FurrBot Final Specs 081313 MG

Robots fascinate me – I've always wanted to build one – and stuffed animals hold a special place in my heart. Somewhat simultaneously, I began learning electronics so I could create a robot someday, while knitting and crocheting amigurumi animals just because they're small and cute. The knitting was coming along nicely; however, I couldn't figure out what type of robot I wanted to create, and hence this project languished.

When I began crocheting a stuffed robot recently based on Nelly Pailloux's book Crobots it occurred to me, *Why stop at having a stuffed robot that just looks cute?* And a light went off in my head.

And here's my response – FurrBot, my first combination robot/stuffed animal, and the first of the HackmanBot family. I finally came up with a robot design that spoke to me, while giving me the opportunity to prove to myself I build a simple circuit.

What is FurrBot?

FurrBot is a robot. He is designed in a single series circuit, powered by a 9-volt battery. When you "pet" FurrBot's back, his LED eyes light up and he "purrs," while vibrating softly to let you know he's awake (thanks to a 3-V motor with a bit of plastic taped to it).

I installed an external On/Off switch to make FurrBot operational and avoid running down the battery, but I also made him interactive by building and incorporating a fur sensor kit designed by Hannah Perner-Wilson that allows the circuit to become complete only when the conductive thread in his fur makes contact. I skipped the resistor – the fur should provide resistance enough. This also means how FurrBot reacts depends on your fur-stroking abilities.

Siblings are on their way!

3D battery holder printed by Justin; motor cover by Dave, using the 5% rule to tweak the size.

Parts

1. Eyes: 2 ~1.8V LEDs + plastic covers from printer tear down
2. Body: Lion Brand Cotton
3. Fur Sensor Kit – designed by Hannah Perner-Wilson :
   - Pattern + instructions: Nelly Pailloux's book Crobots
   - Neoprene
   - Conductive fabric
   - Conductive thread
4. On/off switch
5. DC motor 3V + piece of plastic to put off balance (=make noise)
6. 9V battery
7. Battery/motor holder (3D printed), two screws to attach

Tools

1. Electrical tape
2. Body:
    - Crochet hook
    - Pattern/instructions
3. Fur Sensor Kit:
    - Sewing needle
    - Regular thread
    - Pencil
    - Iron
4. Needle-nose plier
5. Scissors
6. Multimeter
7. Bench power supply.

Preparing LEDs

Facing you with anode to right, twist into a round spiral
twist cathode into a square spiral

Crochet Instructions

ch = chain, st = stitch, sc = single crochet, sc dec = single crochet decrease (dec over 2 sts), blo = back loops only, * = repeat instructions between asterisks, sl st = slip stitch.

Magic Ring:

1. http://www.planetjune.com/blog/tutorials/magic-ring-right-handed/ by PlanetJune June Gilbank [looks pretty good b/c it says first chain doesn't count as a stitch; text/photos, no video]

A magic ring is a way to begin crocheting in the round by crocheting over an adjustable loop and then pulling the loop tight. The advantage of the magic ring method (below, right) is that, unlike the regular "chain 2, x single crochet in 2nd chain from hook" method (below, left), there is no hole left in the middle of your starting round.

Please note: in the following photos, the starting yarn tail is always on the left and hanging down. The working yarn begins on the right and is then picked up over my left forefinger in Step 2.

1. Make a loop a few inches from the end of your yarn. Grasp the join of the loop (where the 2 strands of yarn overlap) between your left thumb and forefinger:


2. Insert hook into the loop from front to back. Draw up a loop.
3. Ch 1. Note: this does NOT count as a stitch:


4. Grab the yarn tail and pull to draw the centre of the ring tightly closed.
5. Begin your second round by crocheting into the first stitch of the first round (below, left). At the end of round 2 your work will look like this (below, right).

2. http://www.instructables.com/id/Crochet-Magic-Ring-Adjustable-Ring/ by canucksgirl [also good]

The Magic Ring (or Adjustable Ring) is used when crocheting in rounds, and should be used for Amigurumi projects. The advantages of using the Magic Ring, is that once tightened, it leaves no hole in the center of your work. It replaces the step of *"Ch 2 and single crochet x in the 2nd chain from the hook",* which is the first step in many crochet projects. If you refer to the main photo, you will see the old method in green, and the Magic Ring in blue. (Notice there's no hole in the middle of the Magic Ring).

