

Modeling Devil Stick Tricks

MA198 Project Narrative

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December 12, 2016

Abstract

The objective of this project was to model a variety of juggling sticks performed on Devil Sticks. We used Javascript, HTML 5, and the Three.JS library. The project shows the movement of the middle sticks as well as the two controlling handsticks. To make the animation more realistic I added hand-like attachments so it appears that it is a person using juggling sticks rather than simply the sticks floating in mid-air.

1 Background

I have been juggling Devils Sticks for nearly six years, but have never seen a digital rendering of the tricks. Devil Sticks consist of three sticks: two hand sticks and one middle stick weighted for balance. The two handsticks are used to manipulate the middle stick. Timing is a major key for keeping control. This is one reason why a digital model is so interesting, because the timing can be easily controlled and kept consistent. This reduces some human error. I like that I also am able to change the speed of the animation to see the tricks in slow motion. I have always found it hard to explain to people what I am doing with handsticks and when I show them in real time they rarely understand. Being able to slow down a trick is also be a good way for someone to learn how to use Devil Sticks.

1.1 Control

One key in Devil Stick juggling is the aspect of control. Control means that the juggler has the ability to manipulate the middle stick in a specific way to perform tricks. It is common to see a beginner struggling as they lose control of the middle stick and end up hitting it randomly, struggling even to keep the stick off the ground. Better control can be gained by hitting the middle stick in specific and consistent locations along the stick. Control while juggling Devil Sticks is often the hardest thing to learn as it is a lot of trial and error, gaining experience and muscle memory.

2 Devil Stick Variations

As I discussed in my seminar there are many different variations of Devil Sticks. To give more background, I will explain a few of the variations.

2.1 Traditional Devil Sticks

Traditional Devil Sticks are made from a single piece of wood. They are narrow in the middle to provide a fulcrum and balance point [2]. The ends are weighted to ensure that there is a bigger *sweet spot* for controlling the middle stick. A sweet spot is the range of points on the middle stick, so having a larger sweet spot means that you can have more control over the middle stick and makes it possible to do more complicated tricks. Unlike other variations, traditional Devil Sticks don't have a grippy coating on the middle stick, although there is typically a coating on the handsticks.



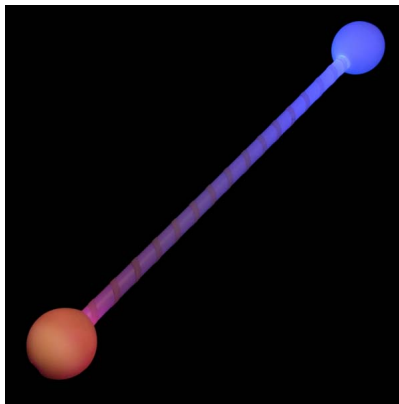
2.2 Flower Sticks

Flower sticks are lighter, shorter middle sticks. They don't narrow in the middle, rather are just a solid stick weighted at the ends. Tassles at the ends of the middle stick help to weight and balance the middle stick. However, the tassles also provide a visual aesthetic that appears like a flower while the stick is spinning, hence the name[2]. Unlike the traditional Devil Sticks, Flower Sticks do have a grippy rubber coating on all of the sticks which makes it easier to control. Flower Sticks are considered to be easier to use as they are lighter, grippier, and slower and are therefore easier to learn first.



2.3 Light-Up/Fire Sticks

These are similar in style to either Flower Sticks or traditional Devil Sticks. Some have LEDs located at the end of the center stick, which creates interesting patterns whilst juggling in the dark. Similarly, the Fire Sticks can be lit at the ends so that the flames create trails as you juggle [2]. These sticks are often heavier to incorporate the LEDs or flame safe material to provide balance, much like the Flower Sticks use the tassels. Caution must be used while using the Fire Sticks as to avoid burns and spreading fire.



3 Physics of Design

The length of the middle sticks and the weighting on the end help to slow rotation about the pivot point, thus creating a larger sweet spot. Another aspect of the design is the weight vs. speed part. This can be explained with the physics equation $\tau = I * \alpha$, where τ is the torque I is the moment of inertia, and α is the rotational acceleration [1]. Rearranging this equation to $\alpha = \tau/I$, we can see that a longer, heavier stick will spin faster and be harder to handle.

