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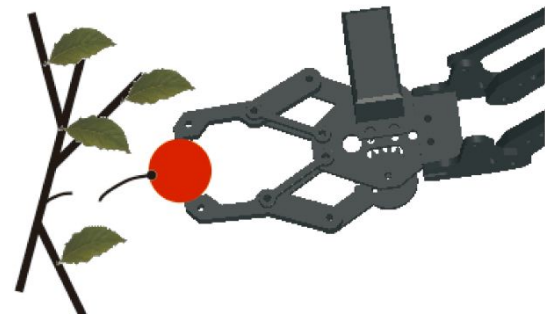
# Pick and Place Simulation of Parallel End Effector Grasping Fruits

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# Background



Approach fruit



Grab fruit



Stalk separated



Fingers open



Unload



Fingers reset



Existing Kiwi and Apple Harvesting Research [1]

# Objectives

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**Goal:** Develop simulated model of robotic harvesting of a piece of fruit for rapid testing and verification of soft robotic end-effectors

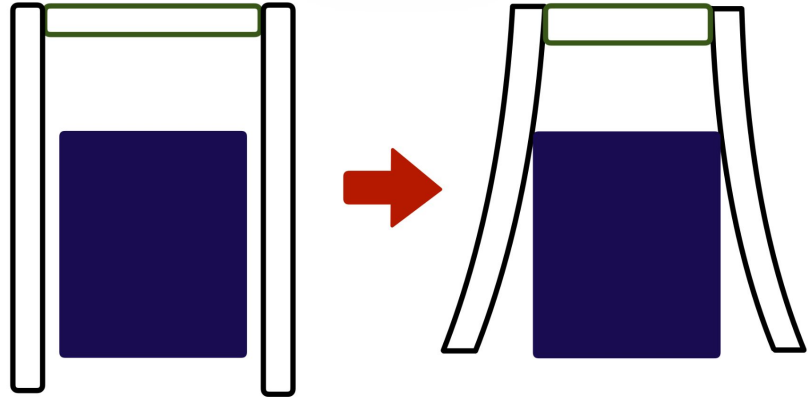
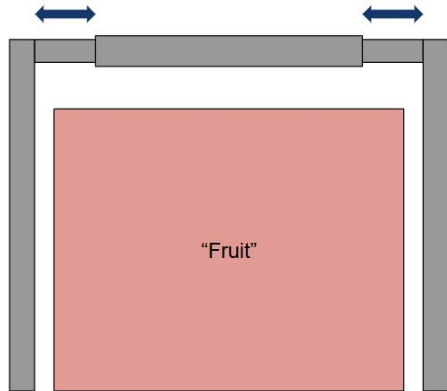
**Components:**

- Linearly closing parallel end effector
- Simulated contact forces
- Fruit deformation



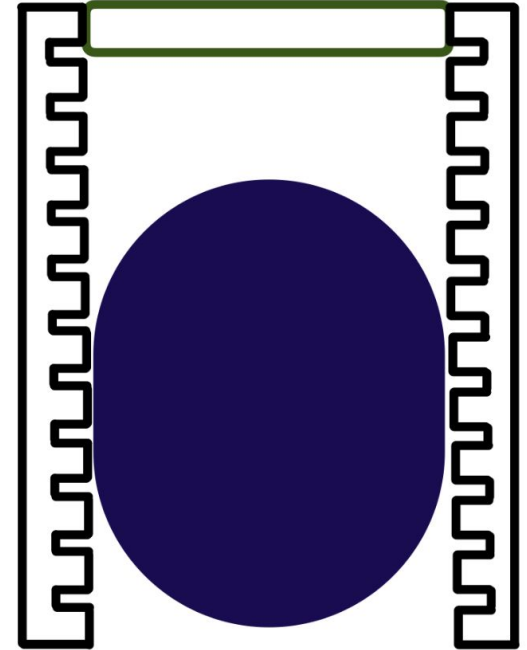
# Stage 1: 2D Gripper

- Gripper within 2D plane
- Gripper prongs are treated as rods
- Fruit modeled as a block of constant width



## Stage 2: Gripper Geometry

- Gripper within 2D plane
- Gripper prongs with varying patterns of geometry
- Introduction of curvature into fruit surface



# Reach Stage: 3D Gripper

- Gripper and fruit represented within 3D space
- Test implementation of varying number of gripper prongs
- Gripper prongs with varying patterns of geometry
- Complex fruit geometry and contact force representation



# Challenges

- Representing contact forces
- Modeling “squeezing” of fruit
- Fruit surface modeling
- Predicting damage to fruit



# References

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- [1] L. Mu, G. Cui, Y. Liu, Y. Cui, L. Fu, and Y. Gejima, “Design and simulation of an integrated end-effector for picking kiwifruit by robot,” *Information Processing in Agriculture*, vol. 7, no. 1, pp. 58–71, 2020. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S2214317318304372>
- [2] P.-L. Chang, I.-T. Chi, N. D. K. Tran, and D.-A. Wang, “Design and modeling of a compliant gripper with parallel movement of jaws,” *Mechanism and Machine Theory*, vol. 152, p. 103942, 2020. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S0094114X20301634>
- [3] E. Navas, R. R. Shamshiri, V. Dworak, C. Weltzien, and R. Fernandez, “Soft gripper for small fruits harvesting and pick and place operations,” *Frontiers in Robotics and AI*, vol. 10, 2024. [Online]. Available: <https://www.frontiersin.org/journals/robotics-and-ai/articles/10.3389/frobt.2023.1330496>
- [4] D. Tong, A. Choi, J. Joo, and M. K. Jawed, “A fully implicit method for robust frictional contact handling in elastic rods,” *Extreme Mechanics Letters*, vol. 58, p. 101924, 2023. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S2352431622002000>
- [5] M. Li, Z. Ferguson, T. Schneider, T. Langlois, D. Zorin, D. Panozzo, C. Jiang, and D. M. Kaufman, “Incremental potential contact: Intersection- and inversion-free large deformation dynamics,” *ACM Trans. Graph. (SIGGRAPH)*, vol. 39, no. 4, 2020.
- [6] K. Chen, T. Li, T. Yan, F. Xie, Q. Feng, Q. Zhu, and C. Zhao, “A soft gripper design for apple harvesting with force feedback and fruit slip detection,” *Agriculture*, vol. 12, no. 11, 2022. [Online]. Available: <https://www.mdpi.com/2077-0472/12/11/1802>