SENSOR INTEGRATED VACUUM GRIPPER

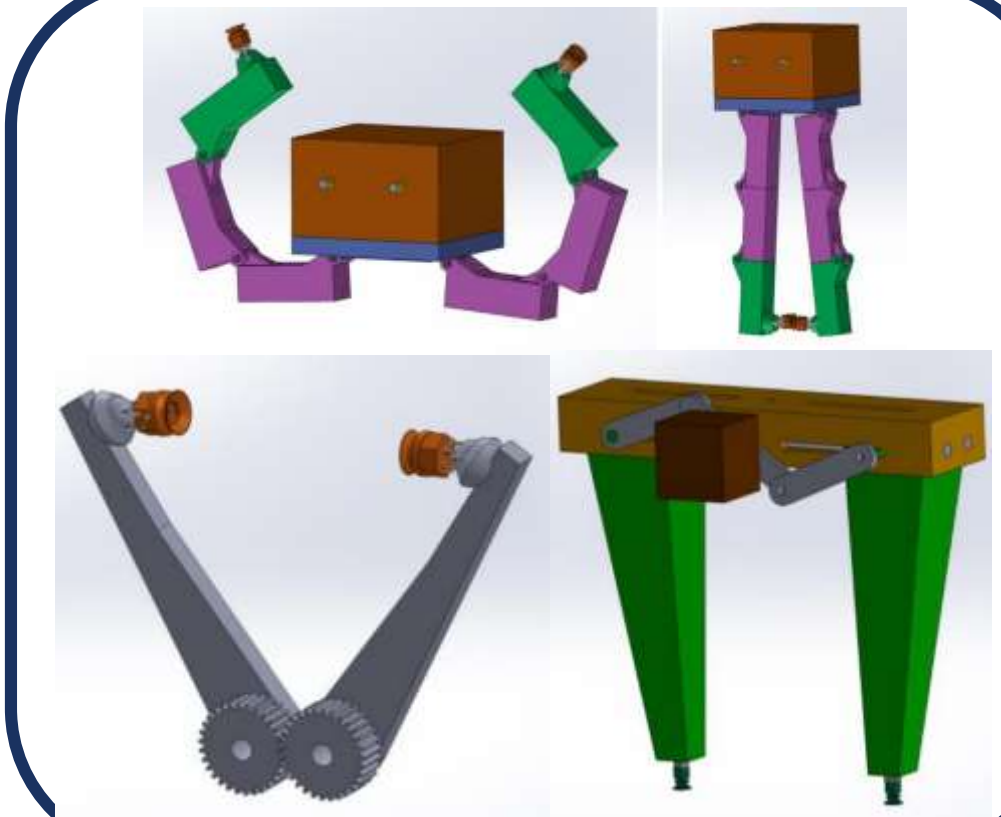
ALEX FURMAN UNDER SUPERVISION OF PROF. RIMON

