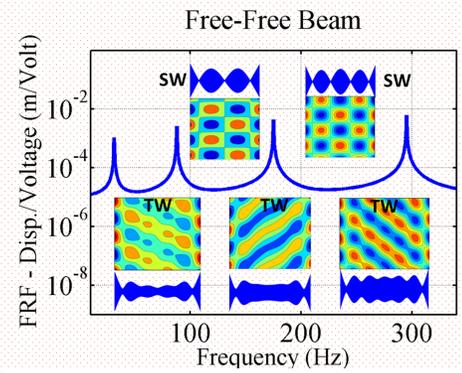


BIO-INSPIRED PROPULSION

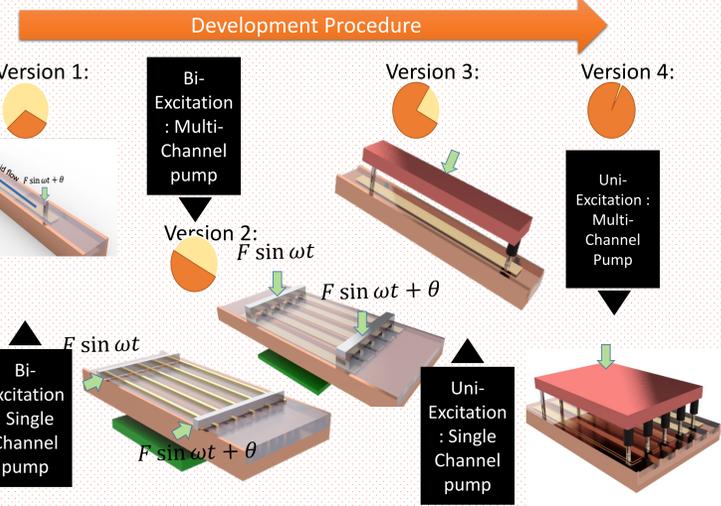


VIBRATIONS BASED FLUID PUMPING

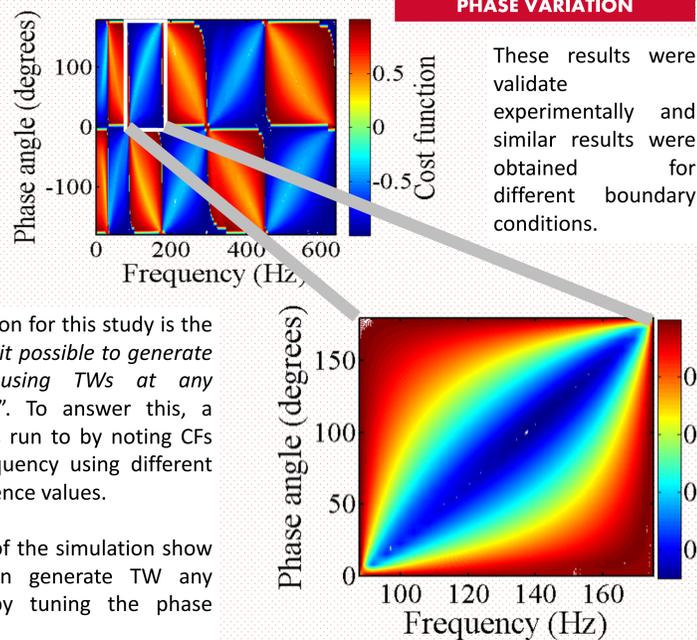


The frequency response function (FRF) for a free-free system is simulated and then experimentally validated. A single PZT is excited at each resonant frequencies to study the wave envelop and time based amplitude variation along the length of the beam.

TWs are studied by initially picking a frequency in between the resonant peaks and exciting both the PZTs with a phase difference of 90 degrees.



APPLICATIONS OF TRAVELING WAVES



The motivation for this study is the question "Is it possible to generate propulsion using TWs at any frequency?". To answer this, a simulation is run to by noting CFs at each frequency using different phase difference values.

The results of the simulation show that we can generate TW any frequency by tuning the phase difference.

TOWARDS NOVEL NONPREHENSILE CONVEYANCE OF LUNAR REGOLITH VIA SURFACE TRAVELING WAVES

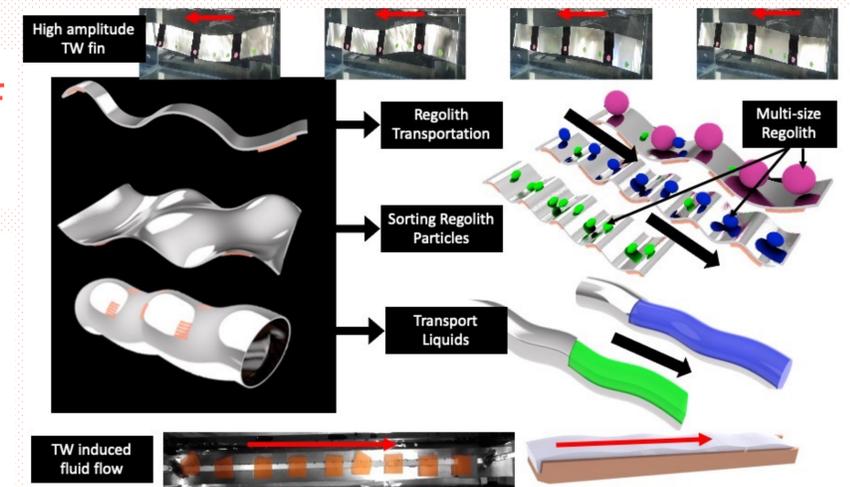
Dr. Vijaya V N Sriram Malladi¹ and Dr. Paul van Susante²,

