1. Treadmill system

1.1 Assembly

Refer to Figure A2 in the Appendix for parts of the air cannon and bracket systems.

A. Assemble air cannons

Screw the nipple onto the cap. Use a hex socket driver or a wrench to tight it. **DONOT** need to push the entire threaded part of the nipple into the cap (Figure 1.1 left). Over-tight the nipple may crack the cap. Screw the cap onto the acrylic tube. Clamp the tube with the clamper. DONOT over-tight the clamper; it can crack the tube. The position of the clamper: the bottom surface of the clamper is about 0.5'' from the bottom of the cap. Make sure clampers on all cannons are at the same position. Use any method to achieve this. In my case, I first clamped one tube, and used it as a reference to set all other clampers to the same level (Figure 1.1 right). Once the tube is clamped, it will be hard to unscrew the cap or nipple; loose the clamper first if those things need to be adjusted later. The air cannon that goes to the bottom of the frame should have a different clamper position since no brackets would be used (Figure 1.4). The clamper position of this one can be manually adjusted later when all other parts are ready and the foam ball is on.

Cut the soft rubber tubing into 10 8ft pieces. Plug one end of the tubing to the nipple of the manifold, put a pinch valve on each tubing and plug the other end to the nipple of the air cannon. The friction could make it very hard to plug the tubing to brass nipples. It is helpful to clean the nipple first and put some saliva around it before plugging. Use 3 manifolds for 9 (3X3) cannons. The rest cannon, which will be mounted to the bottom of the frame, connect to a nipple on the fourth manifold. Cut two pieces of short tubing. Plug them to the other 2 nipples on that manifold and use pinch valves to seal them. Organize the tubings so they do not entangle with each other. Use any method to label each tubing at both ends. So it will be easy to tell which manifold nipple is connected to which cannon (Figure 1.2).

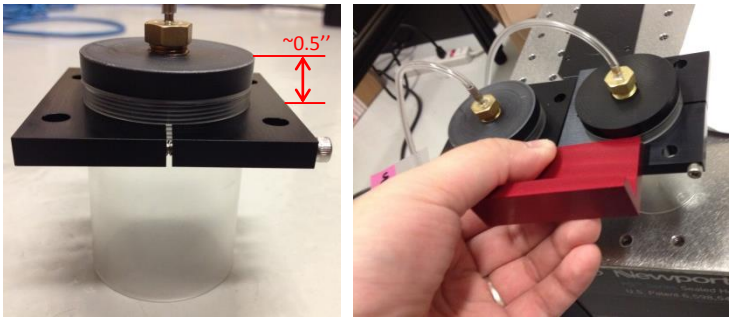

Figure 1.1 Assembly of air cannons.

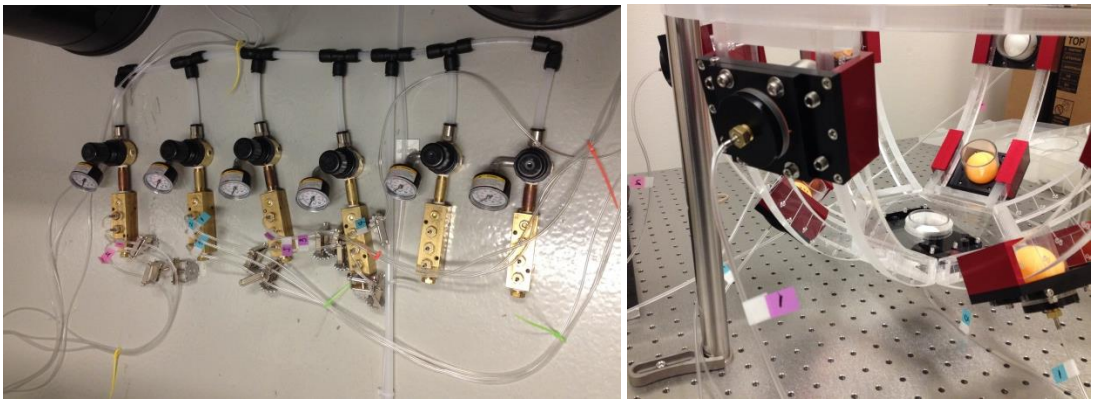

Figure 1.2 Air regulation system and labels.