SEMESTER 1: PROJECT DESCRIPTION

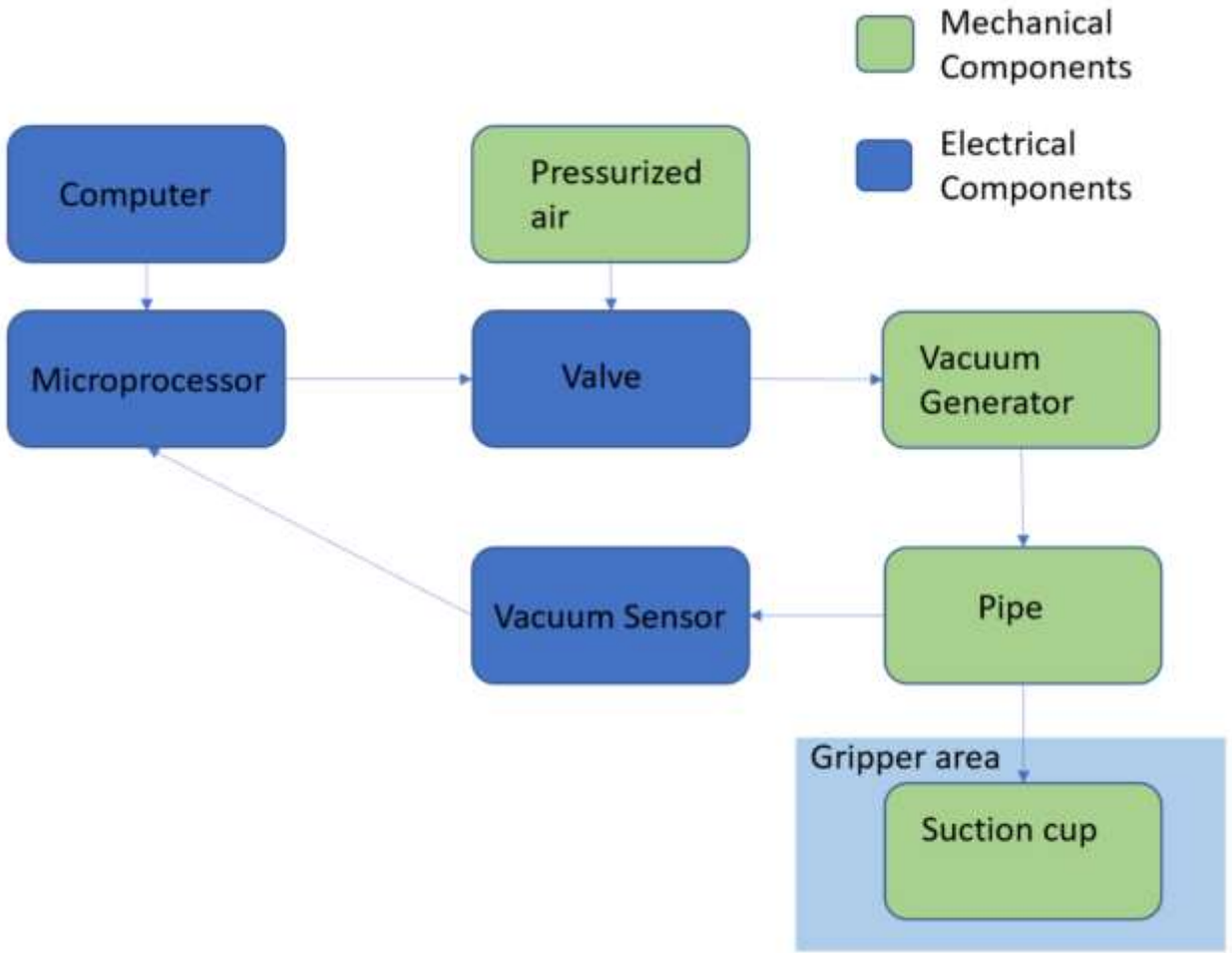
- Create gripper with vacuum tech
- Integrate with ROS

