Microrobot Leg Characterization and Control

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KAUST GIFTED STUDENT PROGRAM

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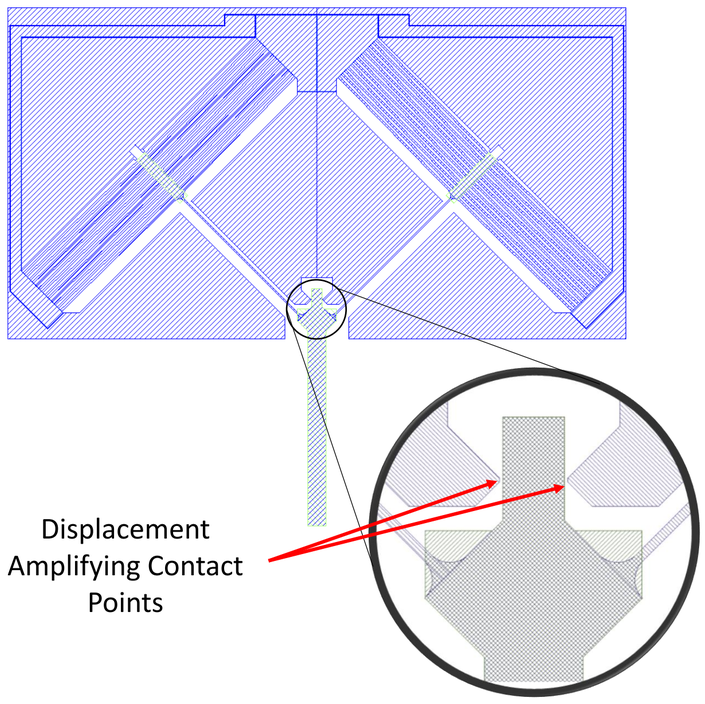
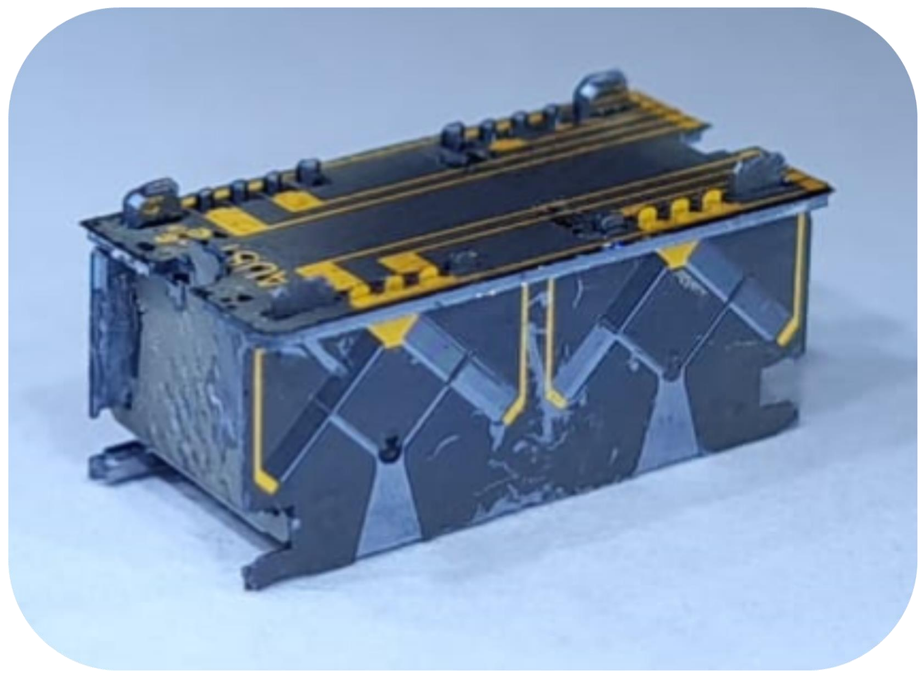
1. Introduction

Our research aims to improve the mobility of microrobots by introducing legs that are electrothermally actuated through two V-shape actuators designed with contact points to amplify the extent of the workspace.
These legs have several advantages over other microrobot legs such as:

- Compatibility with microfabrication
- Large workspace and force output
- Can follow arbitrary trajectories such as the motion of a horse's leg.