¹Vibrations, Intelligent Testing, & Active Learning of Structures group (VITALS), Michigan Technological University, (Contact: smalladi@mtu.edu)



²Planetary Surface Technology Development Lab, Michigan Technological University

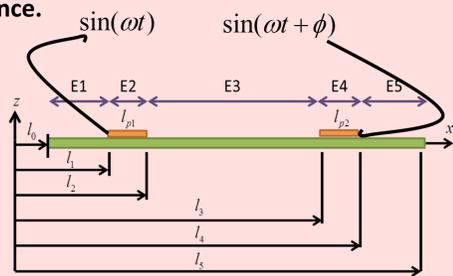
Most ISRU architectures envision robots handing lunar regolith from the extraction zone and transporting it from the mining site to the processing. Then at the processing end, the bulk-material conveyance system transports regolith between different stages of processing and eventually carries out the reacted regolith from the reactors. These processes require transporting raw material, final product, and reacted by-products. As a result, there is a need to develop infrastructure to transport and process lunar regolith.



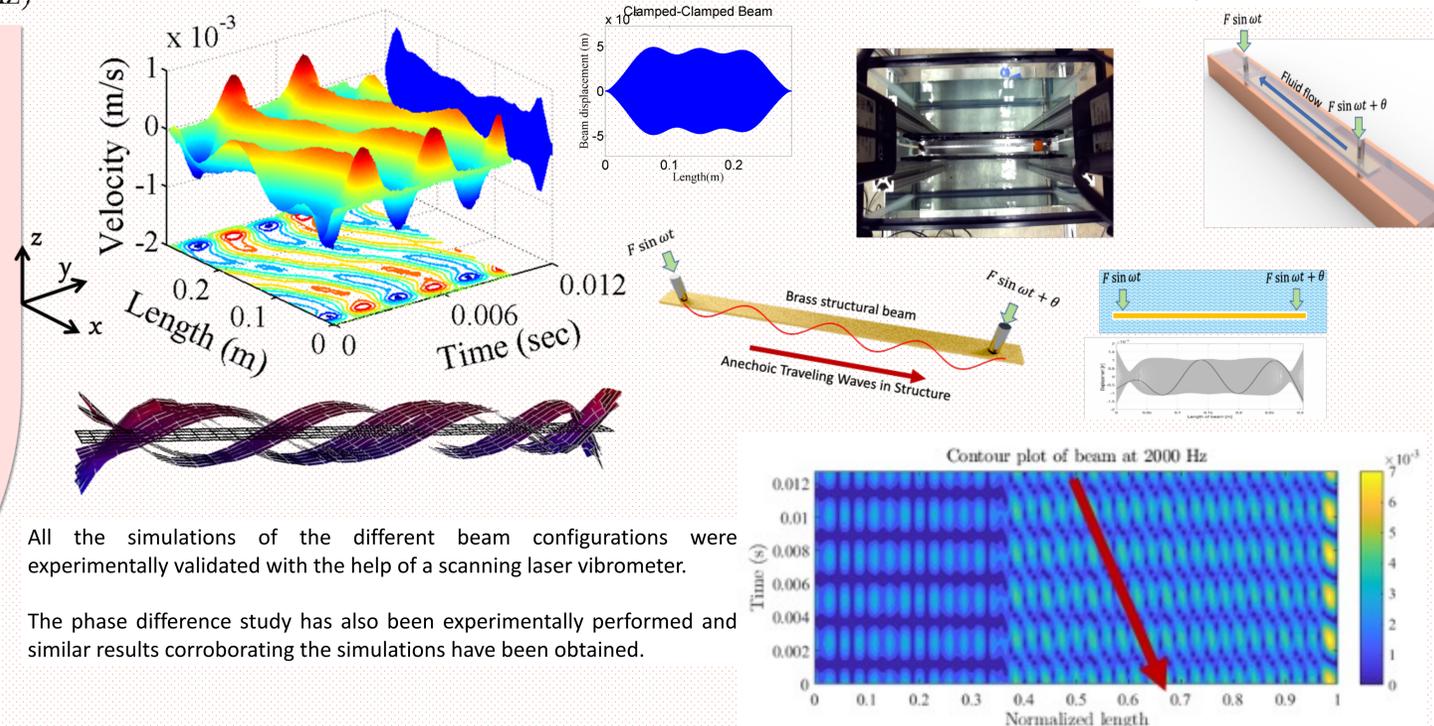
Vibratory conveyors are often easy to maintain, take different form factors, and work at high temperatures. However, they traditionally rely on bulky motor/actuators with rotary parts as well as the presence of gravity, which can prove challenging for low gravity applications. We propose the use of surface traveling waves to transport material as an alternative to these methods. This method has many advantages. With minimal design modifications, one can convert any platform/surface into a material conveyor. Distributed surface actuation with piezoceramics or macro fiber composites (MFCs) is sufficient to generate surface waves that transport material.

MIMO BEAM DYNAMICS

Traveling wave are generated by actuating two PZTs at the same frequency but with a phase difference.



The focus of this study is on understanding the traveling wave generation and propagation by establishing the relationships that illustrate the role of structural and electromechanical parameters.



All the simulations of the different beam configurations were experimentally validated with the help of a scanning laser vibrometer.

The phase difference study has also been experimentally performed and similar results corroborating the simulations have been obtained.

Example: TW WAVE BASED ROBOT

This novel approach leverages the structural design capabilities and ties them to performance requirements through solids state manipulation and activation.

The solid-state structural propulsion will be generated by traveling waves which will eliminate the need for conventional propulsion methods, such as propellers or jet propulsion.