Body: adapted from Crobots by Nelly Pailloux
Round 1 Start 6 sc in a magic ring (6)
Round 2 2 sc in each sc around (12)
Round 3 *2 sc in next sc, sc in next sc*repeat 6 times (18)
Round 4 sc in each sc around (18)
Round 5 *2 sc in next sc, sc in next 2 sc*repeat 6 times (24)
Round 6 *2 sc in next sc, sc in next 5 sc*repeat 4 times (28)
Round 7-10 sc in each sc around (28)
Round 11 *2 sc in next sc, sc in next 13 sc*repeat twice(30)
Round 12-13 sc in each sc around (30)
Round 14 *sc dec, sc in next 13 sc* repeat twice (28)
Round 15-16 sc in each sc around (28)
Round 17 *sc dec, sc in next 5 sc*repeat 4 times (24)
Finish with sl st

Base:
Round 1 Start 6 sc in a magic ring (6)
Round 2 2 sc in each sc around (12)
Round 3 *2 sc in next sc, sc in next sc* repeat 6 times (18)
Round 4 *2 sc in next sc, sc in next 2 sc*repeat 6 times (24)
Round 5 *2 sc in next sc, sc in next 3 sc*repeat 6 times (30)
Round 6 in blo sc in each sc around (30)
Round 7 sc in each sc around (30) (to add height)
Round 8 *sc dec, sc in next 3 sc*repeat 6 times (24)
Round 9 sc in each sc around (24)
Finish with sl st

Fur Sensor Kit Instructions: Hannah Perner-Wilson

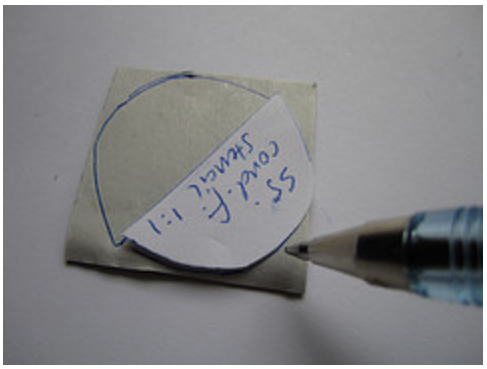
BUILD

Sewing with conductive thread is “challenging”; kinks up and snag, Best to work with shorter lengths.

PARTS: neoprene, conductive thread, conductive fabric

TRACE AND CUT OUT THE STENCILS

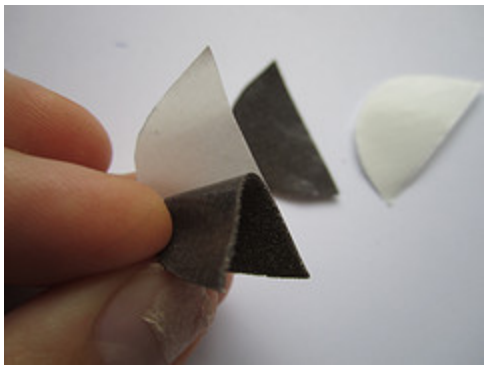
1. Cut or trace the stencils from the other side of this instruction sheet and transfer them to the apropriate materials.
2. Cut out the shapes from the materials and peel away the paper backing from the conductive fabric.



Cut out materials

FUSE CONDUCTIVE FABRIC

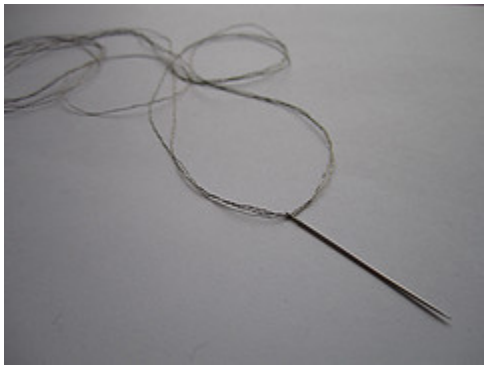
1. Place the conductive fabric pieces with the glue side (shiny side) facing the neoprene.
2. Set your iron to a medium heat (too hot will burn the fabric) and iron over the conductive fabric to melt the glue and fuse the fabrics together.




