SOUNDING TEXTILES

This booklet belongs to: ______________________________

Sounding Textiles

April 6-8th 2015

This workshop is hosted by STEIM and lead by Afroditi Psarra, and Mika Satomi and Hannah Perner-Wilson of Kobakant

Textiles are generally considered to be soundless. They don't make much noise when we wear them, scrunch them up or sit on them. What if textiles themselves created and emitted electronic sound, what soundscapes would we compose for them?

How would our experience of textiles be different, if taking off your t-shirt sounded like walking through autumn leaves, if spanning your bed-sheet played back recordings from a previous night, if your leather shoes composed melodies that became softer as the leather became worn… ?

In three days of workshop we would like to thoroughly explore the possibilities of creating and playing sound with textiles. In order to do so the workshop is structured into two topics that can and should cross paths:

1) Synthesizing Sound from Textiles

2) Playing Sound through Textiles

During the workshop we encourage you to explore, experiment and discover. To iterate through prototypes before refining a final design. To practice and build your skill-set for working with Electronic Textiles (E-Textiles). To crate, compose and manipulate sounds from and through textiles.

Enjoy!

STEIM

STEIM (the STudio for Electro-Instrumental Music) is an independent electronic music center unique in its dedication to live performance. The foundation's artistic and technical departments support an international community of performers, musicians, and visual artists, to develop unique instruments for their work.

>> *steim.org*

KOBAKANT

Mika Satomi and Hannah Perner-Wilson have been collaborating since 2006, and in 2008 formed the collective KOBAKANT. Together, through their work, they explore the use of textile crafts and electronics as a medium for commenting on technological aspects of today's "high-tech" society. KOBAKANT believes in the spirit of humoring technology, often presenting their work as a twisted criticism of the stereotypes surrounding textile craftsmanship and electrical engineering. KOBAKANT believes that technology exists to be hacked, handmade and modified by everyone to better fit our personal needs and desires.
In 2009, as research fellows at the Distance Lab in Scotland, KOBAKANT published an online database for sharing their DIY wearable technology approach titled HOW TO GET WHAT YOU WANT.

>> *kobakant.at*
>> *howtogetwhatyouwant.at*

Afroditi Psarra

Afroditi Psarra, is a multidisciplinary artist working with e-textiles, diy electronics and sound. Her artistic interest focuses on concepts such as the body as an interface, contemporary handicrafts and folk tradition, pop iconography, retrofuturistic aesthetics and the role of women in contemporary culture. Her artworks include a wide variety of media and techniques that extend from embroidery, soft circuits, hacking and creative coding, to interactive installations and sound performances. She holds a PhD in Image, Technology and Design from the Complutense University of Madrid. Her academic researchCyberpunk and New Media Art focuses on the merge of science fiction ideas and concepts with performative and digital practices, and offers a philosophical, sociological and aesthetic analysis of the influence of new technologies in the contemporary artistic process.

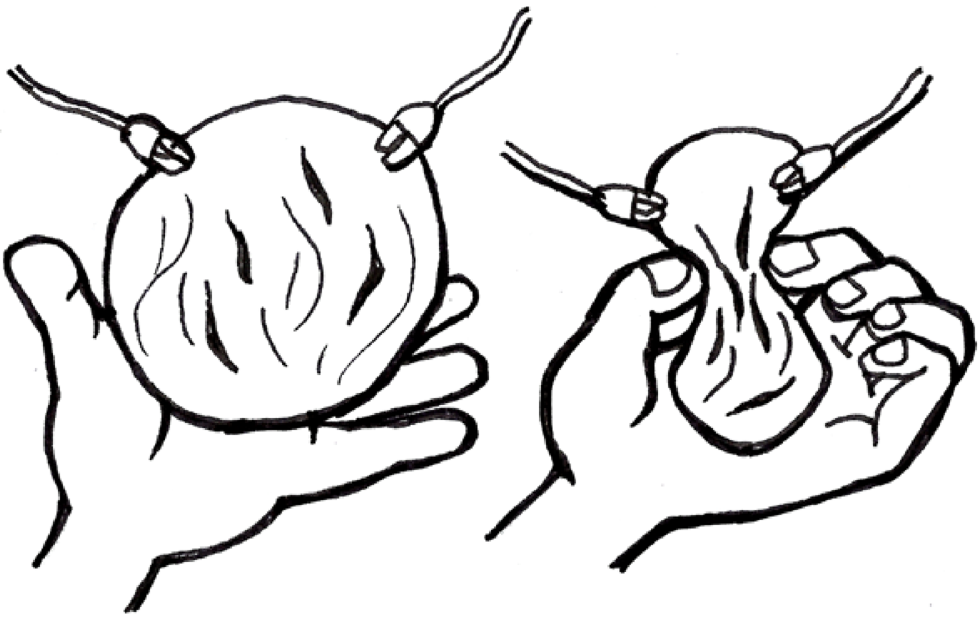
>> *afroditipsarra.com*

Contents

1

Synthesizing Sound from Textiles

Sewing/knitting/knotting/crocheting conductive fabrics, threads and yarns into different forms and textures, connecting them as variable resistors to circuits that synthesize sound.



MEET THE MATERIALS

Karl-Grimm Copper and Silver Thread
Conductive and solderable threads made from thin copper and silver plated copper filaments spun together with strong synthetic core. By Karl-Grimm.

Silverized Nylon Thread
Silver Plated Nylon 117/17 2ply. Resistance: < 2kOhm per meter. By Statex.

Linnen Conductive Thread
60/2 NeL = 36/2Nm = 20/2 Nec. By Bart & Francis.

Stainless Steel and Polyester Yarn Nm10/3
80% Polyester ecru; 20% Stainless Steel 12 micron. Conductive yarn spun from a stainless steel polyester fiber blend. Surface resistance of <104Ω. From Plug and Wear.

Bekinox W12/18 Conductive Wool
20% stainless steel, 80% wool. By Bekaert.

Resistive Thread
65% Silk-35% Stainless steel. Very strong and smooth. Perfect for textile potentiometers and resistors. Yarn Count: 25 Tex. Resistance 800 Ohm/m. From Plug and Wear.

