DLA Report 14

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1 Summary

For this report I continued setting up and troubleshooting the water table. I installed the LED, resolved the water fountain problem, tested various water table configurations, and took some images. The experimental data collected with Mark after last week's group meeting did not yield any meaningful images. Thus, I have done some work to reduce turbulence and plan to take more images after I implement all of my ideas.

2 Description of what was done

2.1 LED Installation

I installed the LED relatively easily! The cord is long enough to plug into any outlet in the lab, so we don't need to plug into the hard-to-access outlet in the background of figure 1. The cord can also be disconnected from the LED for easy storage (see figure 2).

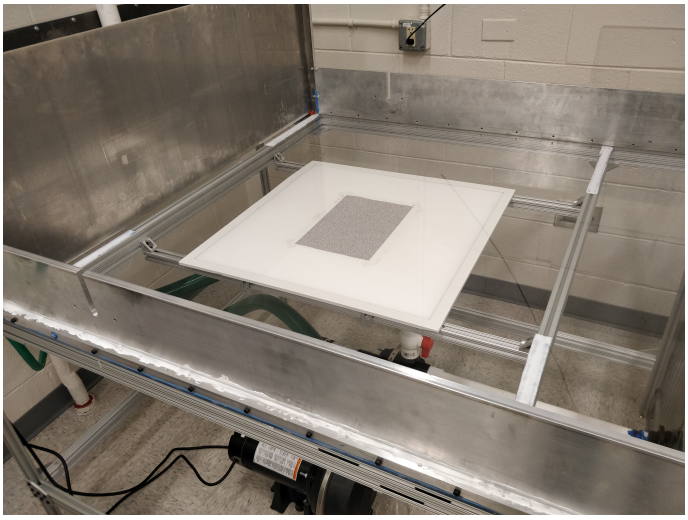

Figure 1: LED under the water table (top view).

Figure 2: LED under the water table (bottom view). Note that the LED has hinges we can use to keep it from sliding off and falling, which is a nice feature. Note also that the black cable connects to a larger extension cable to turn the LED on. This larger cable can reach almost any outlet in the lab, making turning on and off the LED easy. The larger cable can also be stored easily when the water table is not in use.

2.2 Water Table Variations

I was able to resolve the water fountain problem by drilling larger holes into the output pipes of the water table. Below are images of the water table with various modifications:

Figure 3: Pipes with larger holes to allow for smaller fountains when pumps are running.

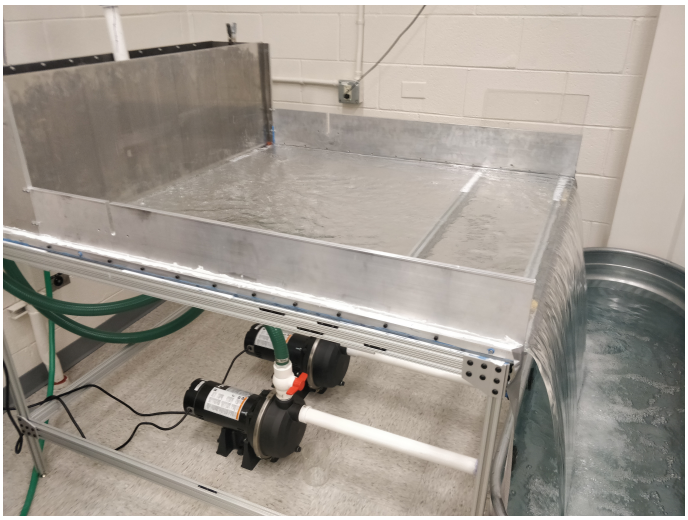

Figure 4: Water table with one pump running.

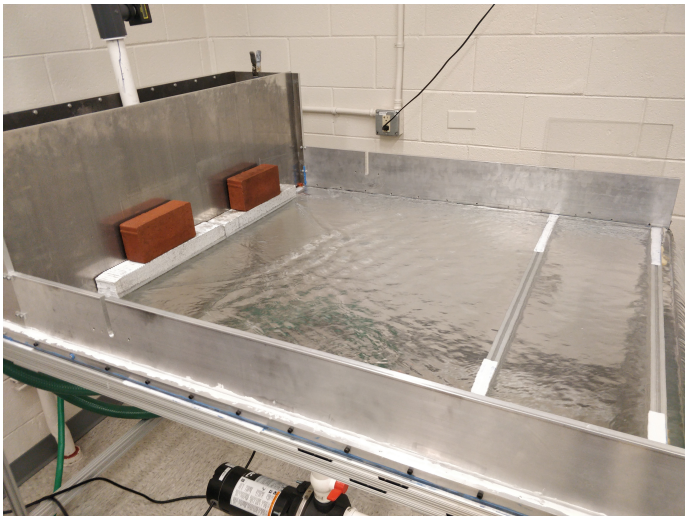

Figure 5: Water table with one pump running and flow straighteners.