B. Test ping-pong balls

First seat all air cannons (already connected to the air regulation system) on a flat surface. Use some rack to do this (see Figure A3 in the Appendix). Or as what I did, use clamper plates as a temporary tool to mount all cannons on the air table's edge (Figure 1.3).

Ping-pong balls are not manufactured in a very precise way. First use a spare acrylic tube to test if a ball can easily go into the tube without large friction. Put passed balls into air cannons. Turn on the air to float all of them. Use the same pressure for all manifolds except the one only connected to one air cannon (~1/3 of the pressure as for other manifolds should be used since only one outlet is open). Push every ball down and feel the force. If a ball is significantly smaller than others, one should feel less resistance when pushing it down. Replace balls until one feels a similar force pushing every one. Mark all chosen balls to avoid confusion in future.

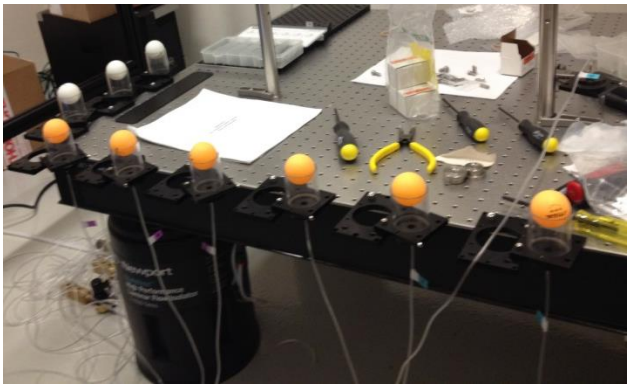

Figure 1.3 Test ping-pong balls.

C. Mount air cannons onto the frame

First screw one clamper plate to the bottom plate of the frame. No bracket ('bowl clamper') is needed for this one. Screw one bowl clamper on each clamper plate. Then put the whole thing on the frame's arm and screw the bowl clamper on the other side (when bowl clampers are installed

on both sided, it cannot go into the arm anymore). There are two potential arrangements of air cannons on frame arms: 1. 3 close to the rim and 3 close to the bottom (in this case only 7 air cannons were used for one treadmill); 2. 6 close to the rim and 3 close to the bottom. The second configuration makes the treadmill more stable but also a little harder to turn. I personally used the second configuration (Figure 1.4). There are reference marks on each arm of the frame. The upper edge of the clamper plate is at 85°/45°. Tighten nylon-tip setscrews to secure positions.