Resistive Tape
Small metal tape with a resistance of 3.2 kohm per linear meter/yard. It can be used as a resistor or to generate heat. Very flexible. Material: 100% AISI 316L stainless steel. From Plug and Wear

EX-STATIC CONDUCTIVE FABRIC
87% polyester, 13% gray BASF Resistat (carbon) fibers woven right into the fabric in a diamond pattern providing surface resistivity of 105 Ohms per square. From LessEMF

Knitted Conductive Fabric

Soft conductive fabric made of polyester and stainless steel wire (80 micron). Material: polyester and stainless steel. Resistance: 1000 Ohm per square longitudinally, 2.2 Ohm per square transverse. By Plug and Wear.

Knited Stainless Steel Fabric

Fabric made of stainless steel wire (80 micron). By Plug and Wear.

Med-tex P180 Silver Plated Stretch Fabric

Silver plated knitted fabric. Antibacterial fabric. Raw material: 94% Polyamide + 6% Dorlastan, Plating: 99% pure Silver. By Statex.

Kassel Silver/Copper Conductive Fabric

Corrosion proof copper-silver plated polyamide ripstop fabric. Conductive woven fabric. High protection against galvanic corrosion, extreme high flexibility. Surface resistivity: < 0.03 Ohms/□. By Statex.

VeilSheild

70% light transmission. 0.1 Ohm/sq resistivity. Woven 132/inch mesh polyester fibers coated with Zinc-blackened Nickel over Copper for better corrosion resistance. Not suitable for prolonged skin contact if you have a Nickel allergy. From LessEMF

Linqstat/Velostat

Packaging material made of a carbon impregnated polymeric foil. Used for protection from electrostatic discharge (ESD). It's piezoresistive properties means it changes resistance with flexing or pressure. By Caplinq/3M.

EeonTex Coated Fabrics

Textile to which a conductive coating has been applied to give it a specific degree of electrical conductivity. Similar to Linqstat and Velostat these fabrics also have piezoresistive properties and can be used for ESD shielding, resistive heating and resistive/piezoresistive fabric sensing. By Eeonyx.

Samples included here:
- knit stretch
- non-woven
- woven twill

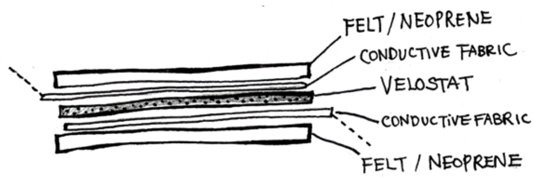
Enameled Wire

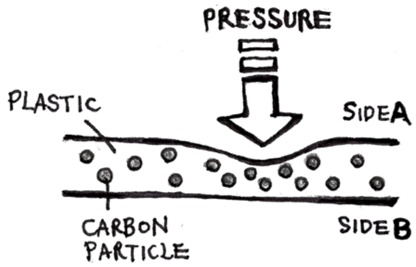
Magnet wire or enameled wire is a copper or aluminium wire coated with a very thin layer of insulation.

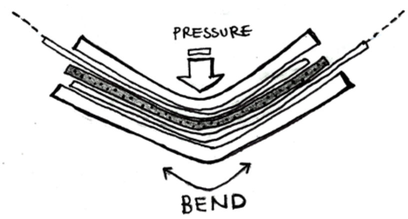
Neoprene Bend Sensor

This sensor is constructed by layering conductive and piezoresistive materials. Velostat is a piezoresistive plastic film that reacts to pressure with a decrease in electrical resistance. The sensitivity of this sensor can be adjusted by controling how large the conductive areas on either side of the Velostat are.

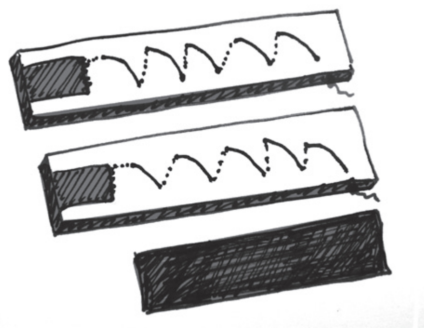
To make a bend sensor with a good range the conductive area should be minimized to just a few points of overlap. To achieve this the contacts on either side of the Velostat are stitched into neoprene as diagonal lines so that when they are sandwitched together they cross and only overlap in one point.

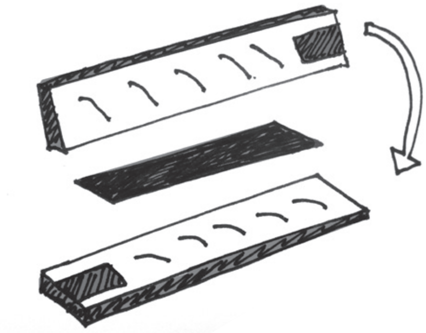




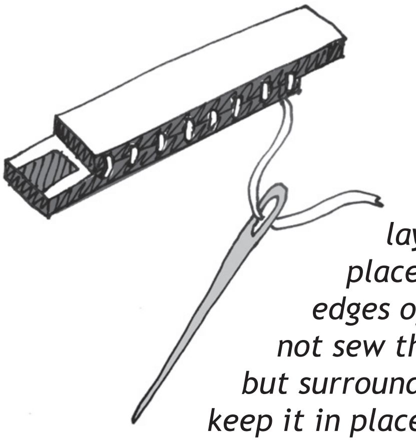


Cut two same size strips of neoprene. Thread the needle with conductive thread and tie a knot in one end. Stitch into the neoprene, exposing the thread in diagonal stitches as shown in the illustrations. Finish sewing the conductive thread by connecting it to a patch of conductive fabric at one end of the neoprene strip. This will make contacting the sensor easier.





Layer a piece of Velostat in between the two pieces of neoprene, with the conductive stitches facing each other. The conductive fabric tabs should be on opposite ends. Make sure the conductive thread and the conductive fabric on either side never touch directly, only through the Velostat.



