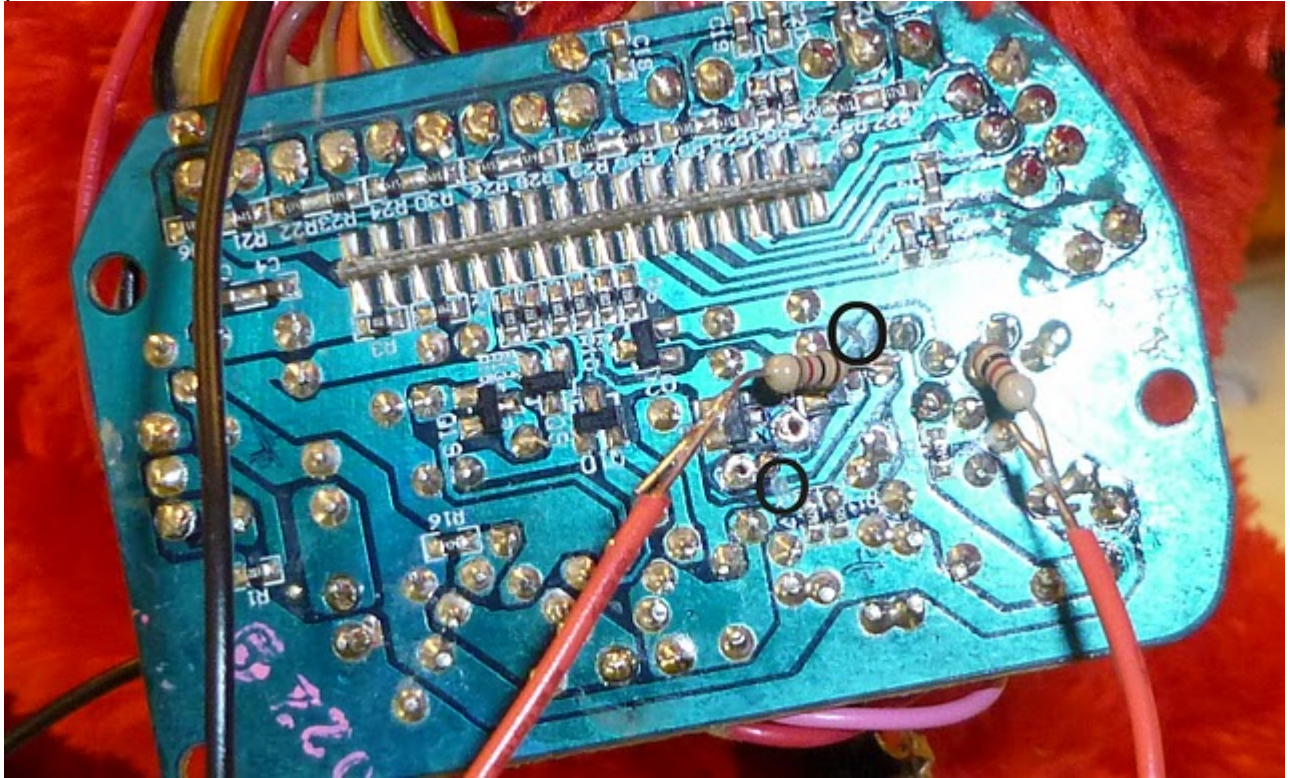




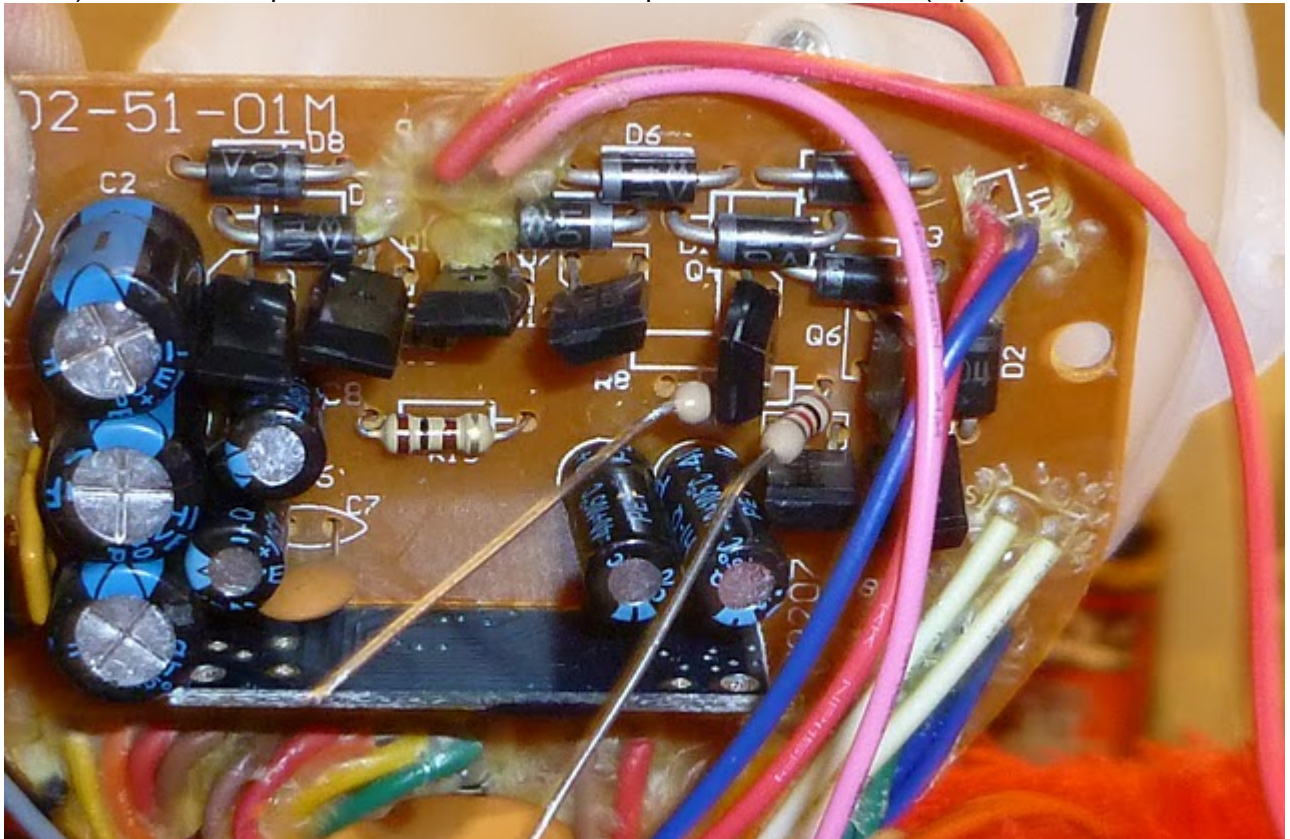
1. Record audio from stock toy onto computer or directly onto Sound Recorder Twig. I recorder to a PC, then modified using Audacity to add words. There are two messages used; "Would you like some tea from Elmo" and "Your tea is done".
2. Unstitch back of elmo's skin from waist to base of head.
3. Cut zip tie around neck.
4. Remove screws in back of plastic body and remove. 8 screws.
5. Locate ribbon cable (5 conductor) that runs from control board to switch disc in shoulder. Cut cable near control board. The switches will be used to control arm motion.
