# Assignment 5 - Video Textures

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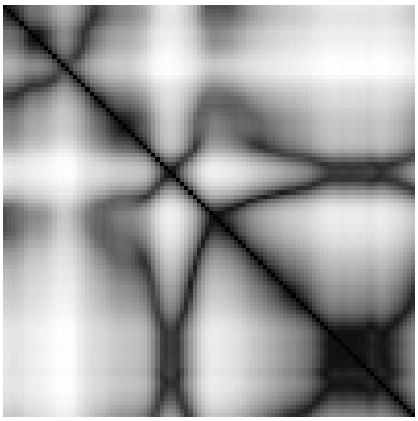
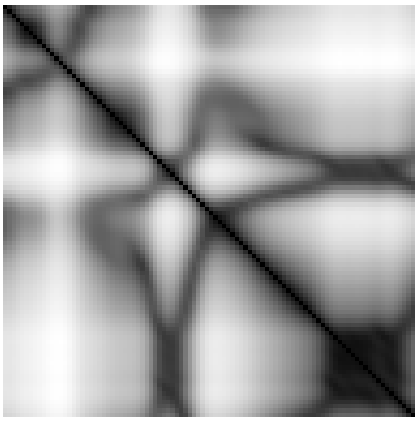
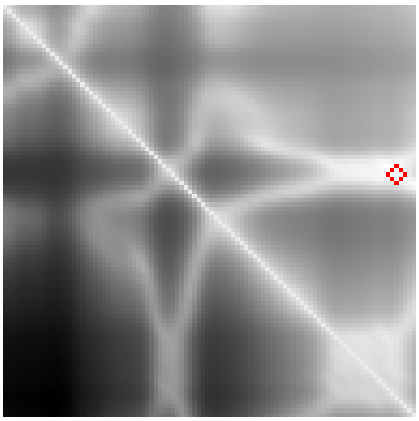


(a) computeSimilarityMatrix()

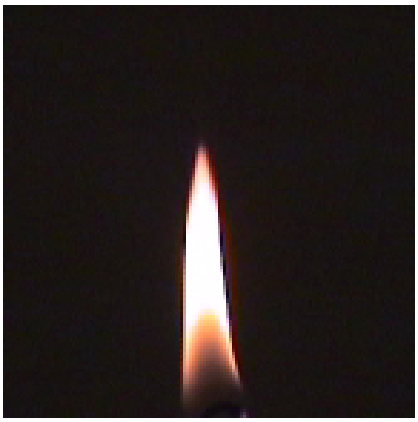


(b) transitionDifference()



(c) findBiggestLoop()

Fig. 1: Sample Candle - Transition Matrices

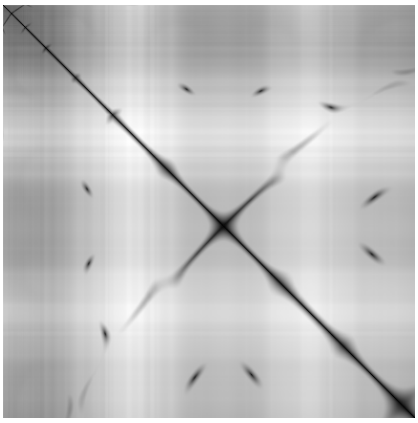


(a) First Candle Video Texture Frame - 040.png

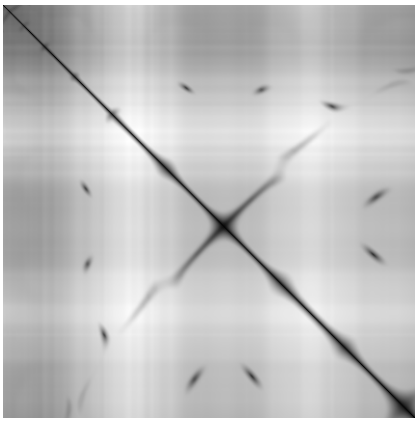
(b) Last Candle Video Texture Frame - 092.png