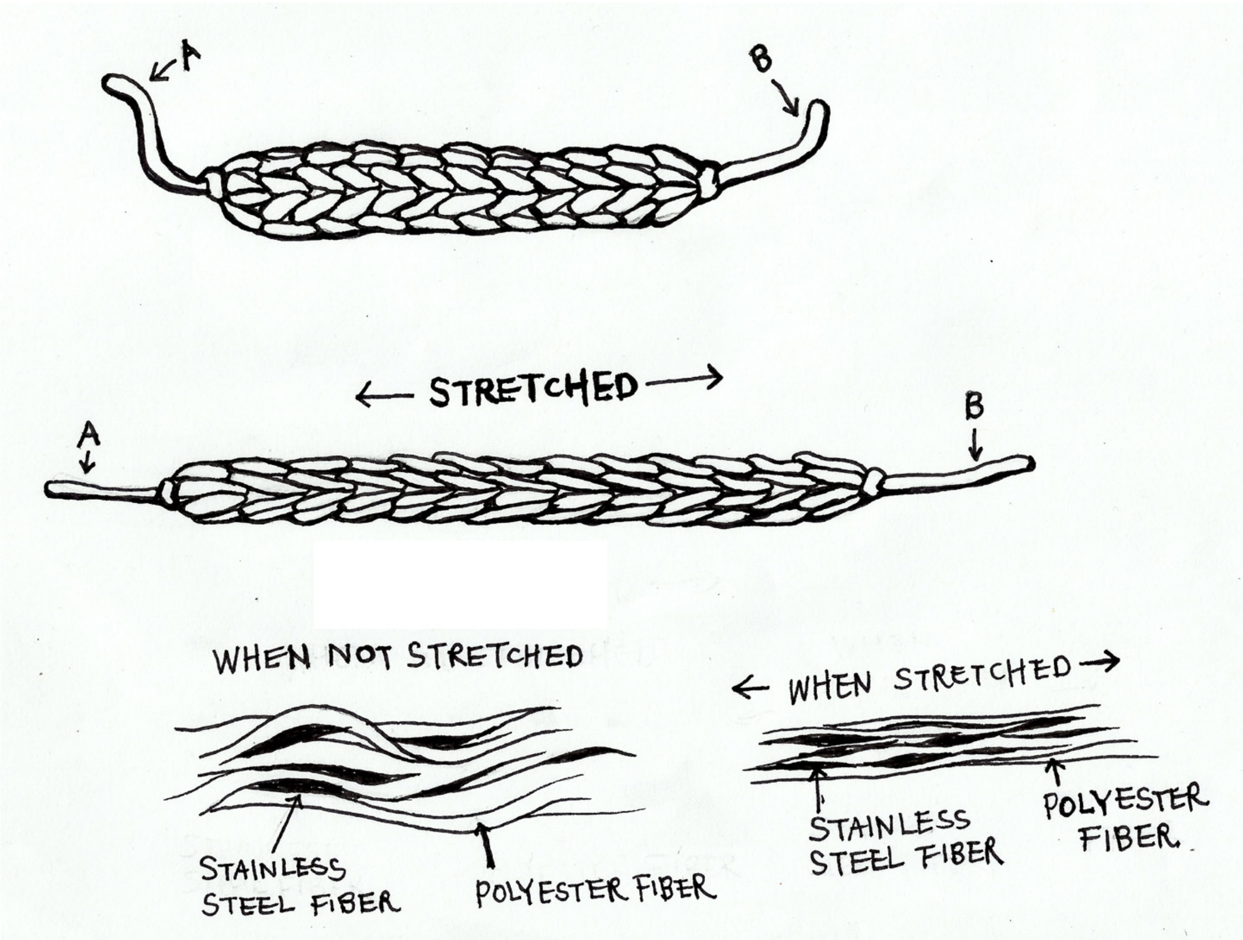
Thread the needle with regular sewing thread. Holding the layered materials in place, stitch around the edges of the neoprene. Do not sew through the Velostat, but surround it with stitches to keep it in place.

To test your finished sensor, connect either end to a multimeter set to measure resistance (Ohm). As you bend or pressure the layers of the sensor together, the resistance should decrease. Depending on the construction of your sensor, the values should range from 2K Ohm to 200 Ohm.

Knit Stretch Sensor

Stainless steel yarn is perfect for knitting or crochetting stretch sensors. The yarn is spun from a stainless stell and polyester yarn blend, making it conductive, but with a very high electrical resistance. When in a relaxed state the individual conductive fibers are not touching much, but when compressed through pressure or stretch, the steel fibers in the yarn make better contact and it becomes more conductive the more it is compressed. We can use this property of the yarn to sense stretch or pressure.

A single strand of yarn can already be used as a stretch or pressure sensor. But you can knit or crochet the yarn into any shape you like to make it more stretchy or squishy and giving you some feedback when manipulting the material.

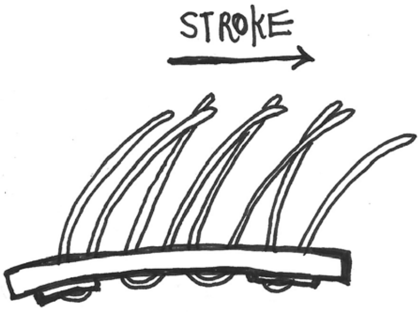


Stitched Stroke Switch

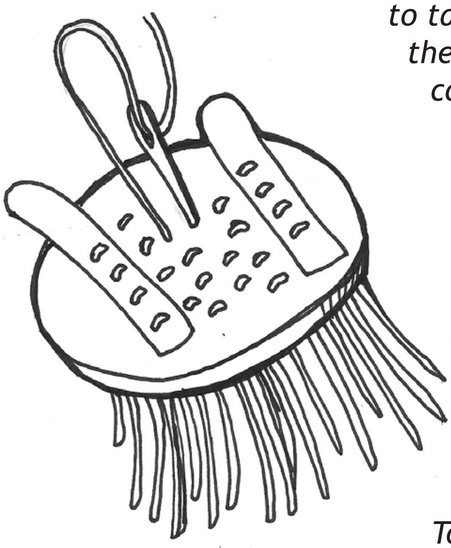
Stitching conductive thread into a neoprene base you can stitch yourself a custom stroke switch. Stroking over the stitched fur causes the hairs of both contacts to touch, closing the switch.

On the peice of neoprene fuse two pieces of conductive fabric to the back side. The distance between the two pieces represents the gap that the conductive fur will need to bridge when stroked.

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.



