*Projects and Stuff*

Accel

Project Log

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# 2012/10/03

This evening I created the initial git repository, and began sketching out initial plans.

I’ll be using Google Sketchup to build most components in this project.

Initial notes:

Ring Radius: 500 mm

Ring Diameter: 1000 mm

(Ring dimensions are drawn to the center of the tube)

Ring Segment central angle: 18 degrees

Total Segments: 20

Ring Segment Arc Length (at center of tube): ~157.0796326794897 mm

Ring Total Circumference: ~3141.592653589793 mm

Tube diameter: 27.4 mm

Tube Thickness: 5.0 mm

Remember to include on each segment:

- Wire guides

- Sensor mountings (LED/magnetic/etc)

- Assembly (3-4 screw posts/holes at each tube end)

- Stand mounts for securing to a surface (closer to surface = better)

Also consider foam dampers at mount points, and a heavy base is best

Consider placing a cheap ADC or Schmitt Trigger along with each sensor to get quick, accurate results back to the main board quickly.

Alternately, use a (Optical - Photo Detectors - Logic Output) as a simple and possibly cheaper solution.

The following math isn't 100% accurate, because I'm calculating it for the center of the tube, but it's near enough not to matter:

My magnet will be 1 inch in diameter, and 1 inch in length. 1 inch is equal to 25.4 mm

With a ring radius of 500 mm, a central angle of 2.91 degrees gives an arc length of 25.4 mm. Expanding with some basic trig, the segment height - essentially the additional tolerance needed in the tube radius to allow the magnet to pass smoothly - is 0.16 mm. For the sake of simplicity, and to provide just a bit of additional tolerance in case of manufacturing imperfections, I'll use an inner diameter of 27.4 mm, well beyond what should be required if everything were ideal. We'll use a wall thickness of 5 mm.

# 2012/12/16

The past couple months have been pretty busy, so while I haven’t made many updates here, I’ve been working furiously on this and other projects. I’ll attempt to catch up here.

In order to reduce costs, I’ve made a design decision to reduce the diameter from 1 meter to 50cm. This also means that the projectile will now be half the original size (~12.7mm), and so the inner tube will also be smaller (~15mm)

I’m going to post the initial Sketchup model for the first coil section prototype and push to GitHub. Then I’ll continue updates here.

I printed the uploaded model on a 3D Touch 3D printer, using natural PLA plastic. I then used 22 AWG wire and coiled 3 layers of wire. I secured it in place with some enamel and tape, and performed some very basic tests between 10 and 24 volts.

The circumference of the entire circle (from the center of the tube) is 1570.79 mm. We’ll round to 1570 mm. I decided 24 segments of 15 degrees each makes more sense. 157/24 = ~65.42 mm. For simplicity we’ll approximate to 65.5 mm. This makes the final circumference (from tube center) 1572 mm, which is ~1.2 mm off from the ideal. This will work just fine.

The length of the segment will be as follows:

End 6 mm

Spacer 4 mm

Coil 25.5 mm

Sensor/Gap 20 mm

Spacer 4 mm

End 6 mm

# 2013/01/01

Uploaded the progress from the past week. I created a new prototype 15-degree segment, including the bend. I’m quickly improving in my abilities to effectively use Sketchup, and am implementing better processes as I learn.

The most recent prototype didn’t print out as nicely as the previous one, and some changes are still required, including larger holes in the bottom.

Here are the latest notes and measurements for the segments:

24 segments of 15 degrees each

65.5 mm Length (through center tube)

1572 mm Total Length (through center hole)

Lengthwise Measurements:

End 07.50 mm

Spacing 03.00 mm

Ring 03.00 mm

Coil 26.50 mm

Ring 03.00 mm

Sensor/Gap 15.00 mm

End 07.50 mm

Other Measurements:

Inner Tube Radius 07.50 mm

Outer Tube Radius 10.00 mm

Ring Radius 14.50 mm

End Inradius 15.00 mm

End Top Bevel 10.00 mm

Bottom Screws XX.XX mm (Actual thread size for 8-32 screw)

End Screws 02.00 mm

End Apothem 30.00 mm

Arc Height 02.14 mm

I still need to determine a number of things to proceed:

* What size screws to use on to hold the ends together, and to secure them to a base?
* How to secure the sensors (and related boards) to the segments?
* Should the tube thickness be increased further in order to facilitate better sensor placement?
* Should I use two curves in Sketchup, rather than a circle, when creating the inner tube? This might prevent the stretching I’ve seen in the latest prototype.