Fig. 2: Sample Candle - Start and End Frames

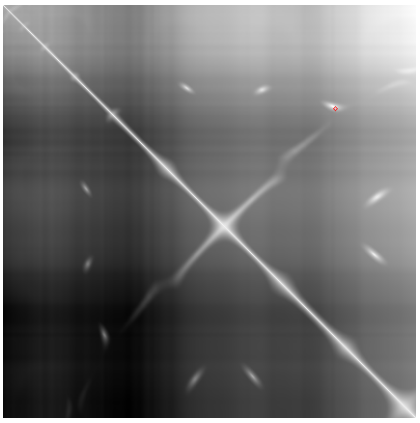
Alpha Value: 0.01
Link to Results: https://gatech.box.com/s/2venaiakyw7ks8kh0cvnlpob599x0pi1



(a) computeSimilarityMatrix()



(b) transitionDifference()



(c) findBiggestLoop()

Fig. 3: Original Best Input - Transition Matrices

(a) Air Hockey Start Frame - 0108.png

(b) Air Hockey Finish Frame - 0345.png

Fig. 4: Original Best Input - Start and End Frames

Description: Puck moving on an air hockey table after a small flick by a finger in Durham, NC
Alpha Value: 0.002
Link to Results: https://gatech.box.com/s/2venaiakyw7ks8kh0cvnlpob599x0pi1

## I. Results Discussion - Sample and Original Inputs

1) **Did you get a good result from the sample candle inputs? If yes, what were you happy with? If no, what were you not happy with? Be specific.**
Yes, I got a good result and was happy with the output of the candle video texture. This was primary because the dynamics of the candle were natural with no random jumps or cuts. However, frame 40 and 92 have some minor misalignment: this is noticeable with close attention to the period just before the quick movement of the flame to the right, where the top of the flame drops a few pixels. Ideally, this could be smoothed with a feathering method.

2) **Did you get a good result from your own video? If yes, what were you happy with? If no, what were you not happy with? Be specific.**
I got a solid result with the air hockey video. The transition between frame 108 and frame 345 was very smooth with no noticeable jump from the puck's location. However, unlike the candle, the puck is not captured in a static position. Similar to the pendulum issues in Professor Essa's lecture on preserving dynamics with transitions [1], the puck appears to exhibit a significant acceleration at the transition point. While not appearing entirely unrealistic, it does appear to violate the laws of physics.
The size of the video frames were a native 1080x1080 square. Using the resize_stack() function provided as part of assignment 4, I reduced the image stack to 540x540 pixels. All outputs from the original set are in this size.

3) **How was the video you took different from working on the sample candle frames?**
The air hockey video varied in two specific ways. The first was the background: the candle frames have a simple black background, which works very nicely for subtraction, even if the camera is not perfectly stable. However, the air hockey image set required a very consistent camera and lighting because of the variety of background colors and shading which could have influenced the sum of squared differences similarity calculation. Second, the candle had a relatively stationary base, with only the peak of the flame moving the triangle significantly. This motion was mostly constrained to the x-axis. However, the red puck in the air hockey frame moves in multiple dimensions. Early in the original video, the puck is at the far end of the rink (varying in y-position and depth) but ends on the near side of the rink. The puck also moves frequently in the x-axis at varying speeds as the puck deflects off walls and experiences some (small amount of) friction. This makes the puck dynamics more difficult to capture in the video texture.