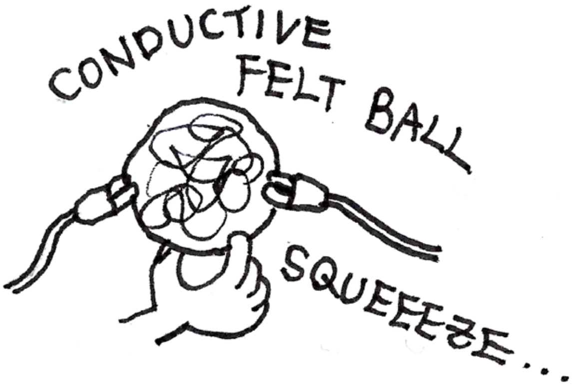
Thread the needle with conductive thread, feel free to take the thread double or quadruple. Stitch into the neoprene from the top side (the side without conductive fabric), but don't pull the thread all the way through. After stitching cut the thread at desired fur length, roughly 2cm. Repeat 5 or 6 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.

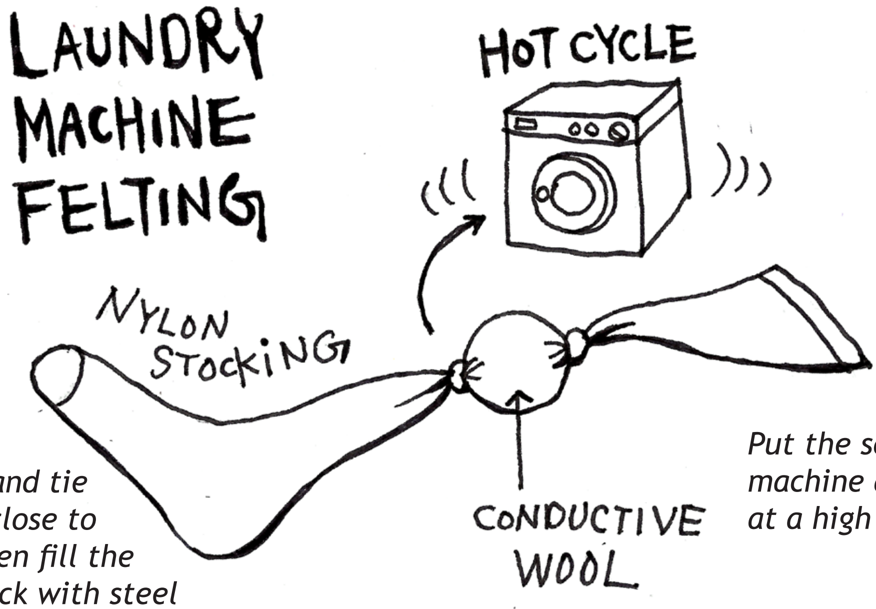


To complete the sensor add some non-condcutive fur by stitching with a non conductive thread. Stitch fur until the sensor is dense and the conductive fur contacts are isolated from one another, yet make contact when stroked.

Felted Pressure Sensor

When wool fibers are stimulated by friction and lubricated by moisture, they lock to each other and are "felted". You can felt steel yarn into a conductive felt ball as it contains natural wool. This felt ball will act as pressure or squeeze sensor as it gets more conductive when the steel fibers are compressed.



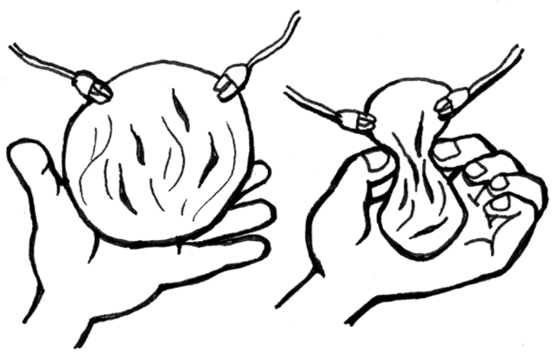


Take a sock and tie a knot in it close to the heel. Then fill the leg of the sock with steel wool fibers and tie another knot at the other end to form a ball shape as shown in the illustration.

Put the sock in the washing machine and wash with soap at a high temperature.

After washing, remove the felt from inside the sock and it shoudl have felted itself together into a nice ball.

To test your finished sensor, connect either end to a multimeter set to measure resistance (Ohm). As you squeeze or pressure the ball, the resistance should decrease.

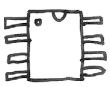


PARTS

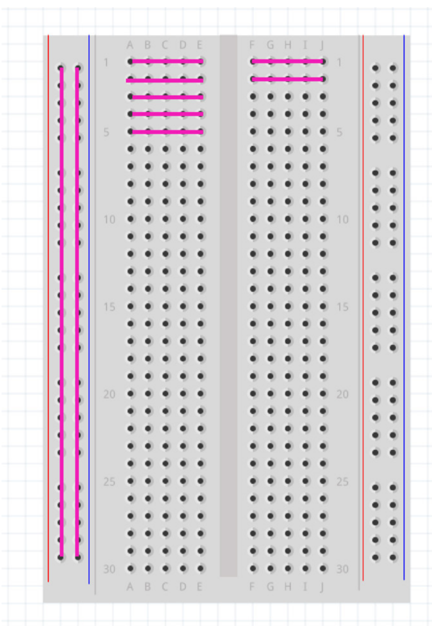
Resistor
Resistors limit the flow of current in an electrical circuit. For example a resistor can be used to reduce the brightness of an LED. Coloured bands indicate the value of each resistor.

Capacitor
Capacitors store small amount of electrical charge and function like tiny batteries, each tuned to a specific value. They a often used in power supply and audio circuits.

Transistor
Transistors are the most basic digital component. They have three legs: a “base”, “emitter” and “collector”. When a small current is applied to the base, the transistor will let a larger current flow from the collector to the emitter and so become a digital switch or amplifier.



Integrated Circuit (IC)
An IC is a set of electronic circuits on one small chip of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from independent electronic components. Imagine several billion transistors in an area the size of a fingernail



Breadboard
A breadboard is a construction base for prototyping electronics. The leads (legs) of components can be poked into the holds of the board where they make electrical connections with other holes along the same strip. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

Atari Punk Console (556)

An Atari Punk Console is an electronic musical instrument that produces “low-fi” sounds that resemble classic Atari console games from the 1980s, with a square wave output similar to the Atari 2600. The Atari Punk Console (commonly shortened to APC) is a popular circuit that utilizes two 555 timer ICs or a single 556 dual timer IC.