6. Test switches to determine function. Black wire is common, red is horizontal, yellow up past vertical (behind head), orange is up in front of head and brown is down.
7. The motors are controlled with a type of H-Bridge circuit. This circuit uses four transistors, two each NPN & PNP. I removed resistors on tan side of board and replaced with 1k resistors connected together then routed to an Arduino output for ground side of bridge, if connected to ground directly the transistors heat from continuous current flow. For positive side, it was necessary to cut traces and apply voltage to transistor base through a 1k resistor.
8. Unscrew control board. Remove resistors R8 and R9.



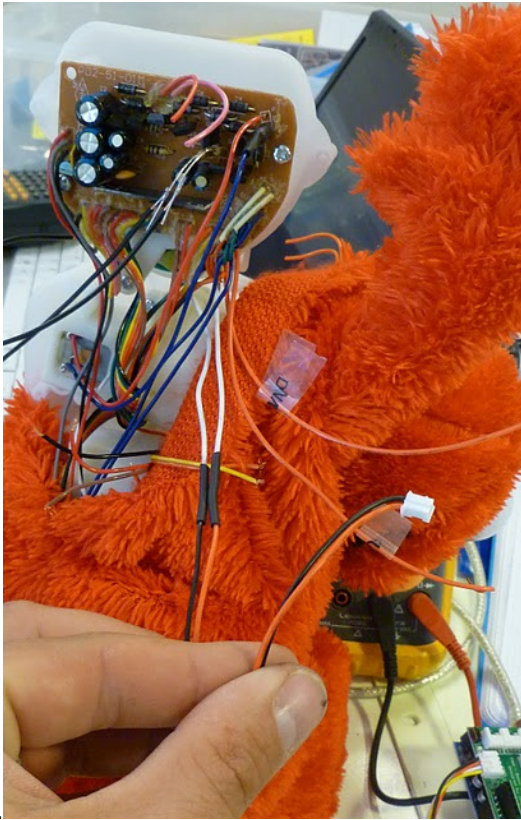
9. Cut traces as shown in this picture:



10. Solder 1K resistors to four points, two on back and two on front. These are connected as discussed in step 7. Use heat shrink tubing or tape to cover joints between wire and resistor to prevent shorting to other nodes. Hot glue wires to board once connected and test for strain relief (mine broke off many times). Picture in step 9 shows two resistors, this picture shows others (replacements for R8 and R9)



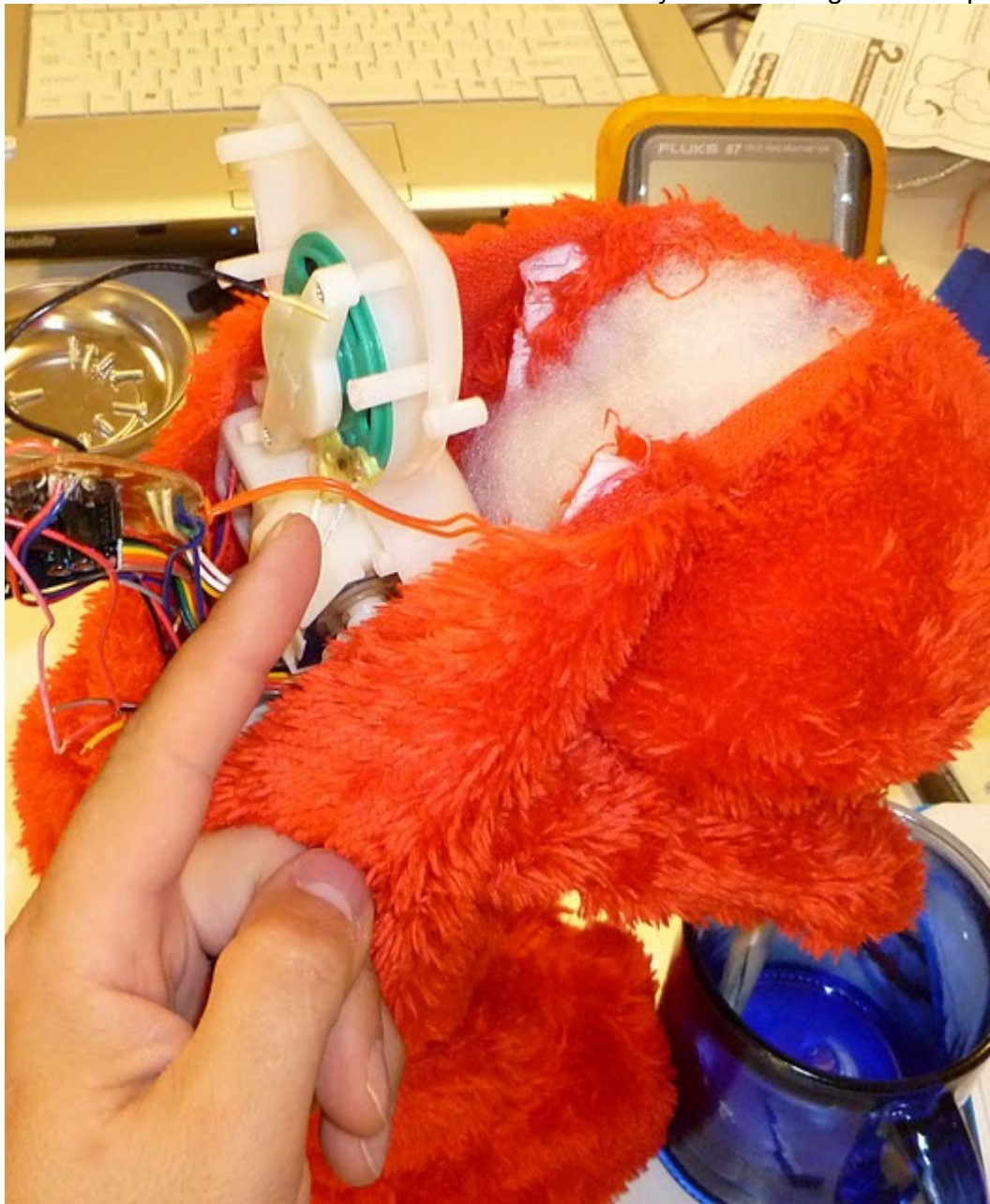
11. Cut speaker wires close to control board. solder Twig speaker wire to Elmo speaker



wire.