4) **List at least 2 things that you found difficult while working on this assignment. For each, explain how you overcame the difficulty.**
Prior to filming and using at the air hockey video, I attempted to use previously filmed videos on my iPhone, such as a video of spinning a hockey puck in my hand or my fiance attempting to throw mini-footballs in an arcade game. Sample images from these videos are available in the Appendix. Although the images appeared like they may work with this pipeline, I was unable to adjust alpha to any result that selected frames other than the beginning and end. This is consistent with the conclusions from Schodl [2], who found that their algorithm generally struggled with complex but structured motion. They also predicted issues with human motion, which I found to be consistent with my results from the arcade game. To overcome this, I created and filmed this air hockey video, which created a more repetitive motion with a more consistent background. This resulted in a simpler sum of squared difference calculation and produced better results. Additionally,

5) **Discuss at least 2 things that you would do differently to create a better original result if you were to do this assignment again.**
I would attempt to do is model the puck's velocity to preserve the speed of the puck. This is the most noticeable element of the current transition. The error of velocity could be added to the distance term, with greater error in velocity suggesting a less similar frame. This might be implemented similarly to the mouse-controlled fish example from [2].
I would also look into making multiple jumps. Although the current gif produces a relatively smooth result, a smoother result may have been possible with a larger number of smaller jumps, particularly for alternative videos with a more complex scene.

## II. Finding Alpha Discussion

1) **Describe how you determined the best alpha value for the sample candle and your original video textures. For EACH result, describe what alpha values you experimented with before deciding on the best alpha value. How was EACH result affected as alpha increased? Decreased?**
The function header for findBiggestLoop() in textures.py specified that larger values of alpha promoted more distant but rougher transitions while small alpha values created smaller loops with better transitions. This narrowed down the initial search space: small values would create the smooth transition I was looking for. In addition, Schodl's cost function used alpha to estimate the cost of a future transition. This was later inverted to find the minimum cost [2]. Schodl suggests using 0.99 ¡ alpha ¡ 0.999 in this situation. For findBiggestLoop(), the argmax would be identified, meaning that alpha would need to be inverted to use the other end of the [0, 1] bounds (i.e. 0.01 ¿ alpha ¿ 0.001). I used this range as my initial estimate.
Starting at 0.01, I varied the alpha value small amounts ( 0.001 per step). The initial loop of [39, 91] was a strong suggestion. Once I hit 0.006, I found the suggestion of [2, 2]. At 0.025, [2, 97]. Lower and higher values kept these constant. The only alternative value I found was at 0.0065 with [40, 91], a small variant on my initial guess of alpha=0.01. Although this may have been a viable option, I chose to use alpha=0.01 since the range of alphas associated with this result was wider (0.008-0.2 compared to 0.0065-0.007), which I used a proxy for a more robust result.
For the air hockey set, I used 0.01 as a starting point, but quickly found [3, 430], the full bounds of the video. This suggested a lower value was needed. At alpha=0.002, the bounds [108, 345], a valid range with a good transition. This was the only good range I found: by alpha=0.0015, the [3, 3] bound had been discovered. Therefore, alpha=0.002 was chosen as providing the best transition.

2) **Was the best alpha for your original video the same as the one for the sample candle? If they were the same, why do you think this is? If they were different, why do you think this is?**
The resulting alphas for each frame set were not the same. This is likely because of the relationship in the scoring function. In order for a middle loop to be selected, the alpha value must be low enough where any non-matching frames do not out-score the starting frame (which always has a score of 0) but high enough that the time difference score component does not only permit the last frame to become the maximum. In the air hockey case, the small tracking object resulted in a tighter spread of the similarity matrix produced by ssd in comparision to the flame. Therefore, there was less difference between a good frame (ex. frame 0345) and a bad frame (ex. frame 430), requiring a smaller and more precision alpha to be used.

## REFERENCES


[1] Essa, I. (n.d.). 06-02 12. Preserving Dynamics with Transitions. https://edstem.org/us/courses/50608/lessons/85094/slides/468581

[2] Schödl, A., Szeliski, R., Salesin, D. H., Essa, I. (2000). Video textures. Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques - SIGGRAPH '00. https://doi.org/10.1145/344779.345012

# APPENDIX

(a) Example Image from Red Puck Frame Set


(b) Example Image from Arcade Frame Set