Atari Punk console is an astable square wave oscillator driving a monostable oscillator that creates a single (square) pulse. There are two controls, one for the frequency of the oscillator and one to control the width of the pulse. The controls are usually potentiometers but the circuit can also be controlled by light, temperature, pressure etc. by replacing a potentiometer with a suitable sensor (e.g., photo resistor for light sensitivity). Most of the time there is also a power switch (often a toggle switch) and a volume knob.

>> http://www.ataripunkconsole.com

PARTS:

1 x 556 IC

2 x 0.01uF Ceramic Capacitor

1 x 10 uF Electrolytic Capacitor

1 x Piezo Speaker

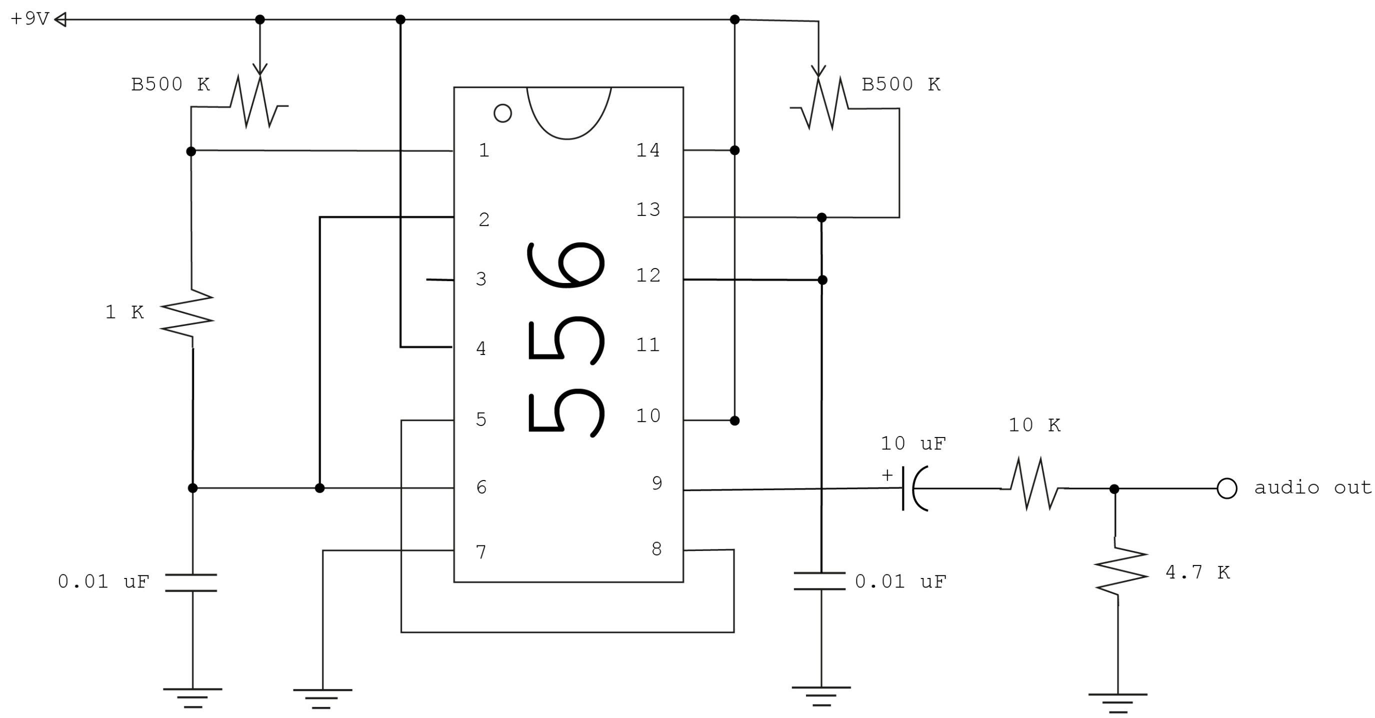
1 x TIP122 NPN-Powertransistor

1 x 1k Ω Resistor

1 x 10k Ω Resistor

1 x 4.7k Ω Resistor

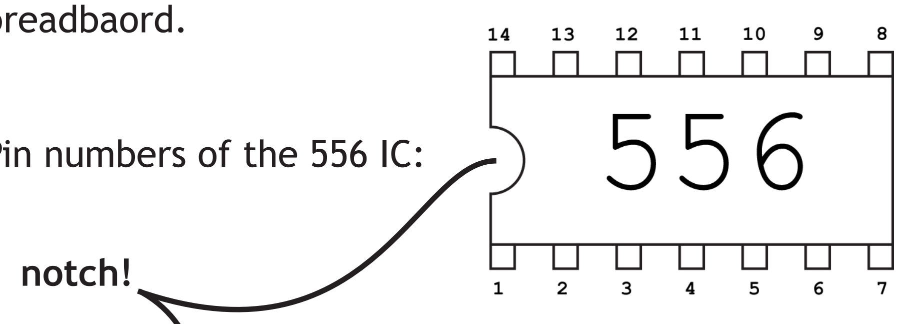
1 x Photocell (LDR)

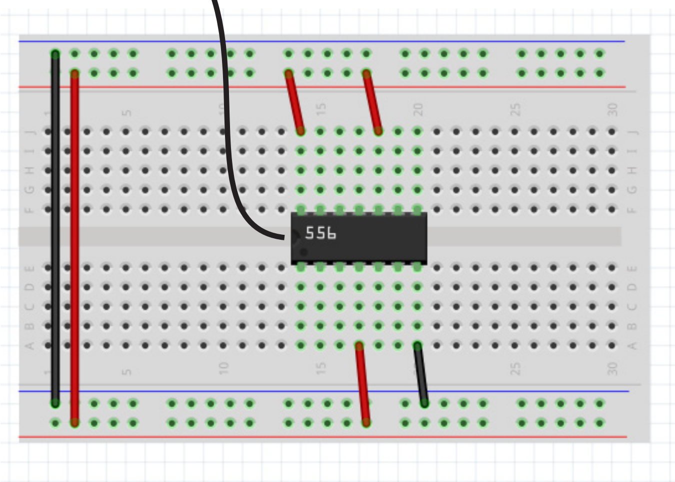


Atari Punk Console (step-by-step)