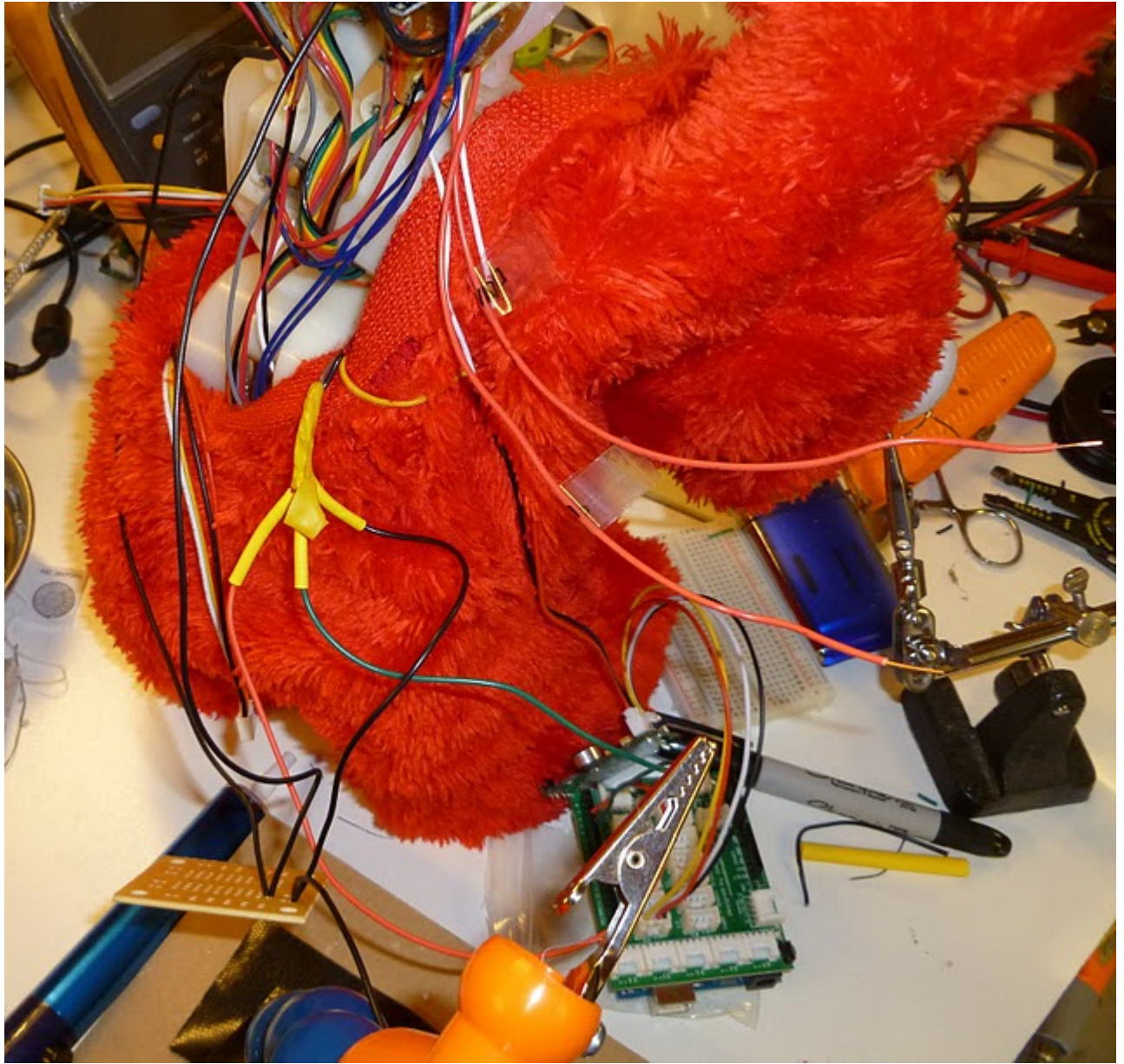


12. Cut wires from chin switch close to control board. They are the orange wires in photo.



13.

