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EFFECT OF BIMODAL GRAIN MIXTURES ON GRANULAR JAMMING GRIPPERS

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Abstract

Granular jamming grippers have emerged as a promising solution in soft robotics due to their ability to conform to objects with different geometries and subsequently increase their stiffness through vacuum activation. However, their grasping performance depends strongly on the physical characteristics of the granular material inside the membrane, particularly particle size distribution and packing behavior. This study aims to analyze the influence of bimodal mixtures of *spherical grains with diameters of 5 mm and 3 mm on the mechanical performance of a granular jamming gripper. Five particle-size concentrations were evaluated: 10%–90%, 30%–70%, 50%–50%, 70%–30%, and 90%–10% for 5 mm and 3 mm grains, respectively. The methodology is based on numerical simulations using the Discrete Element Method (DEM) coupled with Computational Fluid Dynamics (CFD), maintaining constant operating conditions such as membrane geometry, filling volume, vacuum pressure, target object, and activation procedure to isolate the effect of grain concentration on grasping force, conformability, and gripping stability. The expected findings suggest that intermediate mixtures may improve the balance between surface adaptation and force transmission, as smaller grains can fill voids between larger particles and increase packing efficiency. Statistical analysis, including analysis of variance, will be used to identify significant differences among the evaluated concentrations. This work concludes that particle-size concentration can be considered a relevant design parameter for improving the performance of granular jamming grippers without modifying their external structure or actuation system.*

Keywords:
Soft Robotics, Granular Jamming, DEM Simulations, Soft Gripper

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