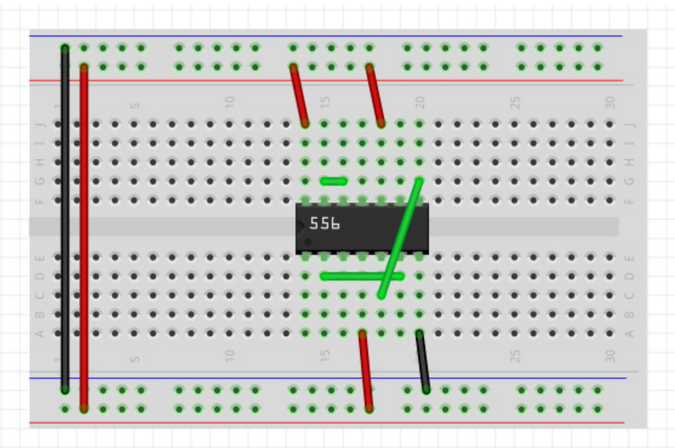
The following steps describe how to assemble the Atari Punk Console circuit on a breadbaord.

Pin numbers of the 556 IC:

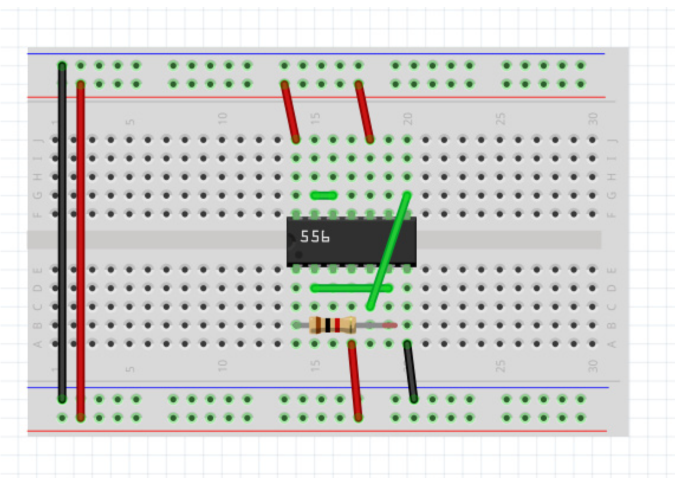




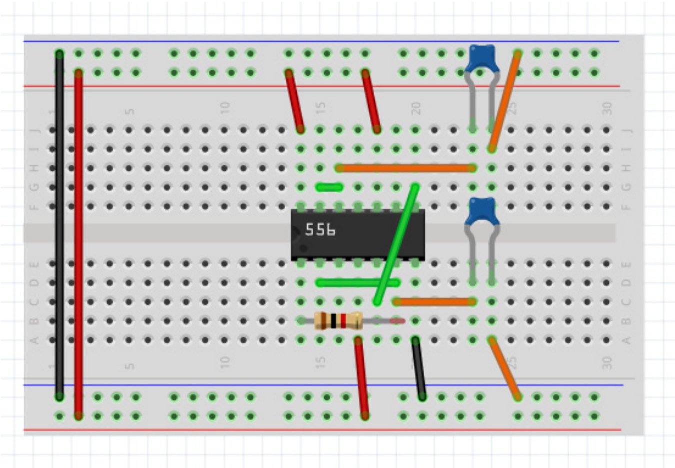
Step 1: Power Connections
insert IC into the board. pay attention to the notch orientation.
connect pin4 to 9V.
connect pin10 to 9V.
connect pin14 to 9V.
connect pin7 to GND.
make sure to connect the 9V (+) and GND (-) power rails on both sides.



Step 2: More Connections
connect pin2 to pin6.
connect pin5 to pin8.
connect pin12 to pin13.

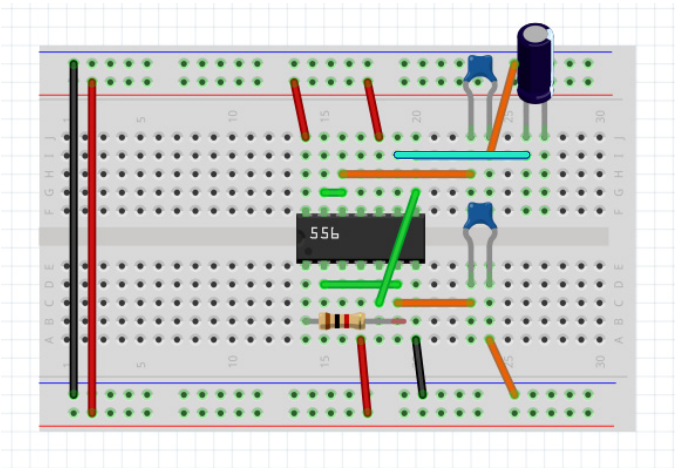


Step 3: First Resistor
connect a 1k resister between pin1 and oin6.



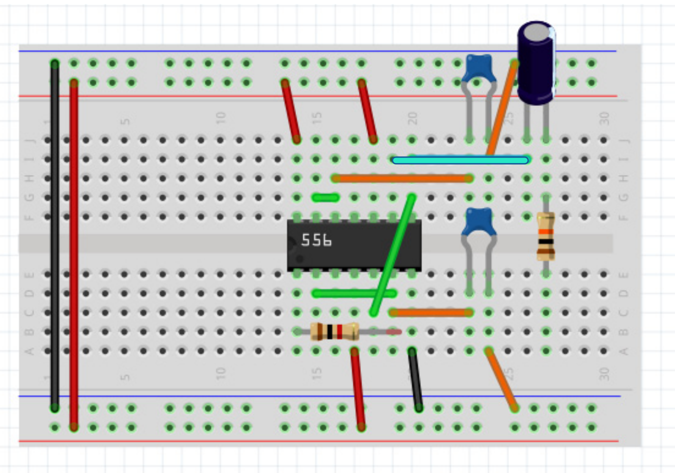
Step 4: Add Capacitors
connect a 0.01uf capacitor between pin6 and GND.
connect a second 0.01uf capacitor between pin12 and GND.

note: these ceramic capacitors do not have a polarity, it does not matter which way around the legs go.

