Supplemental Thesis Material

There are eight videos included as online supplemental material for this thesis ("The Flying Carpet and Other Tales"). A brief description of each follows:

Video 4.1: "Low Frequency Traveling Wave"

The sheet is vibrating in a traveling wave shape, as a result of applying a traveling wave of voltages (~300 V amplitudes) to the actuators, but at only 2 Hz. This low frequency allows viewing of the actual traveling wave vibration. However, frequencies this low are not sufficient to propel the sheet. The sheet is connected to conductive threads to supply power, and is suspended from elastic threads in this case (~1 cm above the ground, so no propulsion would be observed even at higher frequencies).

Video 4.2: "Large Amplitude Standing Wave"

The sheet is vibrating in a standing wave shape, as a result of applying the same voltages (~300 V amplitude sinusoid) to each actuator, at 16 Hz. This frequency was near resonance for this setup (sheet suspended from elastic threads), resulting in a large (~1 cm) amplitude vibration.

Video 5.1: "High Frequency Traveling Wave – "Flying Carpet""

A demonstration of the propulsion caused by a traveling wave at 100 Hz. The sheet is supported on a cushion of air from the air table, ~1 mm above it, and is connected to conductive threads to supply power. When the sheet is off (as it is initially), its equilibrium position is near the center of the air table, and it does not move significantly. When the sheet is on, in this case with a traveling wave propagating to the left, it is propelled in the opposite direction (to the right in this case). The video shows the sheet turning on and off in several cycles, and it thus moves back and forth. Because the frequency of vibration is 100 Hz, the actual wave shape cannot be seen; rather the sheet seems to "shimmer" when on.

Video 5.2: "Smoke Test"

This video demonstrates that air is indeed being pumped under the sheet by the traveling wave (100 Hz). The sheet is suspended from elastic threads ~1-2 mm above the ground. When the sheet is turned on, in this case with a traveling wave propagating to the right, it is propelled in the opposite direction (to the left in this case). The smoke is rising from a smoke stick to the left of the sheet, and when the sheet moves over it, the smoke is sucked under the sheet. Due to a non-ideal bump in the sheet, the smoke exits the side of the sheet near its center, rather than the back (i.e. right) end. Note that, if the sheet was not vibrating, but was merely placed over the rising smoke, the smoke would billow around it in all directions, rather than being sucked under the sheet.

Video 7.1: "Propulsion under High Humidity"

Under high-humidity conditions, static electricity is reduced, allowing the sheet to propel itself faster (~2 cm/s in this video) while resting on the ground. The sheet moves on a Teflon tape surface that has been treated with anti-static spray. The sheet is supported on Teflon "skis", ~800 μm high, and is connected to the power supply by conductive threads.

Video 7.2:

Videos of two passive test samples sliding down an 11° ramp. **(a)** The sample with 0 to 2 mm supports ("Tilted Test Sample") initially moves in close to a straight line, but then rapidly rotates, an indication that its back end is lifting, as described in the text. **(b)** The sample with 0.5 mm supports ("Level Test Sample") moves in close to a straight line for the entire video, but an increase in its acceleration at around 1.25 seconds after it begins sliding is an indication that its front end is lifting, as described in the text.

Video 7.3: "Cart Follows "Flying Carpet""

Video of a motorized cart that can follow the sheet to provide power. The sheet is "on" (propelling itself to the right) for ~2 seconds, than off for 1 second, than on again. It is shown moving at ~0.8 cm/s on an un-treated surface (an overhead transparency).