Robotics and Autonomous Systems Thesis Defense

Design, Fabrication and Characterization of PDMS Pads for Friction based Mobility of Tube Inspector Robot

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Abstract

This thesis presents a study on the optimization of Polydimethylsiloxane (PDMS) pads, centered around a bespoke friction setup designed to enhance the operational efficiency of tube inspection robots through advanced frictional mechanisms. By surface texturing of PDMS pads, inspired by the adept locomotion of certain lizards, this research pioneers the development of PDMS pads aimed at significantly elevating the adaptability and effectiveness of robotic systems in the challenging domain of industrial tube inspection.

A cornerstone of this study is the novel friction setup, which has been carefully engineered to simulate real-world operational conditions with high precision. This custom-built apparatus, capable of exerting variable normal loads and accommodating diverse surface textures on curved pipe surfaces, has been instrumental in uncovering the intricate frictional dynamics of PDMS pads. Notably, the setup's capacity to measure forces with a 6-axis load cell, providing critical insights into shear forces in multiple directions, stands out as a pivotal contribution to the field.

Through exhaustive experimentation facilitated by this advanced friction setup, the research has demonstrated that the design and texture of PDMS pads, particularly those featuring triangular grooves at a depth of 1mm, markedly influence their frictional performance. These pads exhibit superior traction, especially under higher loads and on corroded surfaces, underscoring the importance of angular groove geometries in enhancing mechanical interlocking with surface irregularities.

The inverse relationship observed between the coefficient of friction and applied normal force across various textures further highlights the nuanced mechanical behavior of PDMS under stress, accentuating the critical role of the custom friction setup in enabling these discoveries. This insight necessitates a refined approach to load application, ensuring optimal frictional engagement.

This thesis not only advances the understanding of PDMS pad frictional behavior but also introduces a new frictional device testing method through its innovative friction setup. Future explorations will build on this foundation, probing the effects of different PDMS compositions, surface treatments, and environmental conditions on frictional performance, propelled by the capabilities of the custom friction setup.

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Zoom Link: https://asu.zoom.us/my/tellsiddh

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