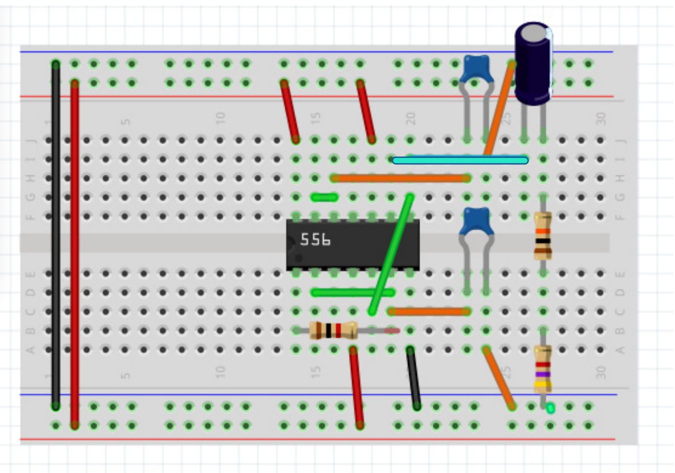


Step 5: Add Capacitor
connect the 10uF capacitor's positive leg to pin9 and the negative leg to an empty row on the breadboard.

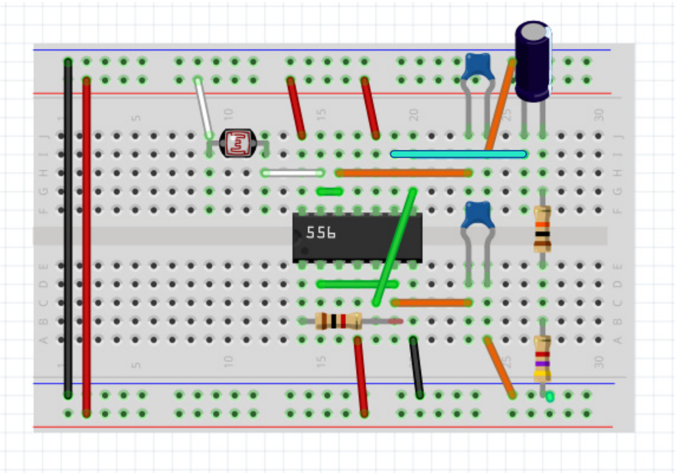
note: this film resistor has a polarity! the longer leg indicates the positive lead (+) and the negative lead (-) is marked with a minus sign on the side of the package.



Step 6: Second Resistor
add 10k resister between 10uF capacitor's negative lead and an empty row of breadboard.



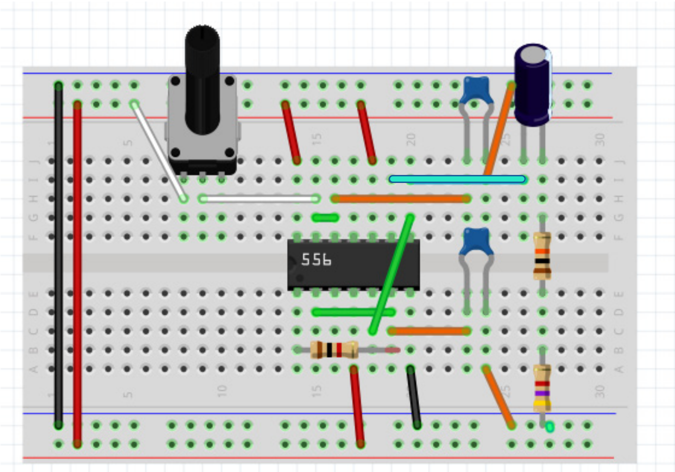
Step 7: Third Resistor
add 4.7k resister from 10k resister's empty strip to GND



Step 8: Connect LDR

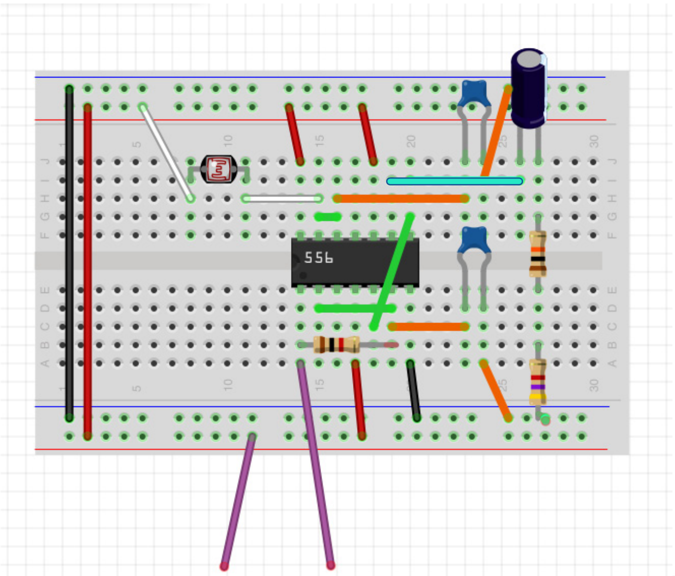
connect the LDR (Light Dependant Resistor) between pin13 and 9V.

the LDR is a variable resistor and will be one of the two inputs that control our sound. the other input will be the textile sensor.



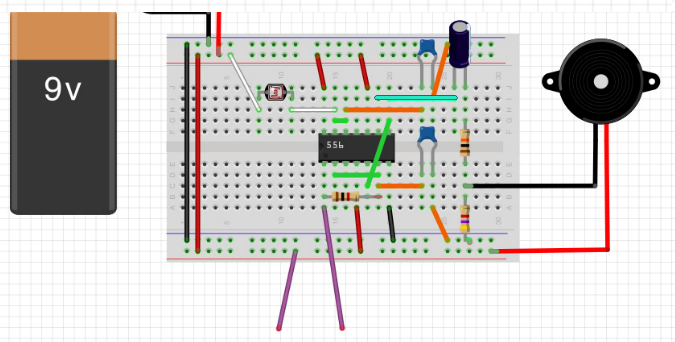
Step 8*: Alternative Pot

instead of the LDR you can also add a potentiometer or fixed resistor between pin13 and 9V.



Step 9: Add Input Leads

extend pin1 and 9V with cables. later you will connect these to a conductive textile and this will be the second input that controls the sound.



