Investigation of Artificial Gravity Habitat Dynamics

Oklahoma State University Space Cowboys Research Team

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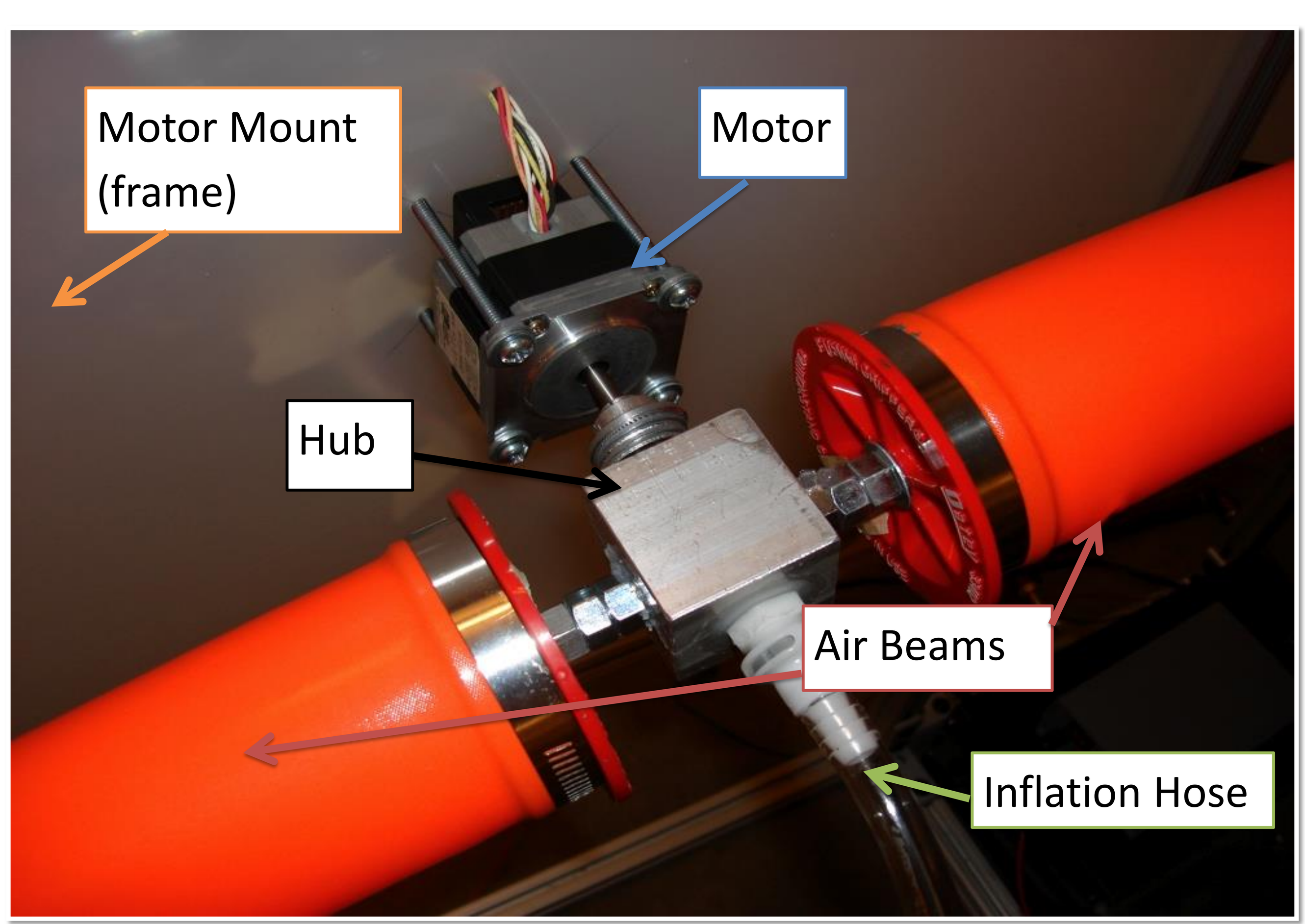
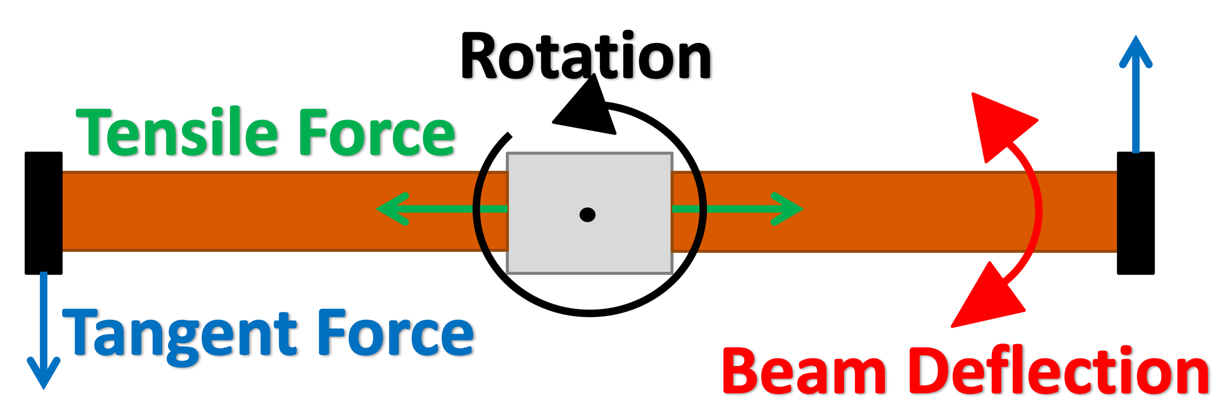
Abstract