Peel off paper backing from conductive fabric and fuse to neoprene with a medium hot iron

STITCH CONDUCTIVE THREAD

1. Thread the needle with conductive thread, feel free to take the thread double or quadruple.
2. Stitch into the neoprene from the top side (the side without conductive fabric), but don't pull the thread all the way through.




Thread needle with conductive thread and stitch into neoprene

Stitch into neoprene and trim with scissors

STITCH CONDUCTIVE FUR

After stitching, cut the thread at desired fur length, roughly 2 cm. Repeat 5 or 6 times. Each time the conductive thread should penetrate all the way through the neoprene and make contact with the conductive fabric fused to the reverse side.

Stitch both sides

STITCH MORE CONDUCTIVE FUR

1. Continue stitching conductive fur to both patches of conductive fabric and then add two or three stitches of fur to the center.
2. When you stroke over the fur, from one side to the other, the conductive threads from one side should touch the center ones, and these in turn should touch those on the other end.

Add some hairs to the middle

When you stroke across the sensor, hairs from one side should touch those in the middle and these should touch the hairs on the other side

ADD SOME NONCONDUCTIVE FUR

1. Thread your needle as before, but this time with a non-conductive thread of similar weight. Any colour you like.
2. Proceed to stitch fur until the sensor is dense and the conductive fur contacts are isolated from one another, yet make contact when stroked.


Switch to a non-conductive thread and fill up the rest of the space with non-conductive hairs


Top and bottom

TEST FINISHED SENSOR

Connect the ends of your sensor to a multimeter set to measure continuity.

As you stroke across the sensor the resistance should sink to near zero Ohm. Flickering is normal. When the sensor is not being stroked the multimeter should measure no connection. Ruffling of fur may be necessary at times.

FurrBot Assembly:

Current flows from hi to lo (anode to cathode; + to -)

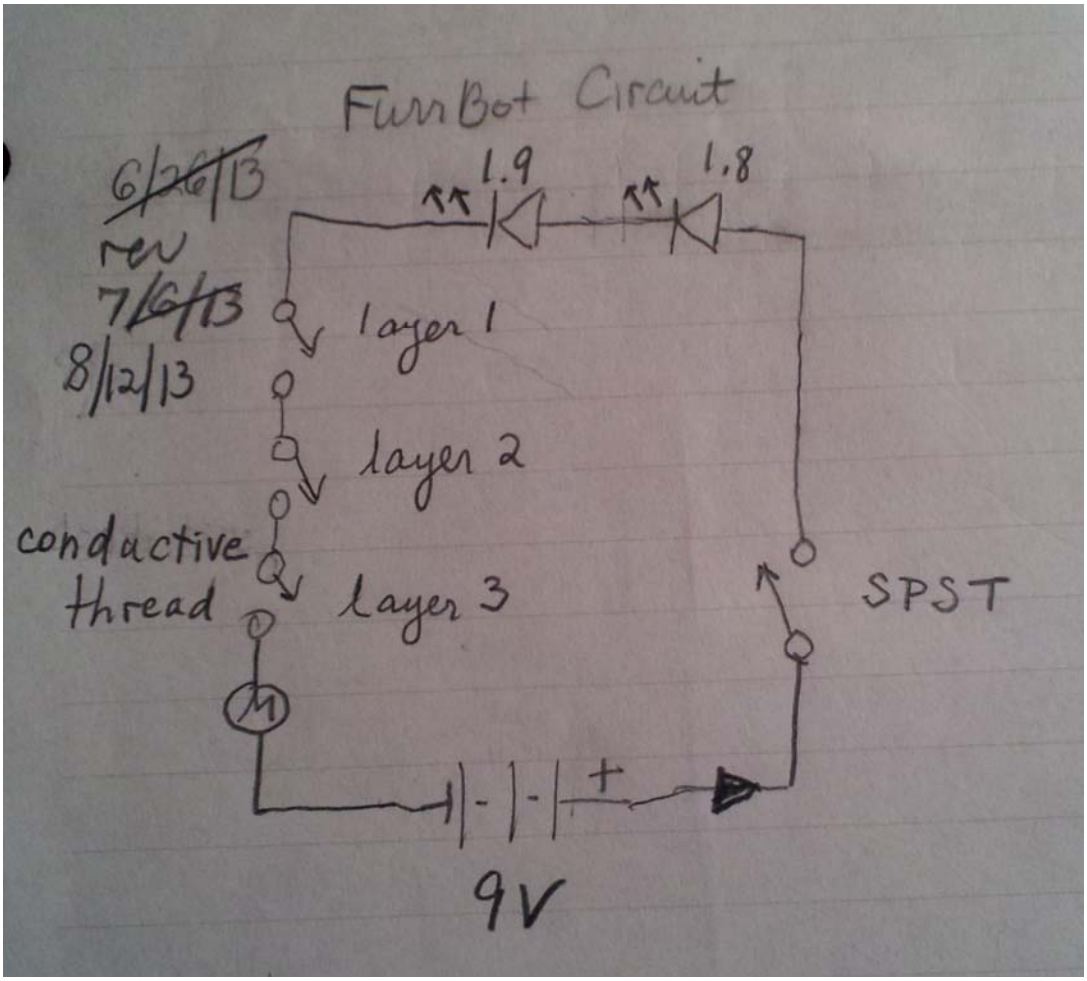
[FYI, electrons flow in opposite direction, toward positrons]