4 Project Details

This project models five different tricks. In addition to the digital model includes gifs all of the different tricks done in real life for a side-by-side comparison. The project thus becomes a teaching tool. Side goals of this project is to learn website design and learning how to use LaTeX for documentation. I will have learned how to use Javascript and the Three.JS library better as I progressed through the project. The five different tricks represent different difficulties to perform. Here I provide descriptions for each of the tricks.

4.1 Toss Up and Down

This trick involves tossing the middle stick up and down using the two hand sticks simultaneously. This is a basic trick that is generally one of the first things learned. It is considered easy as there is no need to balance the middle stick on one stick at any time. Both handsticks can be used to stabilize the middle stick when catching it.

4.2 Idle

Tossing the middle stick between the two hand sticks is called idling. This trick as the name *idling* suggests, is an in-between trick that it easy to control. It is commonly used as a transition to learning other tricks. Idling is one of the most common filler tricks as you can easily transition to a multitude of different tricks. In order to control this trick you want to hit the middle stick slightly above center and to rotate it onto the other hand stick. It is best to use as little force as necessary in order to keep the middle stick under control.

4.3 Vertical Spin

Here the middle stick is spinning in a vertical circle around one of the hand sticks. This trick is fairly difficult to master because it requires great control and

timing to keep the middle stick balanced. The idea behind this is to rotate one of the handsticks in small circles with the center sticks balanced just off center.

4.4 Elliptical Spin/Helicopter

In this trick you alternate handsticks to control the middle stick in the horizontal elliptical path. This trick can be quite difficult to control as you are making minimal contact with the middle stick. This, like the idle trick is frequently used as a transition between two different tricks or as a way to start a trick.

4.5 Horizontal Spin

This is one of the tricks you can transition to from the helicopter trick. The idea here is to use one of the handsticks to toss the spinning middle stick up and down. This trick can be viewed as a combination of multiple of the previous tricks described here. It ties in the up and down aspect of the toss Up and down trick while also maintaining the rotation from the helicopter trick. This combination of skills makes the horizontal spin one of the most complex skills to learn.

4.6 Colors

In order to have some visual appeal, I used a random color generator so that whenever one of the trick animations are refreshed the handsticks, middle stick, and the ends or the middle stick have new colors. To do this I used the following code [3].

```
32 function getRandomColor() {  
33     var letters = '0123456789ABCDEF';  
34     var color = '#';  
35     for (var i = 0; i < 6; i++) {  
36         color += letters[Math.floor(Math.random() * 16)];  
37     }  
38     return color;  
39 }
```

This generates a random string of letters and numbers which serve as the input for color of an object.

4.7 Gifs

As part of the thought that this project can be used as a teaching tool, I created a series of gifs to go along with my trick animations. For each trick that I did an animation for I also made a gif of me performing that trick on my Devil Sticks. On the website I put the links for the animation and gif of each trick side by side.

5 Project Steps

- 1) Created a realistic model of the middle stick and modeled its motion for each of the tricks using 3.js.
- 2) Added in the handsticks and coordinated their motions to fit with my model of the middle stick.
- 3) After the motion of both the handsticks and the middle stick was complete, the hands glyphs to suggest hands, but not waste resources in modeling realistic hands, were added.
- 4) Create gifs of each of the tricks for a side by side comparison.

6 Conclusion

This project overall satisfied the goals that were set at the beginning of the semester: creating a good visual model of Devil Sticks, a teaching tool. Given more time it would have been helpful to add in a tail to the middle stick for easy visual tracking of the motion. I had attempted to add a tail but after experimenting with different methods, I was unable to succeed. Additionally it would have been interesting to model different variations of Devil Sticks, however for simplicity's sake it was best to just stick with one variation for the project.

References

- [1] *Devil Sticks: Physics of Devil Sticks Design.*
http://jugglebox.wikia.com/wiki/Devil_Sticks
- [2] R. Stavins *Hypergraphics Seminar Presentation: Devil Sticks*
- [3] Stack Overflow user "Anatoliy" *Random Color Generator in Javascript.*
[http://stackoverflow.com/questions/1484506/
random-color-generator-in-javascript](http://stackoverflow.com/questions/1484506/random-color-generator-in-javascript)