FINAL PRODUCT

INITIAL IDEAS



SEMESTER 1: SYSTEM DESCRIPTION

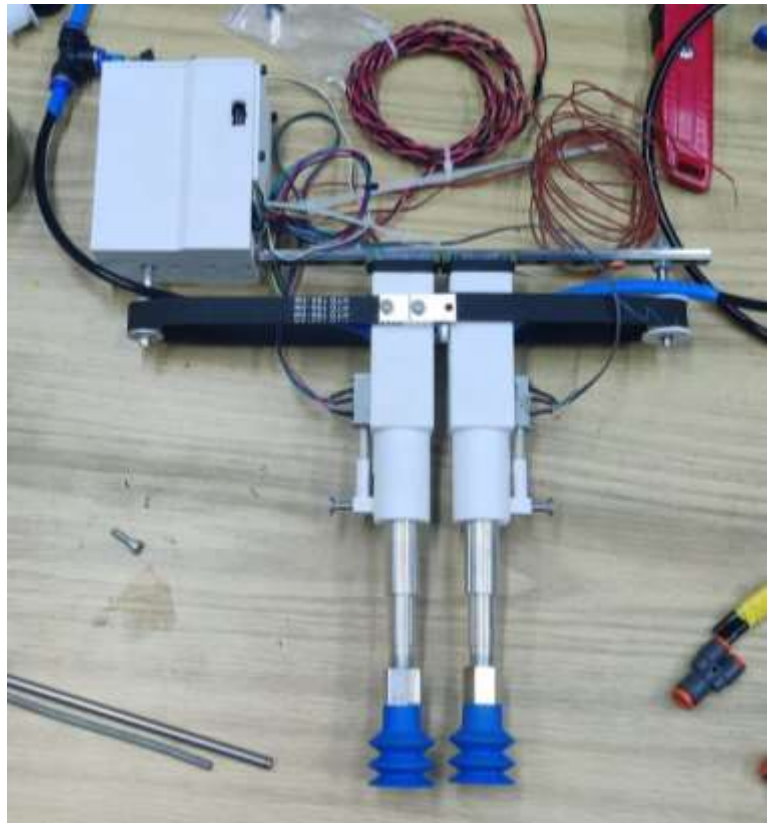


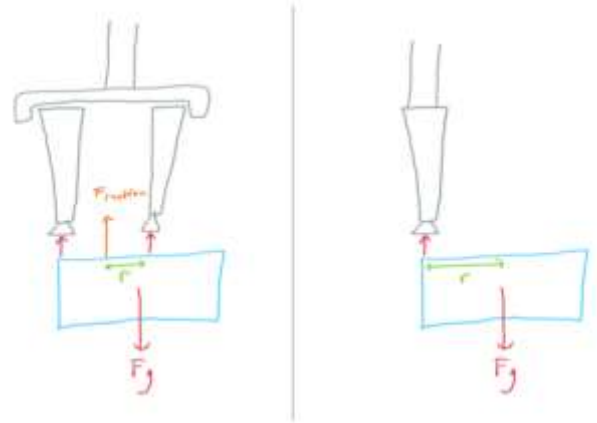
SEMESTER 1: DESIGN STRENGTHS + WEAKNESSES

- Strengths:
  - Very compact
  - Strong suction
- Weaknesses:
  - Only handles smooth surfaces well
  - Requires very accurate placement
  - Does not handle torques well at suction cup

SEMESTER 2: PROJECT DESCRIPTION

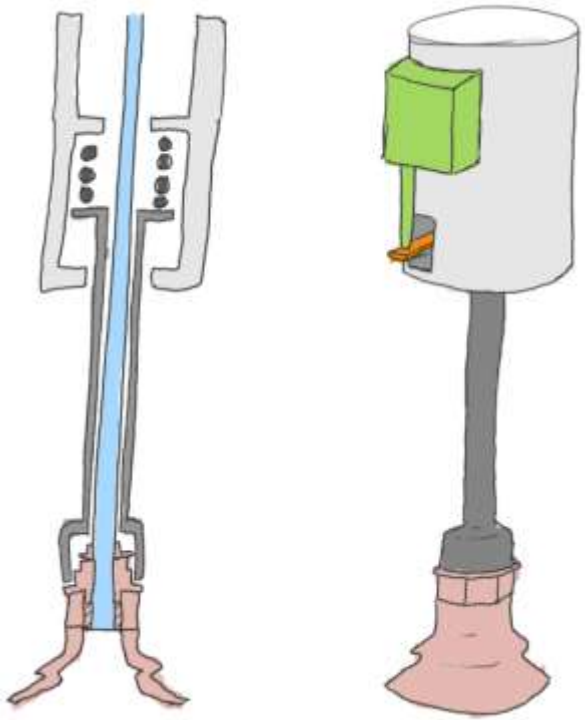
- Minimize design weaknesses
- Improve gripper placement given inaccuracies in Computer Vision