# 2013/01/05

In building the next version of the segment prototypes, for the inner radius I used 2 curves with a radius of 7.5 mm and a width of 7.25 mm, creating a pseudo-ellipse 15 mm by 14.5 mm. This is because when we eventually curve the tube, it will widen as part of the transform. If we used a 15 mm circle instead of two thinner curves, we end up with a tube that's more than 15 mm wide. I then did the same with the outer radius of the tube.

For the screws holding the segments to the base, I’ll use 8-32 screws, ¾” long. The base material will be ½” (approx. 12.7 mm) thick, and the screw heads are 4 mm, so I’ll counter-sink 4 mm into the base material. This means approximately 8.7 mm of threaded screw length will be going into the bottom of the segments. I’ll round up to 10mm. I’m using an 8-32 screw model, provided by Google, to create the holes using the solid modeling tools.

I will be using X-XX screws ½” (12.7 mm) to hold the segments together. Because this screw is so small in diameter compared to the thickness of the part, I will simply make simple 2 mm holes.

The screw holes must be added **after** the 3D part has been bent, so that the screw holes are not deformed.

For the sensors, I have decided to use infrared emitting LEDs and infrared phototransistors. The plan is to use 3 parallel-to-serial shift registers (74HC165) to clock the status of all 24 segment sensors into the microcontroller so that we’ll be able to see the status of all 24 sensors at a given instant.

On the Phototransistor Board, we’re using a common-emitter configuration, since we’re most concerned with voltage (as the input to the Schmitt trigger), and not current. The Collector-Emitter Saturation Voltage is 0.4 V. Max current for the device is 20 mA.

Collector Resistor: (VCC – ½VCC) / I

(5 – 2.5) / 0.005 = 500 Ohms

Emitter Resistor: VE / I

1V / 0.005 = 200 Ohms

# 2013/02/04

I have made a huge amount of progress over the past couple weeks, and haven’t done very well on documenting. I’ll attempt to go back over some of the changes.

The first three prototypes were designed in Sketchup. While I had a lot of success using this method, I had four distinct concerns:

* While the program is easy to use, it is not open source, and STL exports require either the Pro version or potentially buggy plug-ins.
* I had to design each prototype from scratch. While it became easier as I repeated steps with each prototype, I couldn’t just go back and make a simple change.
* Sketchup is not designed for making precision parts. It was primarily created as a method of roughing out architecture, and while it has improved significantly, it’s not the best tool for the job I’m working on.
* The tool I was using to bend the segments distorted the inner and outer tubes, requiring me to use curves to arrive at a final product that would be approximately round.

For the next prototypes, I used OpenSCAD. While somewhat of a memory hog, OpenSCAD allows me to make very precise parts. And because parts are designed programmatically, I can make changes anywhere on the part at any time.

In prototype 3 I accidentally countersunk holes in the wrong side of the ends. I have corrected this in prototype 4.

Prototype 5 includes a flat top to the segment, which allows for the installation of a printed circuit board. This board will perform the following functions:

* Turn sensors on or off, depending on instructions from the master control board
* Process and return sensor data to master control board
* Turn the coil on and off in either direction
* Sense coil temperature, turning on a fan when any coil is too hot

Clearly these boards will need to have good isolation of different voltages and current paths.

One of the main points of this project is to be able to test various control algorithms using various architecture. To that end, the inputs and outputs will be well documented so that any processor (Microcontroller, ARM, FPGA, PC, etc) can potentially be used as the master controller.