Continuum Locomotion Alternative for Robotic Adaptive-Exploration (CLARA)

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Abstract

Current forms of remote pipe inspection, such as borescopes, are limited in their maneuverability. We propose a salamander inspired soft robot as a novel pipe inspection tool that can overcome many pipe sizes, vertical pipes, tees, and bends using a variable diameter suspension mechanism. The origami body uses a Yoshimura crease pattern to create deformable cable driven bellows, enabling steering without traditional rigid mechanisms. To enable closed-loop position and velocity control, we introduce a smart motor driver PCB, useful for applications beyond this project’s scope. They communicate over I2C by a custom mainboard receiving remote commands via Wi-Fi and UART from gamepad input. The system achieves 4.5” of linear compression, 1.6” of diameter range, and 85.8° of maximum bending angle.

Background

• Origami is a tool to create desired mechanical behavior when rigid mechanisms are insufficient
• Crease patterns produce desired behavior, such as the Yoshimura pattern which features axial compression when connected in a three-pattern module
• Salamanderbot applied this pattern with thread and motors to compress the module, climbing sharp inclines and navigating through turns

Goals and Objectives

Explore the capabilities of a soft robotic origami module in the inspection and exploration of pipe networks too small, expansive, or dangerous for humans.

Create a more inclusive electrical schema to be applied to projects outside of CLARA through the creation of smart motor drivers capable of controlling individual N20 motors.

Develop a control architecture that allows for wireless communication of autonomous as well as teleoperated control of the module.

Active Variable-Diameter Suspension

Yoshimura Continuum Module

Smart Motor Driver PCB

Mainboard

Mechanical Performance

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>1.1</td>
<td>lbs</td>
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<tr>
<td>Yoshimura Module Length</td>
<td>1.5 - 6.0</td>
<td>in</td>
</tr>
<tr>
<td>Maximum Turning Radius</td>
<td>85.8</td>
<td>deg</td>
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<td>Effective Diameter Range</td>
<td>3.6-5.2</td>
<td>in</td>
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<td>Wheel Compression</td>
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<tr>
<td>Maximum Speed</td>
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<td>in/s</td>
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Control Structure

References