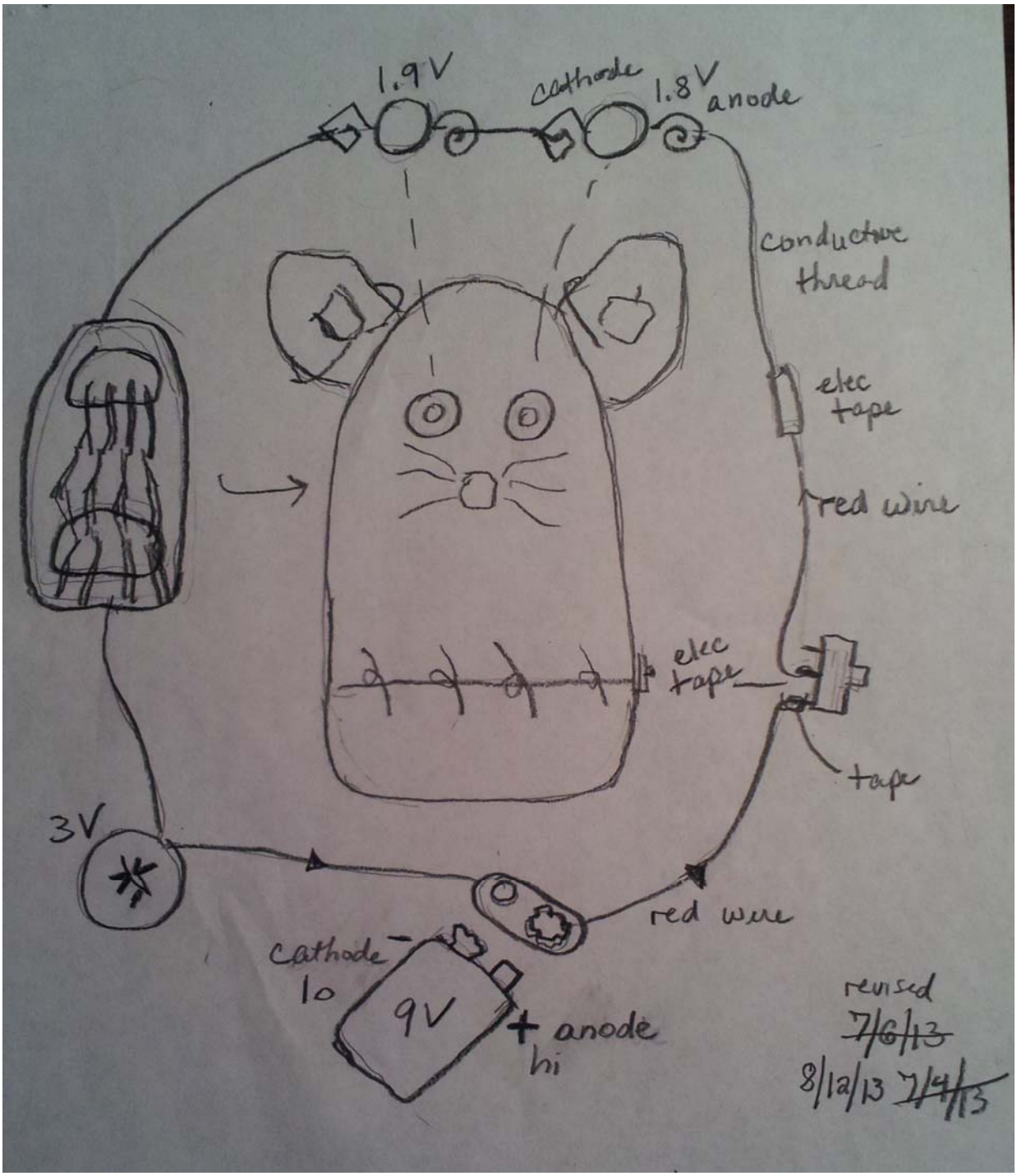
Tape = electrical tape

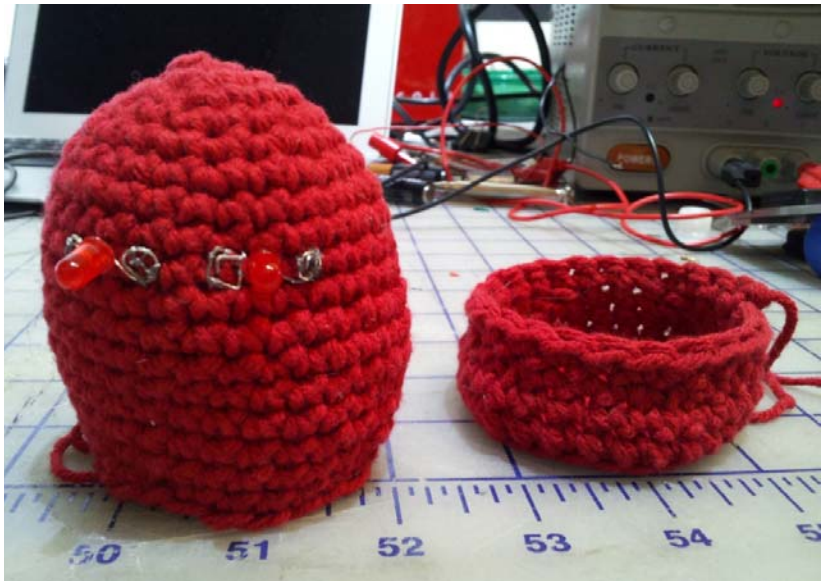
1. Battery hi end (+, anode) soldered to red wire.
2. Wire taped to a single end contact of switch (either is ok).
3. Middle contact of switch taped to new red wire.
4. Red wire taped to conductive thread.
5. Conductive thread stitched along inside of FB, then sewn to right side of left eye (right in picture) anode (long connector, rounded plastic, +) of LED. Cut thread – doesn't make contact with cathode.
6. With new conductive thread, left side of this eye's LED cathode (shorter connector, flat plastic usually, -) sewn to inside FB; don't cut thread.
7. This conductive thread is run inside FB, then sewn to right eye (left in picture) anode of next LED. Cut thread.
8. With new conductive thread, left side of this eye's LED cathode sewn to inside FB; don't cut thread.
9. Conductive thread run along FB wall to fur sensor, then sewn to top panel of conductive fabric panel (previously ironed to neoprene). Fur sensor sits outside FB; stitches kept hidden. Cut thread.
10. Bottom conductive fabric panel of fur sensor (previously ironed to neoprene) taped to new conductive thread.
11. Conductive thread taped to red motor wire.
12. Black motor wire taped to black battery wire.
13. Black battery wire soldered to lo end (-, cathode)