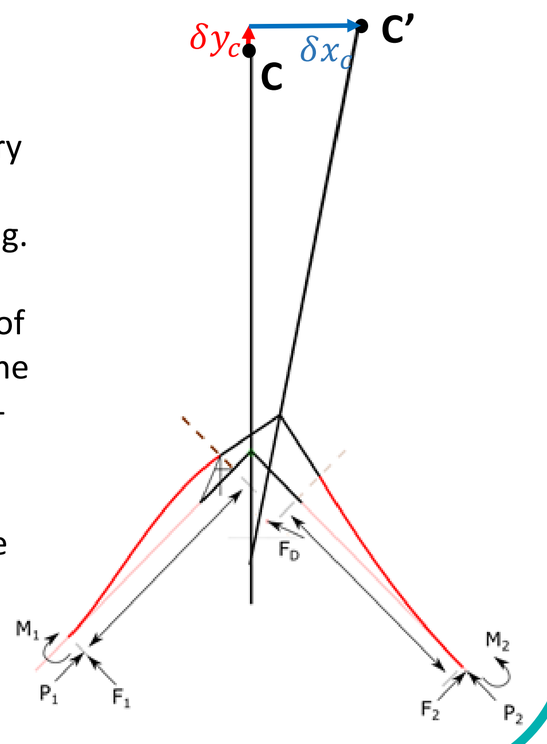


2. Kinematic Models

We used beam theory, the force-deflection curves for the V-shape actuators, mechanics and geometry to produce two models to characterize the behavior of the leg.

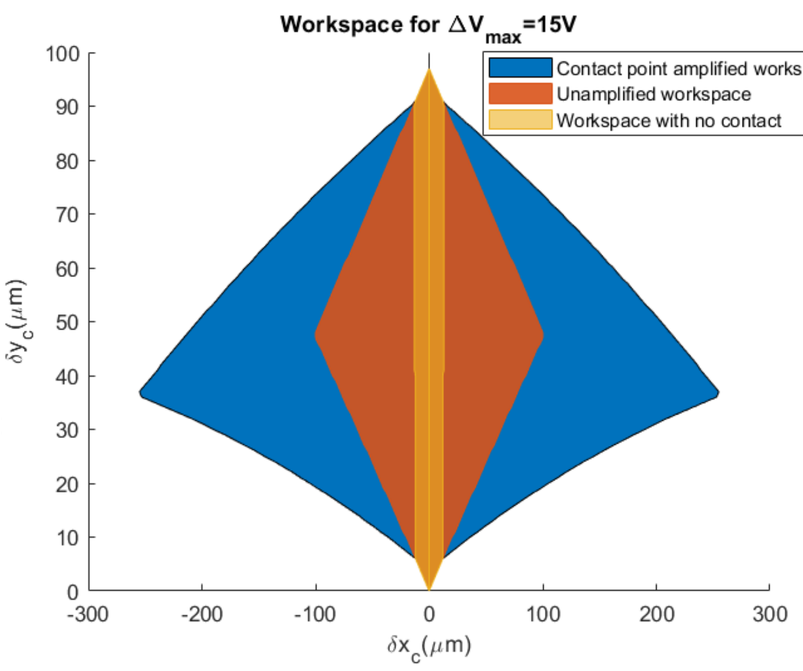
❖ **Forward Kinematic Model**
Used to predict the displacement of the leg's tip $(\delta x_c, \delta y_c)$ based on the input voltage differences on the V-shape actuators $(\Delta V_1, \Delta V_2)$.

❖ **Inverse Kinematic Model**
Used to calculate the input voltage differences $(\Delta V_1, \Delta V_2)$ needed to move the leg's tip by a certain amount $(\delta x_c, \delta y_c)$.



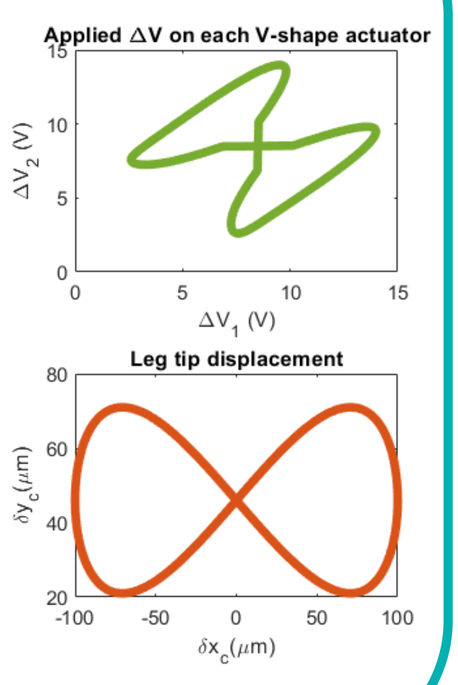
3. Workspace

Using the forward kinematic model, we can determine the extent of the leg's workspace and how the contact points amplify the leg's displacements.
From the figure you can see how the contact points amplify the extent of the workspace significantly by acting as a lever.