Figure 6: Water table with one pump running and flow straighteners (inside sluice gate).

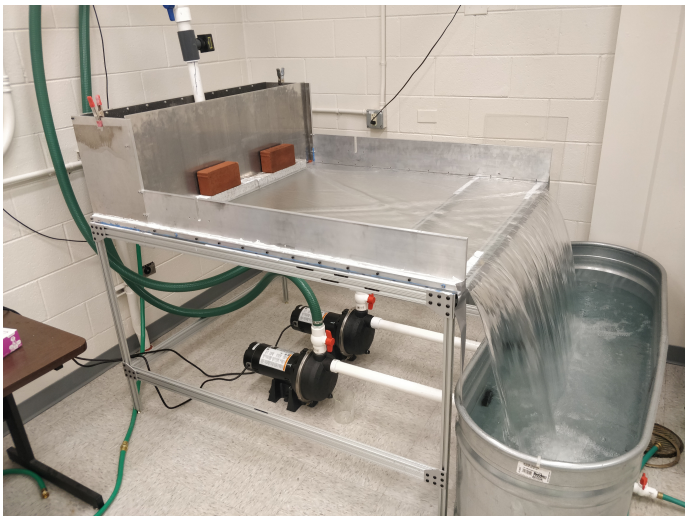

Figure 7: Water table with two pumps running and flow straighteners.

Figure 8: Water table with two pumps running and flow straighteners (inside sluice gate).

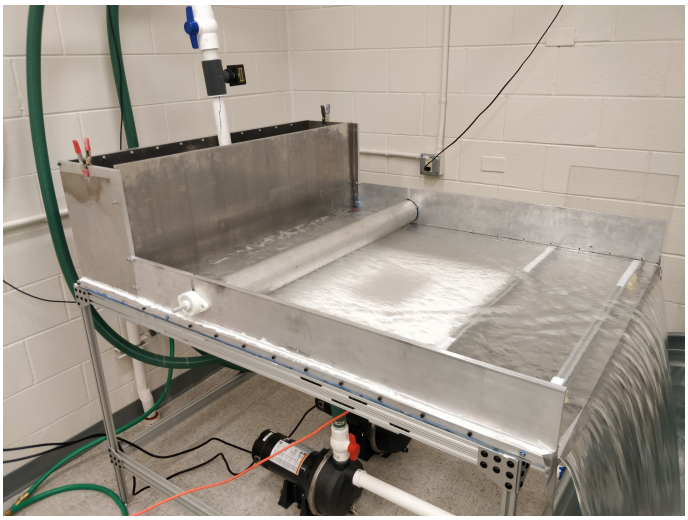

Figure 9: Water table with two pumps running and cylinder.

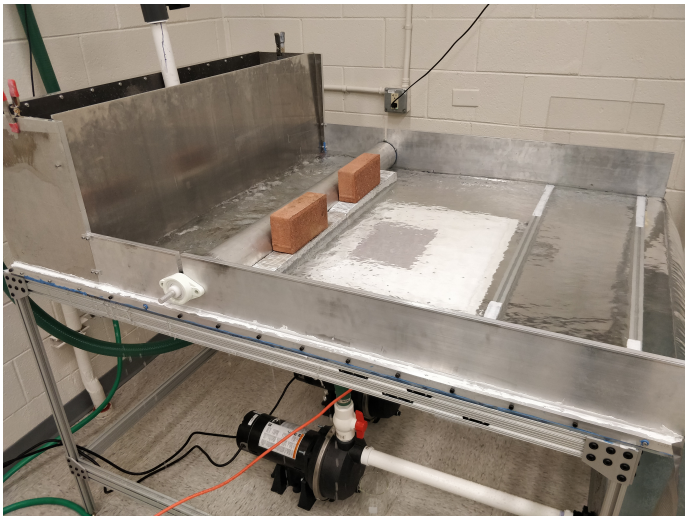

Figure 10: Water table with two pumps running, the cylinder, and flow straighteners. Note that this image was taken after figure 9, potentially resulting in more water being built up behind the sluice gate/ cylinder causing the water to be smoother in this image. It's also possible the acrylic was bending due to the bricks on the flow straighteners, causing a concave shape on the water table where water was collecting.