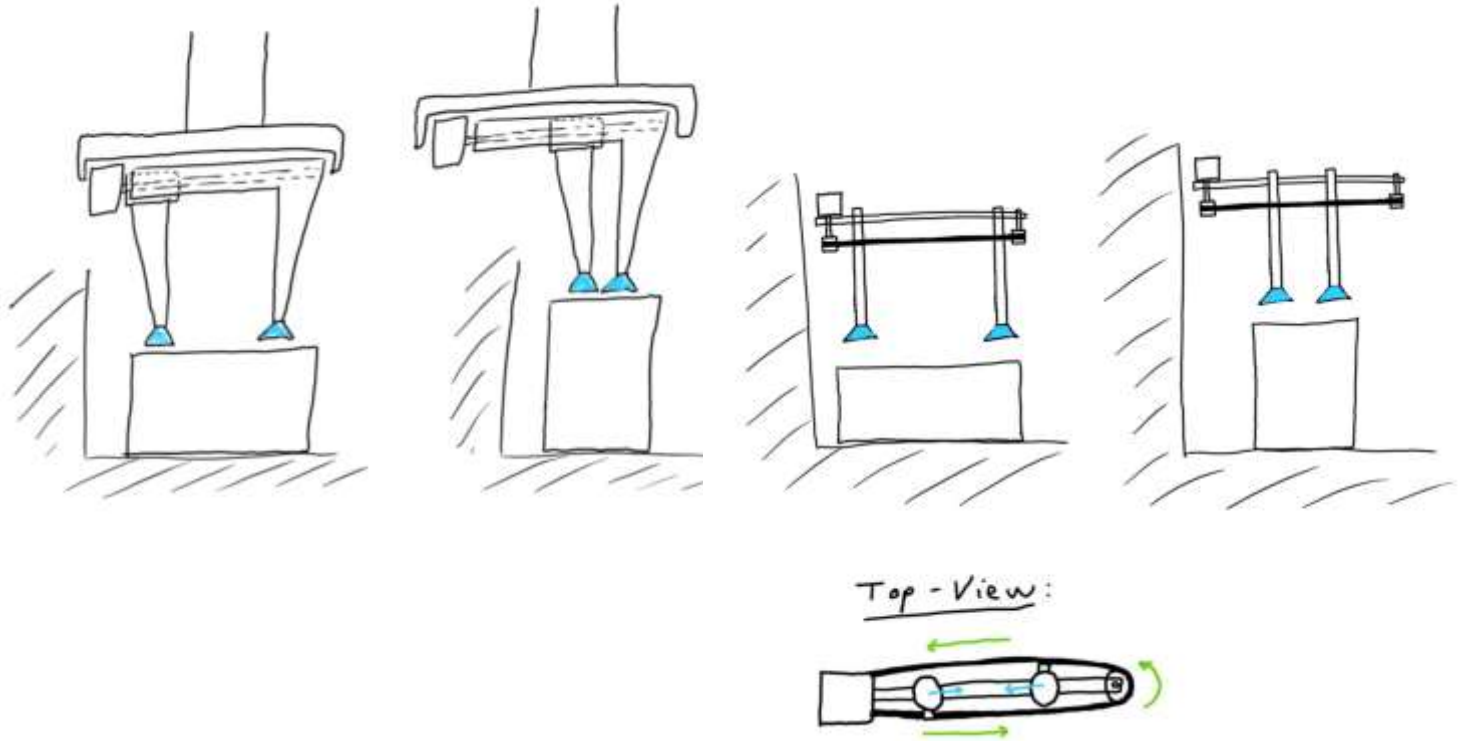


SEMESTER 2: ILLUSTRATIONS

- Finger Design

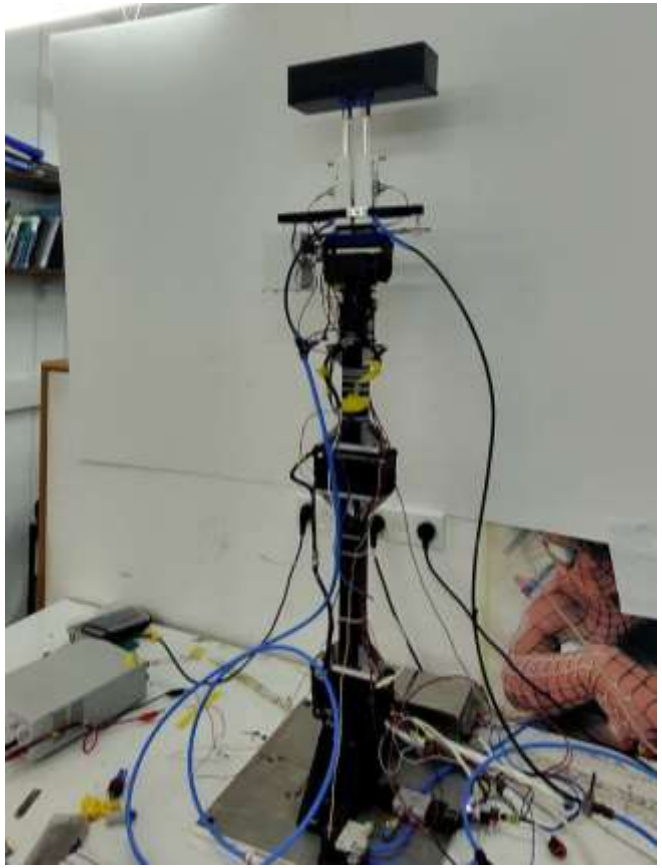


- Belt Driven vs Lead-screw Driven



SEMESTER 2: DESIGN STRENGTHS + WEAKNESSES

- Strengths:
  - Addresses torque issue from previous design
  - Now possible to create correction algorithms due to the potentiometers
- Weaknesses:
  - Force produced in each finger effectively halved (only one vacuum generator)
  - Bigger than last design
  - A lot more mechanical parts + electronics – harder maintenance
- Notes:
  - More testing should be done to determine if extra vacuum generator is necessary
  - Some components of the design can be improved in later iterations