14. Extend wires with 16-20cm pieces of hookup wire. Add a piece of perf board or similar for ground connections.



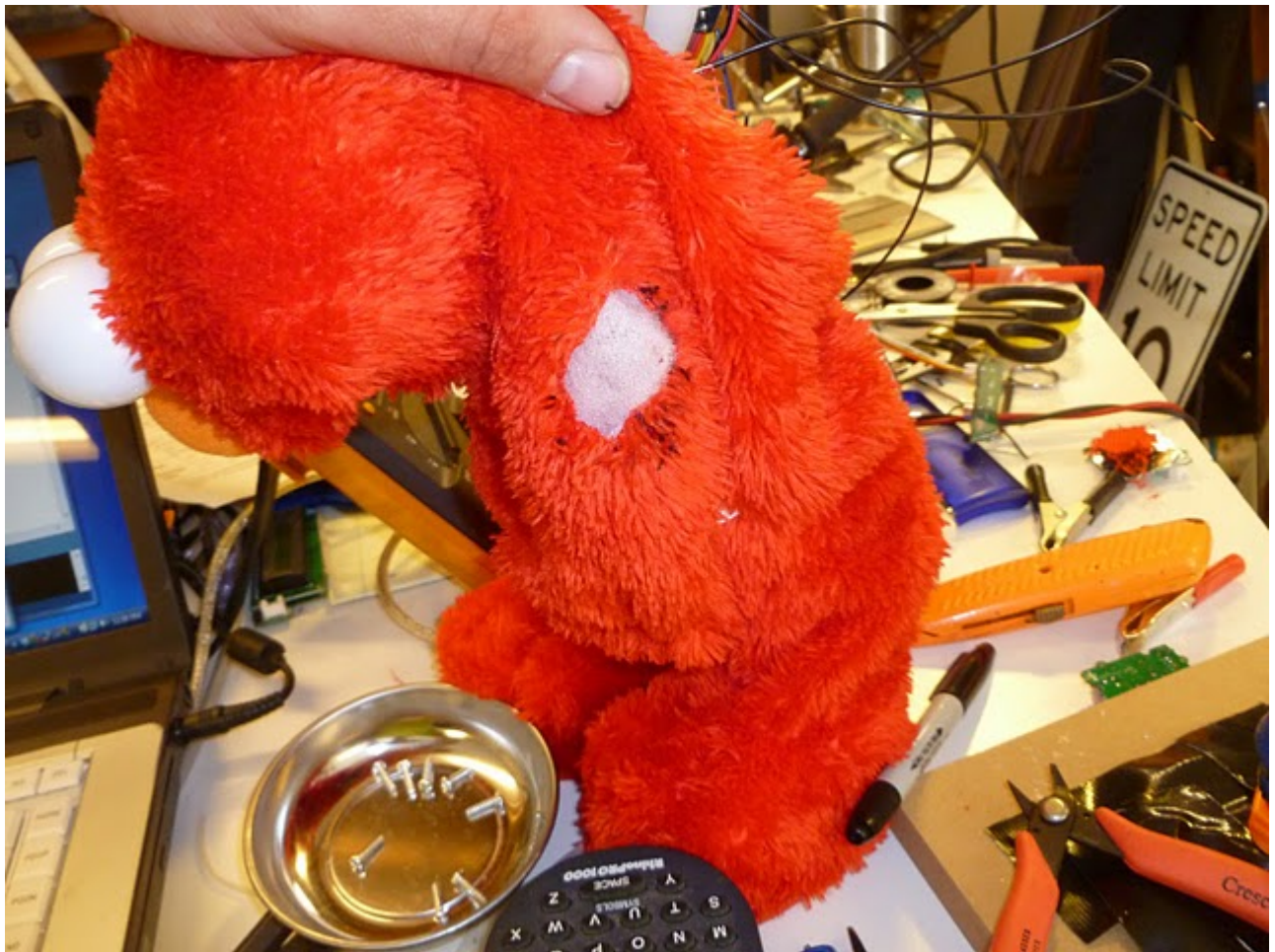
15. Plan pin/port usage. See table

Stem Port	Pin(s)	Device	
2	2	PIR Sensor Twig	
6	6,7	Sound Recorder Twig	
10	10	Buzzer Twig	
I2C		OLED	
NA	3	Lip Switch	
NA	4	Up Switch	
NA	5	Down Switch	
NA	8	Motor Up	
NA	9	Motor Down	
NA	11	Motor Ground	

16. Install PIR sensor. The sensor can be located in many locations, I chose near the left ankle to make it somewhat hidden and out of the way. To install make a small hole in the fabric for the sensor to show through, about 1cm. Plug a cable into sensor Twig and then position Twig from inside of fabric so that the sensor is exposed. If necessary, glue in place.