Future envisioned missions to deep space elicit problems and challenges not fully investigated by the world's spaceflight organizations. One of the most prominent issues is prolonged exposure to weightlessness. The human body functions day-to-day with the resistance and force of gravity; in the absence of this phenomenon, bones/muscles swiftly atrophy. Another alarming effect, which has been acknowledged in recent years, is loss of vision due to prolonged spaceflight. Researchers hypothesize that lack of gravity increases pressure on the optic nerve, thus causing vision loss. An effective way to generate a force similar to gravity is to rotate a body to produce centrifugal force. For a small scale investigation of this concept, the Oklahoma State University Space Cowboys team has designed an inflatable beam-rotating experiment. The effects of various internal pressures on the beam's stiffness and rotational stability will be examined. Inflatable structures are lightweight, have a high ratio of deployed to packed volume, and could provide sufficient support for a rotating spacecraft that produces an artificial gravity force. The experiment is designed to allow the deployment pressure to be altered between test runs (parabolas). As spaceflight becomes more ambitious and missions of longer duration become both desirable and possible, spacecraft designs must provide crew members with an Earth-like gravity environment.



Hypothesis

The Oklahoma State University Space Cowboys hypothesize there is a correlation between deployment pressure and beam stiffness that in turn produces stable rotation. Each test will fix a defined inflation pressure. A near constant acceleration criteria, along with advanced motion tracking methods, will be used to quantify the optimal inflation pressure that produces inflatable beams that resist wrinkling when rotating. The team expects that there will be a measurable difference between the pressure required to induce wrinkling during ground tests and in 0-g. Ground tests in 1-g will be performed with the same pressures to be examined during actual flight testing so that the differences between the two environments can be compared.



Method

The experiment consists of an inflatable, rotating beam structure that is intended to generate artificial gravity by means of rotation. The rotating beam assembly consists of two beams, made of heat sealable polyurethane-coated nylon, that are connected to a hub joint which is mounted onto a DC stepper motor. The hub joint consists of a hollow cavity, allowing for the inflatable beams to be stored inside prior to deployment. Additionally, the low pressure system will be connected to the hub joint via a quick-connect valve. In this manner, the hub joint will act as both a storage device and a means of inflating the beams during deployment. Under this design, both air beams will share a common inflation pressure. The experiment will be monitored and triggered by a separate accelerometer mounted on the test frameOnce inflated, the DC stepper motor will begin spinning at a specified (and monitored) RPM, and the motion tracking cameras will be triggered to begin recording point cloud data using retro reflective IR markers placed on the inflatable body

Expected Results

The team anticipates that varying internal beam pressure will have a direct impact on overall rotational stability of the inflatable model. The pressure, acceleration, and motion capture data will be taken during the deployment sequence and subsequently rotation. The Space Cowboys expect that the flight data will show a lower inflation pressure(s) is sufficient to produce stable rotation, which includes constant acceleration at the ends of the beam and resistance to wrinkling/bending, compared to its ground control counterpart. Regardless whether or not the hypothesis is correct, there are significant findings either way. Not only does the experiment prove/disprove relatively new ideas, but it also refines requirements for future spacecraft.