FUTURE WORK: ALGORITHMS

Model Of The CV Problem

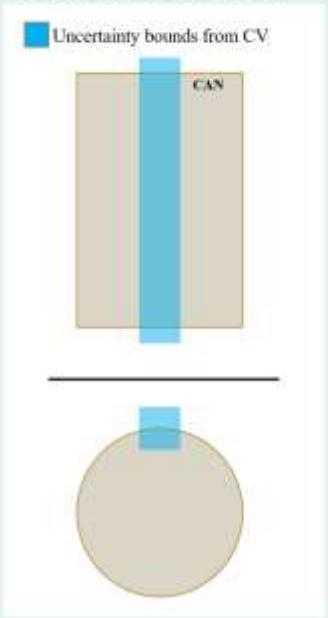
In our problem, we assume an inaccurate CV algorithm, which provides a target line for positioning of the gripper for grasping. It is assumed the CM found by the CV is inaccurate, and is defined as follows:

$$CM_{CV} = [x_{CM} \pm \Delta x, y_{CM} \pm \Delta y, z_{cm} \pm \Delta z]$$

Where

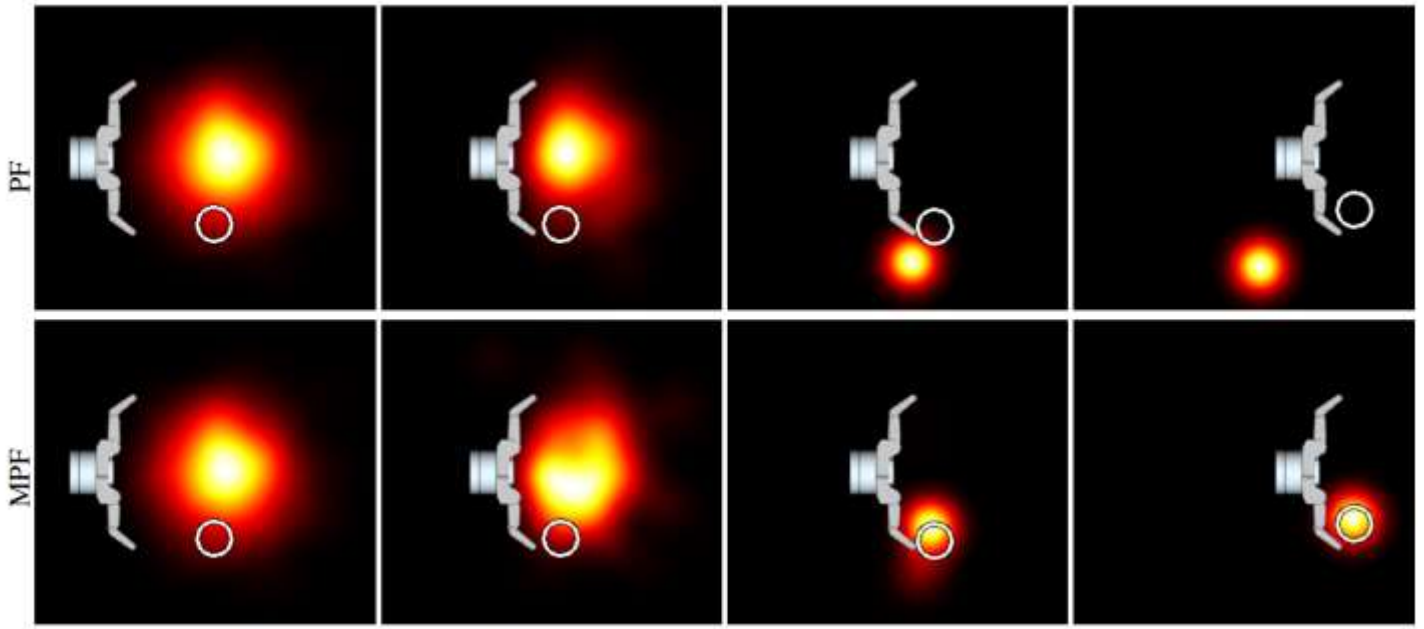
$$0 < \Delta x < x_{max}, 0 < \Delta y < y_{max}, 0 < \Delta z < z_{max}$$

We further assume the orientation of the target line to be correct.



Next Steps and Future Work

The current design of the gripper allows for more generalization of the CV problem. For example, the orientation or length of generated target line may be inaccurate. These inaccuracies become more apparent when attempting to grasp an object which is tilted in space. The increased reliance on the depth reading from the camera increases errors substantially. Instead of a procedural algorithm, we can use belief state estimation using a particle filter, and update the belief state through contact with the gripper (as demonstrated in the paper "*Pose Estimation for Contact Manipulation with Manifold Particle Filters*" by *Koval, Dogar, Pollard*, and *Srinivasa*). Other algorithms can be developed using the gripper, such as impedance control for planning trajectories in a crowded area.



(a) Prior Belief (b) Before Contact (c) After Contact (d) Final Belief