17. Install OLED. The OLED Twig is positioned on the left arm like a tattoo (by the way, look for the SEEED programmable tattoo kit in the near future). Cut a small hole in the fabric



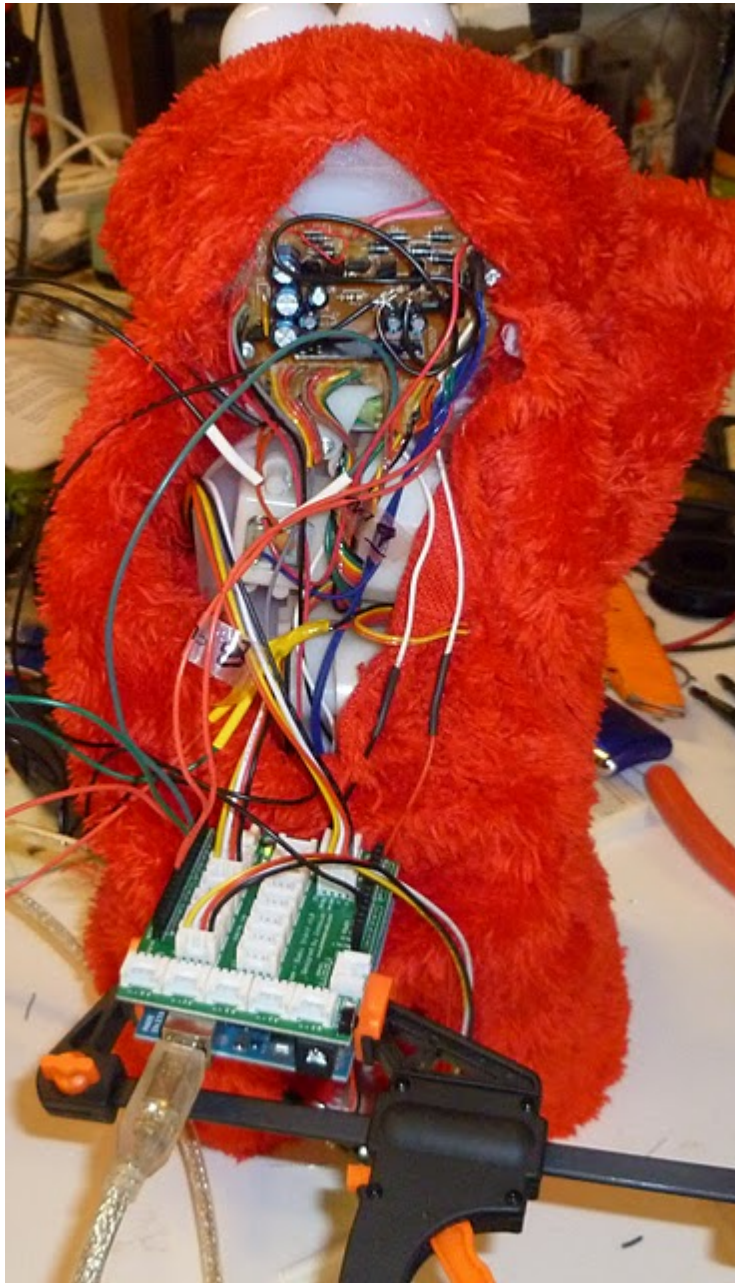


the same size as OLED screen. The Twig needs to be installed in correct orientation for viewing. Connect to I2C port with cable. Add small amount of hot glue once Twig is tested.