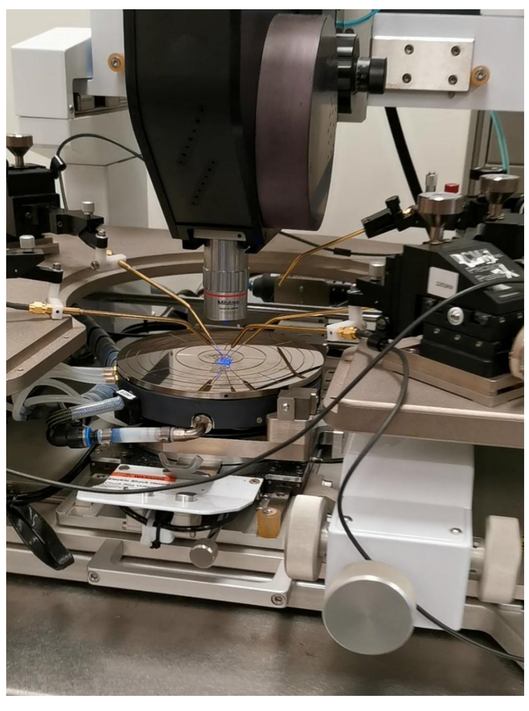
4. Trajectory Generation

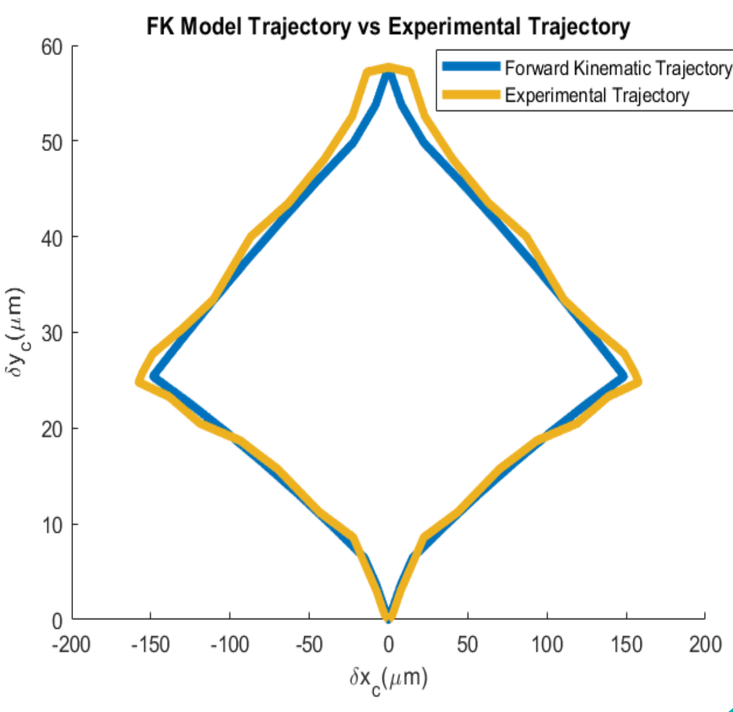
Using the inverse kinematic model, we can produce trajectories that mimic the motion of animals and humans as well as trajectories that can adapt to uneven terrains. Arbitrary figures like the infinity symbol shown here can also be produced.



5. Experimental Results

The experimental measurements made using the electronic probe station (shown on the right) closely follow the predicted displacement curve produce by the forward kinematic model.





6. Conclusion and Future Work

We were able to model the behavior of the microrobot leg as well as create several trajectories for it to follow. We hope to synchronize the motion of the 4 robot legs to create a straight-line motion using a trajectory like the one produced by the Chebyshev-Lambda mechanism commonly used for legged macro robot locomotion.

7. Acknowledgment

This research project was supported by KAUST and the KAUST Gifted Student Program. Ali would like to thank Dr. Hussein Hussein and Dr. Hossein Fariborzi for their continued guidance, support and mentorship.