Tests during assembly:

1. That each 1.5V LED worked w/3V battery (carefully – don't burn out); could have also used bench power supply for all tests)
2. Voltage of the motor w/power supply
3. Fur sensor connection w/multimeter to measure continuity (resistance ~0 Ohms
4. Each connection
    - Battery/switch
    - LEDs attached
    - Fur sensor attached
    - Motor attached
5. What I sort of did, but not really – focus on next time
    - Multimeter
    - Resistance
    - Amp, Ohm, Current


FurrBot Circuit
6/26/13
rev
7/6/13
8/12/13
1.9
1.8
layer 1
layer 2
conductive thread
layer 3
SPST
M
+
9V


1.9V
cathode
1.8V
anode
conductive thread
elec tape
red wire
elec tape
tape
3V
red wire
cathode
lo
9V
+ anode
hi
revised
7/6/13
8/12/13
7/4/13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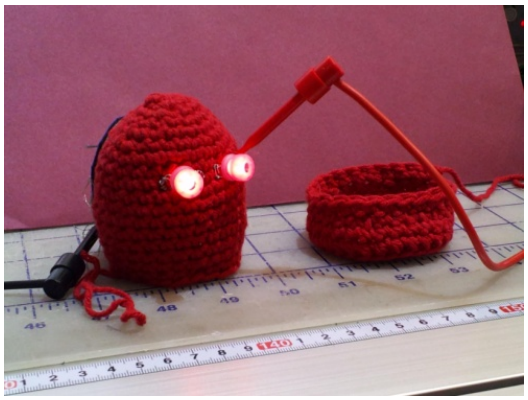
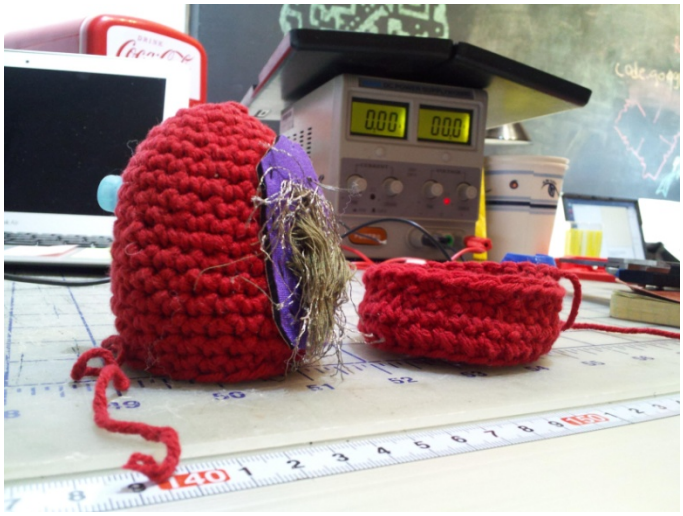
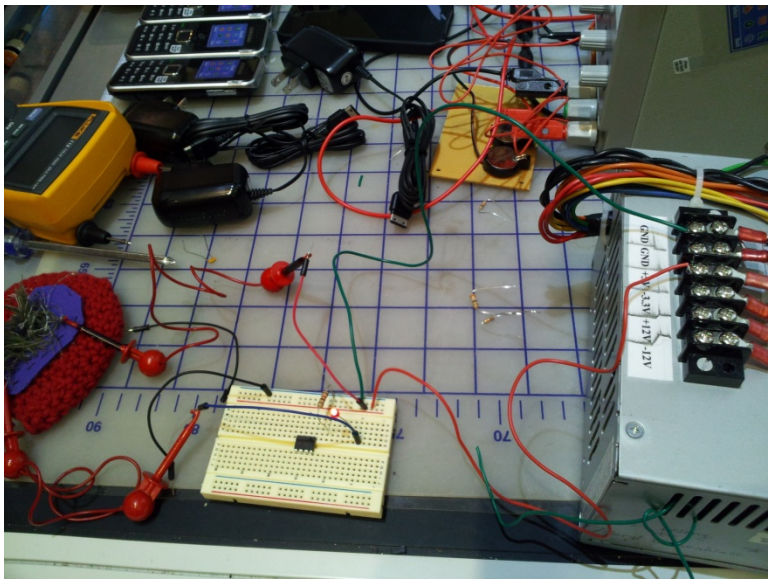
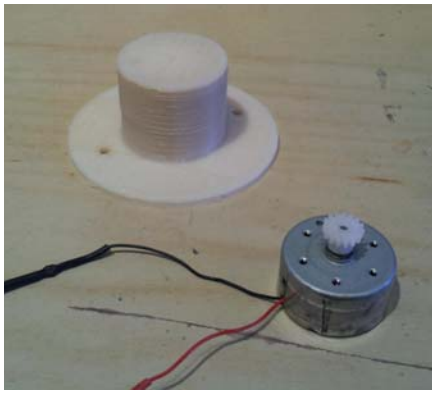
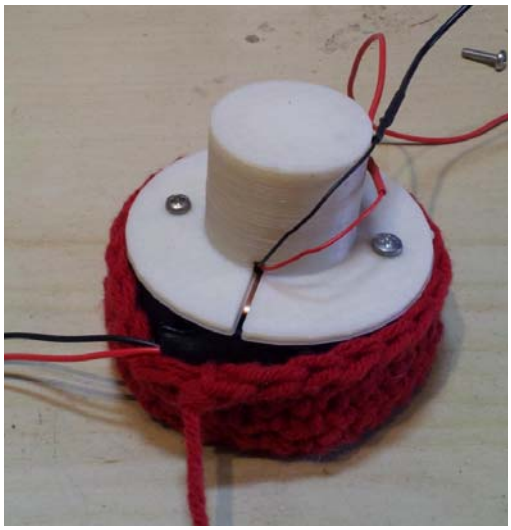