2.3 Problems

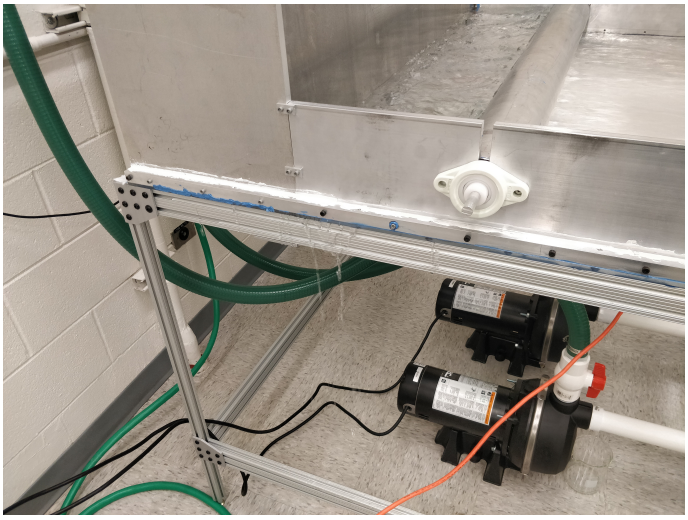

Figure 11: Water table with two pumps running and cylinder (leaking). I think that the leaking was a result of the water height behind the cylinder being large enough to go through the slits built for the cylinder. Not sure how to best approach fixing this leak if we want to be able to move the cylinder around.

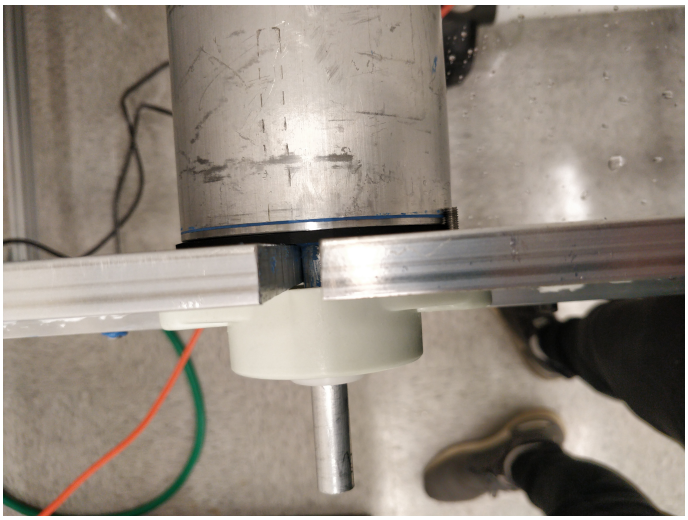

Figure 12: Water table with two pumps running and cylinder (leaking). This image demonstrates where I think the leaking is occurring. I turned off the water table before being able to identify the exact cause of the leak.

Figure 13: Water table leakage when pumps are disconnected. Disconnecting the pumps results in water velocity decreasing, but this means that surface tension causes water to go everywhere since it misses the tank. I thought moving the table forward a bit would fix this, but even with over an inch of overhang there is still leaking. The best solution to this would be to replace duct tape with a stronger lip for the water table, but some brainstorming is required for the best way to make a stronger lip. 3D printing comes to mind but it seems like an over-engineered solution to this problem. Note that there is water dripping down the leg of the water table, this was from the same leak identified in figures 11 and 12.

Figure 14: Slanted sluice gate. When the water table is run with two pumps the sluice gate starts to slant. This makes sense since, as we know, the sluice gate isn't as secured to the table as it could be. This may or may not be a problem, but it's important to mention. I have plans to fix this, see the section Water Table Work 2.5 below.