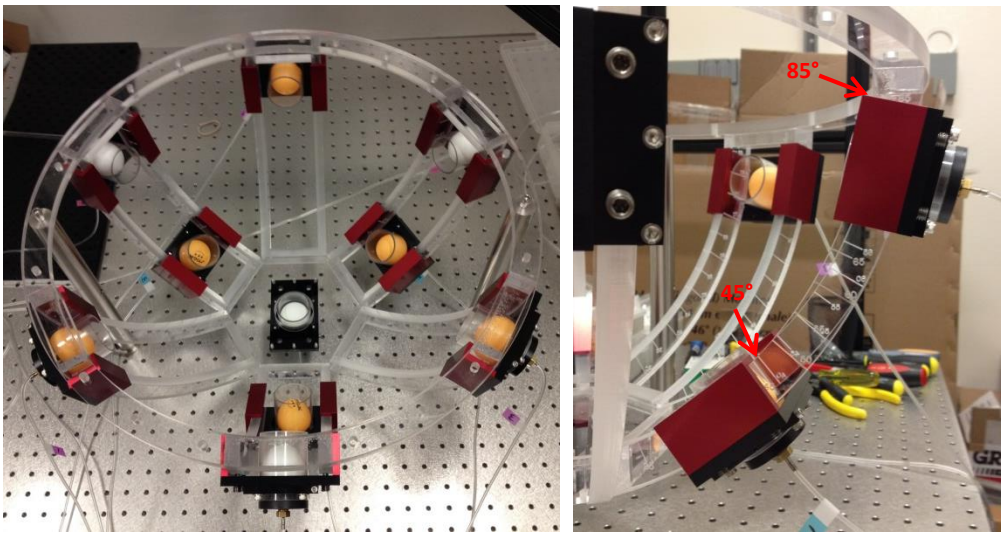

Figure 1.4 Air cannons and bracket systems on the frame.

1.2 Glue foam spheres

Note: Always handle foam spheres gently. They are very delicate.

A. Weight the sphere

Carefully take sphere halves out of package. Weight each one with a scale. They should be 28-33g as required. In fact, most would be 31-33g. Use a marker pen to write down the weight on the inner surface. Halves with the same weight should be glue together to make sure the sphere will have uniform weight distribution.

B. Prepare the aluminum ring

Cut several pieces of parafilm (each spans 5 sections). Use the parafilm to cover the inner surface of the ring's rim (Figure 1.5). Make sure there is no gap.

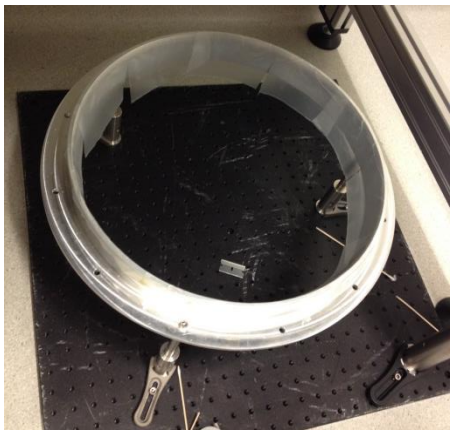

Figure 1.5 Cover the aluminum ring with parafilm.

C. Initial gluing

Shake the foam glue (from FoamFusion) while holding the cap. Use a Q-tip or needle to open the tip if necessary. Squeeze some glue into a weighting dish. Take one half. Use a Q-tip to carefully cover the rim with a layer of glue (Figure 1.6). If the glue drips onto the outer or inner surface, quickly remove it.

Put the half into the ring. Let the bottom touch the floor (Figure 1.6). Make sure it is not tilted. Push the other half into to ring until rims of the two halves firmly touch each other. Carefully swing the plastic plate to the top of the sphere. The height of this plate was pre-set so that it should just touch the top. If the plate is blocked by the sphere, it means the two halves may not touch each other at all positions. Turn the black threaded ring (Figure 1.6, red arrow) 1-2 rounds to move the plate upward a little. This will release extra pressure on the sphere. Leave the sphere overnight to dry.

D. Complete gluing

After dried from the initial gluing, carefully take the sphere out of the ring. Peel off parafilm. A substantial portion of the rim may not be actually glued. It is fine as long as the two halves are glued together seamless at some positions. Use some tiny pieces of tape across the seam to hold the sphere.

Put something (box, foam block etc.) on the floor plate at the ring's center. Seat the sphere on top so the seam won't touch the ring (Figure 1.7). Use a Q-tip to cover the unglued seam with a thick layer of glue. Wait for 1-2min to let the glue soaked into the gap. Gently scratch the seam with a Q-tip to thin the glue. Be careful not to let the glue touch tapes. It may be helpful to put the sphere in a way that the seam plane is perpendicular to the floor. Glue the top half of the seam at this step and do the other half later. Gravity can help the glue to get into the seam.

Wait 4-6h until the glue is dried. Gently remove all tapes. Repeat the step above to apply the glue on previously taped areas and any gaps. Make sure no gaps are left eventually because the animal's paw can easily stuck into a gap.

Figure 1.6 Initial gluing of foam sphere.

Figure 1.7 Complete gluing.