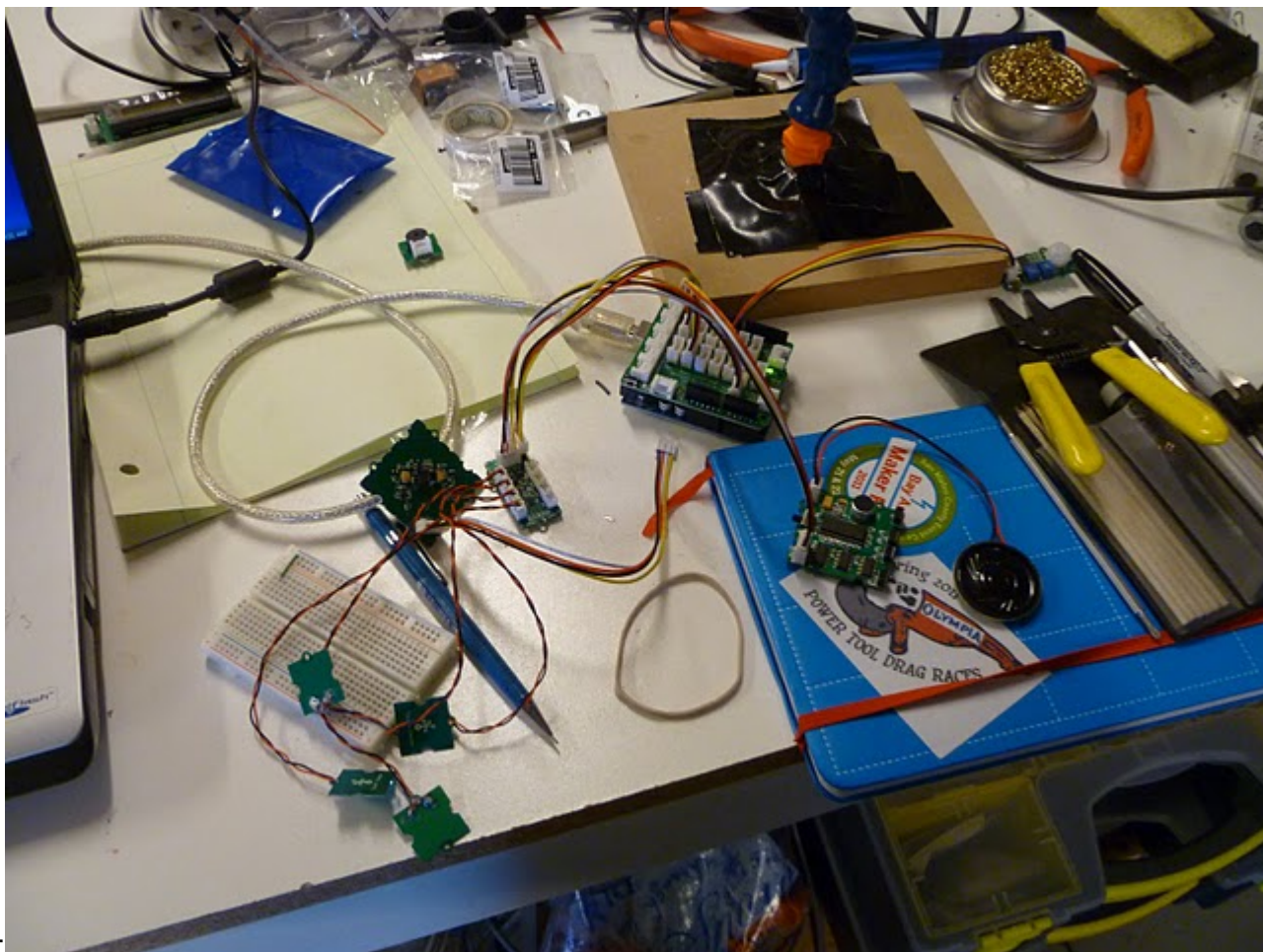


18. Everything is now connected and ready to test.



Much of my testing led to connections and methods above, so this should be easier. I put the Twigs and Stem together before assembly as a





test:



19. Function of code. The basics are this:
  - a. when PIR senses motion, have Elmo talk and display message
  - b. when lip switch is pressed lower arm with teabag, hold for specified time, then raise arm and notify user with tones through Buzzer Twig, audio message and message on OLED
20. Most of the code is derived from Seeed examples. One main issue, delay and millis don't work when an interrupt is "active". This is why the interrupt is used to change a "flag" variable and that is looked at by an if statement. My preference was to have the interrupt go directly to the dipbag function.
21. Tickle Tea Elmo in action: [http://www.youtube.com/watch?v=8JOLHb7\\_zo](http://www.youtube.com/watch?v=8JOLHb7_zo)