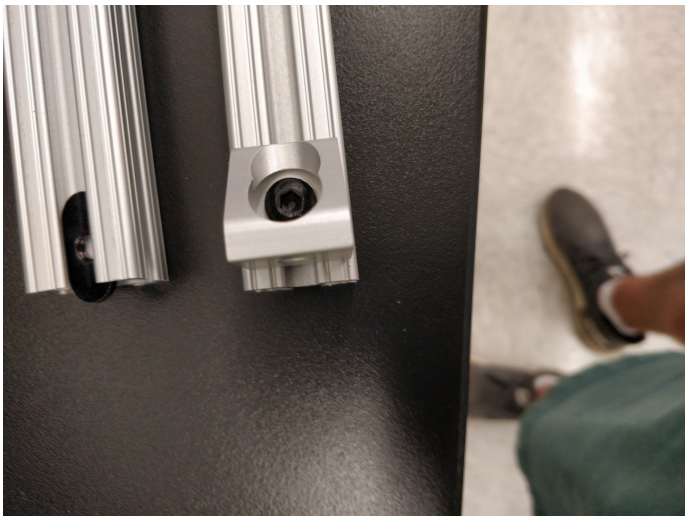

Figure 15: 80/20 sizing. It turns out that the provided 80/20 aluminum bar for the LED is just slightly too big. This isn't a major problem, since it can easily be machine down to size. We would only need to do this if we want to attach the LED about an inch closer to the bottom of the water table.

2.4 Data Collection

After last week's group meeting, Mark and I took some images on the water table. We had one pump running since having two pumps running on the same outlet trips the breaker.

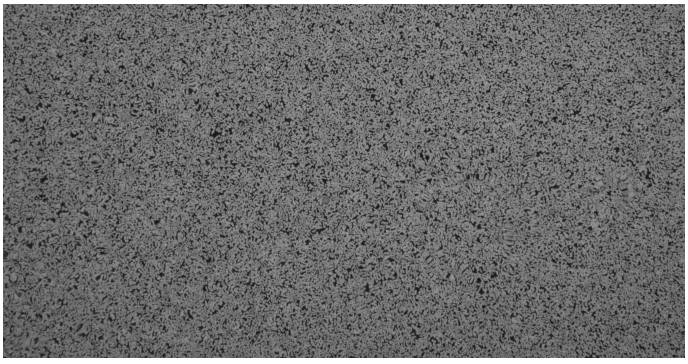

Figure 16: Still water image.

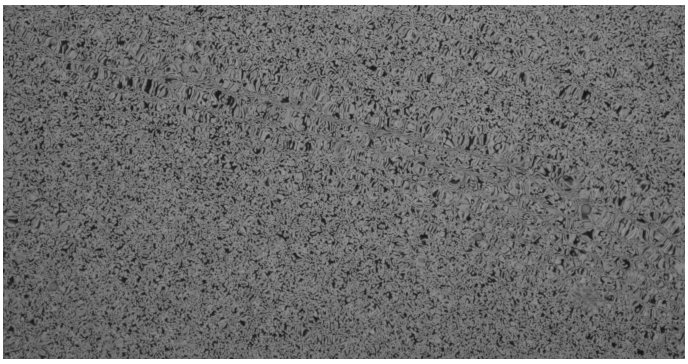

Figure 17: Moving water image.

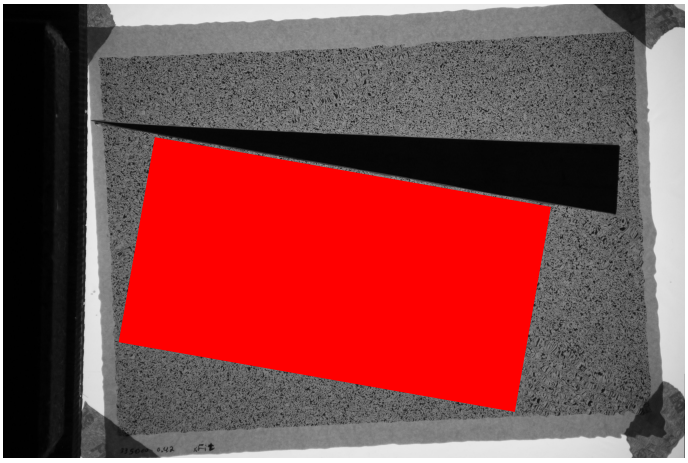

Figure 18: Area used for FSSS.