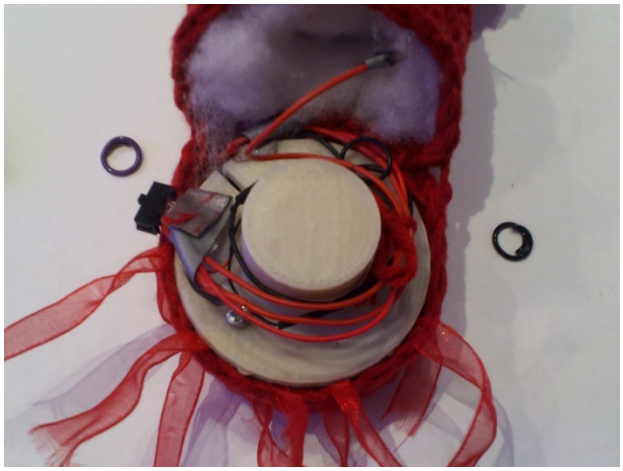




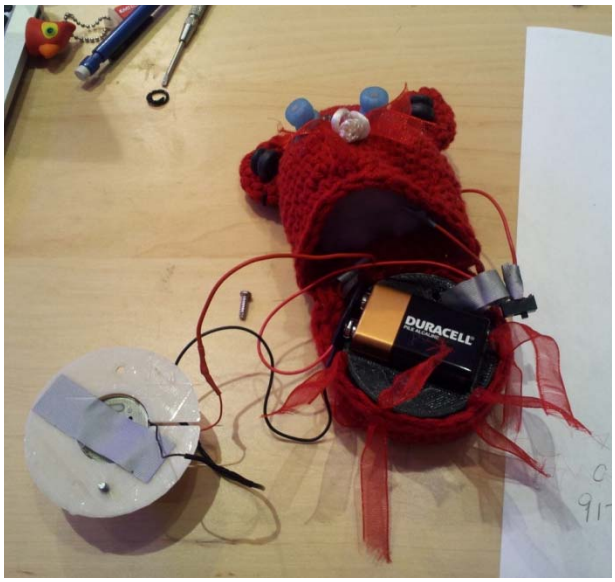

Energizer
9V








RadioShack


DURACELL