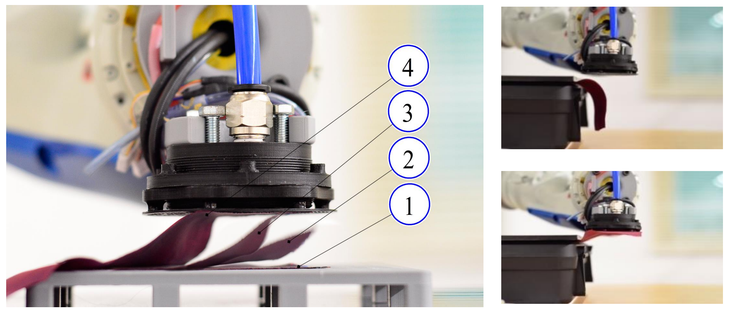


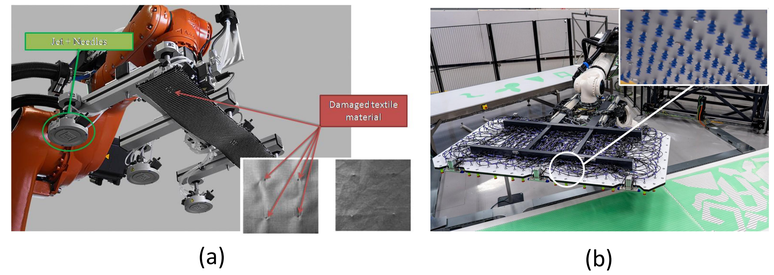
Fig. 3 Grasping the object from a distance, where 1-2-3-4 is the sequence of movement of the object during grasping.

Broad Impact

- **Benefits to society** (Minimizing damage during robotic medical applications; Increasing energy efficiency during the manipulation of flexible materials in manufacturing)
- **Broaden dissemination to enhance scientific and technological understanding** (New combined gripping systems and methods of manipulation flexible objects)

Textile/Film in Industrial Applications

Grasping and manipulating non-rigid objects, textiles, paper, leather, films, and other often poses challenges in automating the manufacturing processes. These materials are easily deformable and lose their shape under the force of their own weight.



(a) (b)

Fig. 4 Gripping systems for non-rigid materials: (a) - gripping system is based on the commercially available combined Schmalz Bernoulli-needles grippers; (b) – commercially available vacuum system for grasping flexible objects

Thus, the research goal of this proposal is **to develop grasping systems providing effective gripping with a maximum lifting force and control framework for dexterous manipulation of flexible objects in robotic applications**. This proposal has three specific objectives:

(1) Develop combined grippers devices capable of effectively grasping flexible material;

(2) Proposal for the dexterous method of manipulating flexible materials when using pneumatic grippers;

(3) Construction of a recognition system and real-time planning of dexterous manipulation of flexible materials in manufacturing.