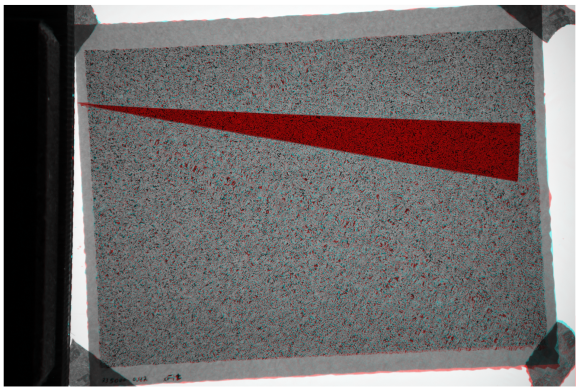

Figure 19: Image registration overlapping images. Notice that there is a lot of noise across the entirety of the overlapped area between the two images.

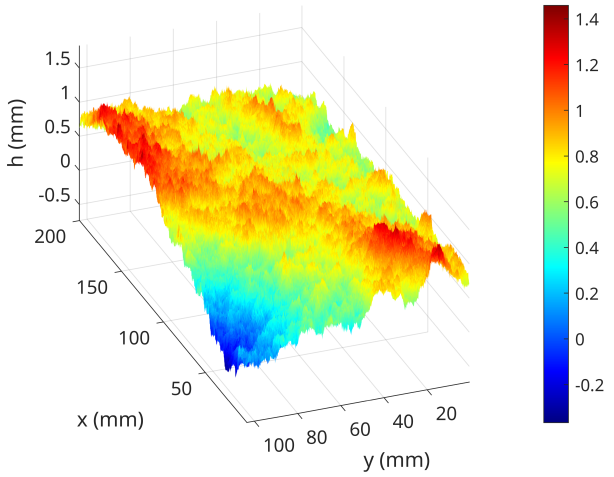

Figure 20: Result of FSSS. The wave structure is not clear in this reconstruction due to lots of noise between the two images. Ideally we only want differences in pixels to be from the waves, not from noise due to variations in time from the water table.

I didn't average the input images because I'm not aware of a way to average the input images when there is a lot of variation between images that are supposed to be the same. Averaging in the normal sense removes noise when the imaged area is the same, like for pictures of the solar system. In those cases, the pixel values are averaged. In my case, since there is so much variation in

the surface height between images that are supposed to be the same, the pixels are just going to become gray, making FSSS ineffective. I think that reducing noise in images taken would allow us to average surface heights to remove noise in surface height that we've seen in previous images like the water drop.

2.5 Water Table Work

I think it would be best for me to do some changes to the water table to reduce noise as much as possible. Some ideas I have are:

- Using screws to hold the sluice gate in place. These screws would support the sluice gate from the flat sides on both sides, instead of what we currently have where the sluice gate is supported by screws pushing into it.

Figure 21: Image of proposed sluice gate solution.

- I think zip-tying rags to the pump outputs will help reduce turbulence. It has the same effect as the sponges should have, but they will stay in place.

- I can bring in an extension cord I have to use two pumps at once without tripping a breaker, since different outlets in the lab correspond to different breakers.

I was able to implement the latter two changes and plan on starting the sluice gate fix tomorrow April 13th. After the sluice gate is fixed I'll run the water table again and see if there is improvement and think of other changes I can implement.

Figure 22: Rags zip-tied to the pump's pipes outputs. This should help reduce turbulence in the water.

2.6 Poster

I also spent a significant amount of time working on my DLA poster! The link to the current version is here.

3 Description of Next Steps

- I will present my poster at the DLA symposium this Friday! Details are pending. This means I need to go and print my poster.
- Continue resolving water table issues. This includes changes I mention in Water Table Work (2.5).
- Try to take images of the dot pattern and begin collecting data.
- I need better a better way to use image registration, in particular, I need some fixed points downstream. This can be temporarily overlooked through the use of subtracting the mean displacement field.
- It might be good to try to pursue having the "still" images generated in 3D modeling software if we can't reduce turbulence in the water. Then, the "still" images will be perfect and we can pass the real "moving" water images to FS-SS.

4 Questions

- I'm curious if there are any other turbulence-reducing ideas.

- What are your thoughts on using the 3D modeling software?
- Any questions/comments for me?