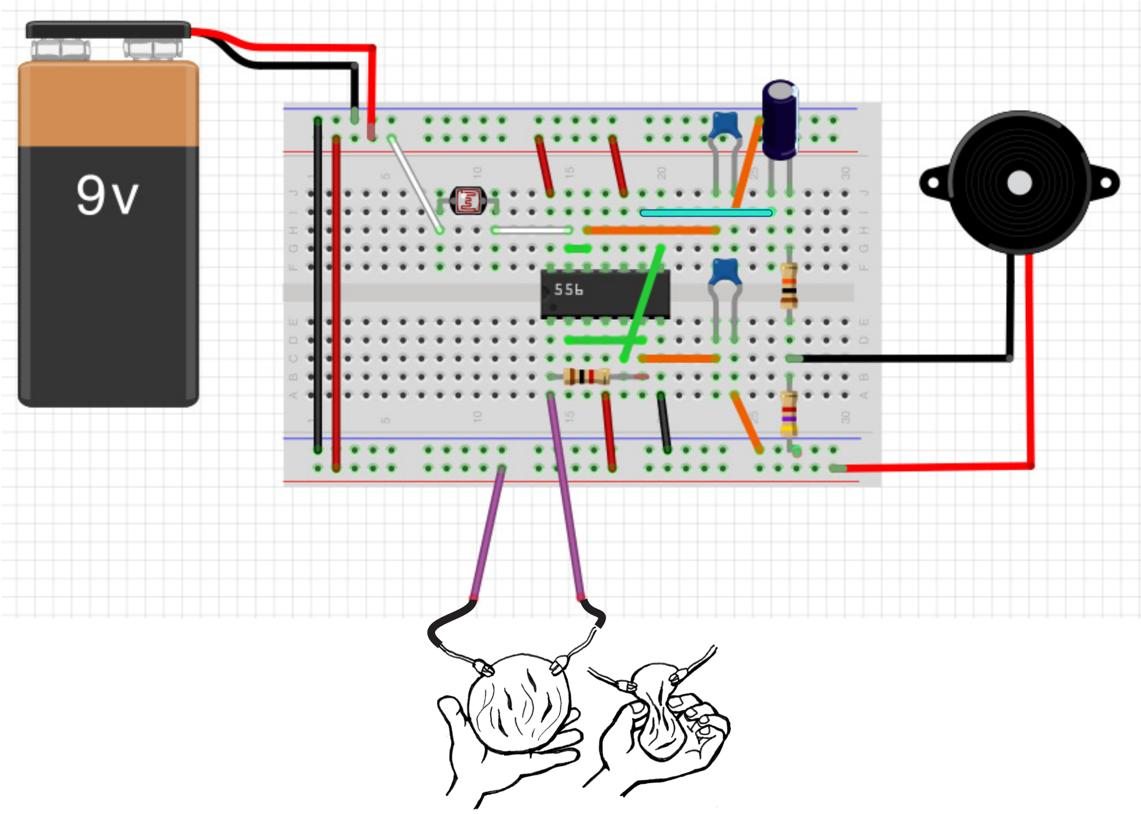
Step 10: Add Speaker

connect one side of the speaker to the connection point of 10k and 4.7k resister. The other side of the speaker to the 9V.

Step 11: Connect Textile and Power Circuit

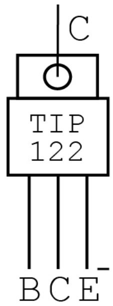
to complete the circuit we need to connect a conductor with high resistance to the input leads we added in step 9. take a piece of conductive wool and poke the leads into this.

finally, connect the leads of the 9V battery to power rails of the breadboard. if everything is wired correctly, your circuit should now make sound! if it does not, you need to “de-bug” this and get it working before continuing onto the next step.

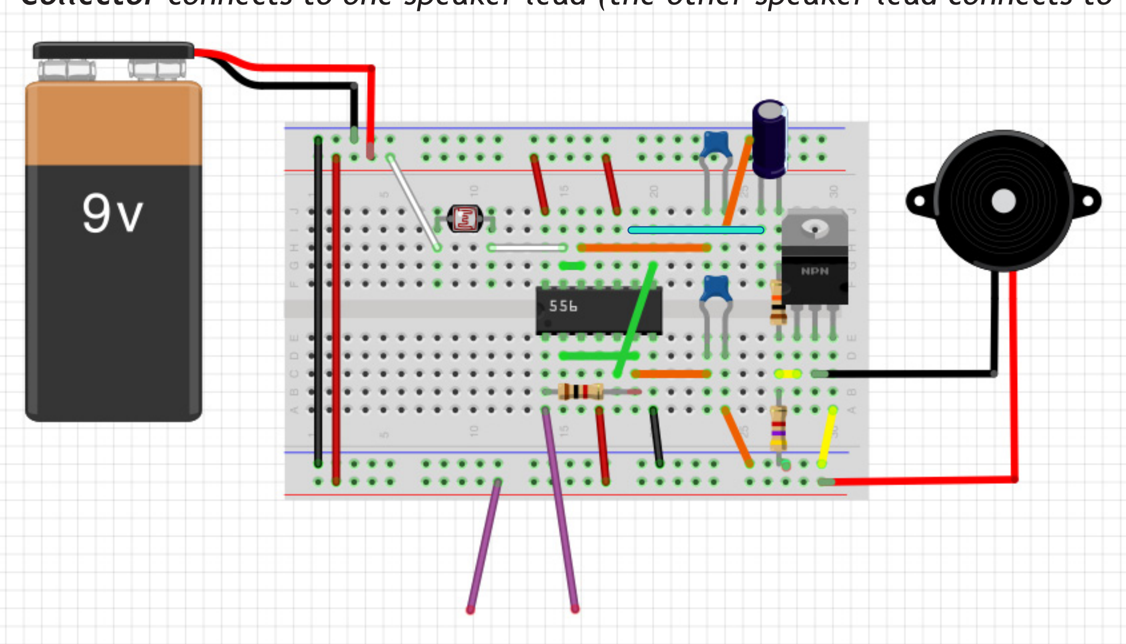


Step 12: Amplify Audio

to increase the colume of the speaker you can add a transistor (TIP122) to amplify the sound signal. the three pins of the transistor are called Base (B), Collector (C) and Emiter (E). They connect to the circuit as follows:



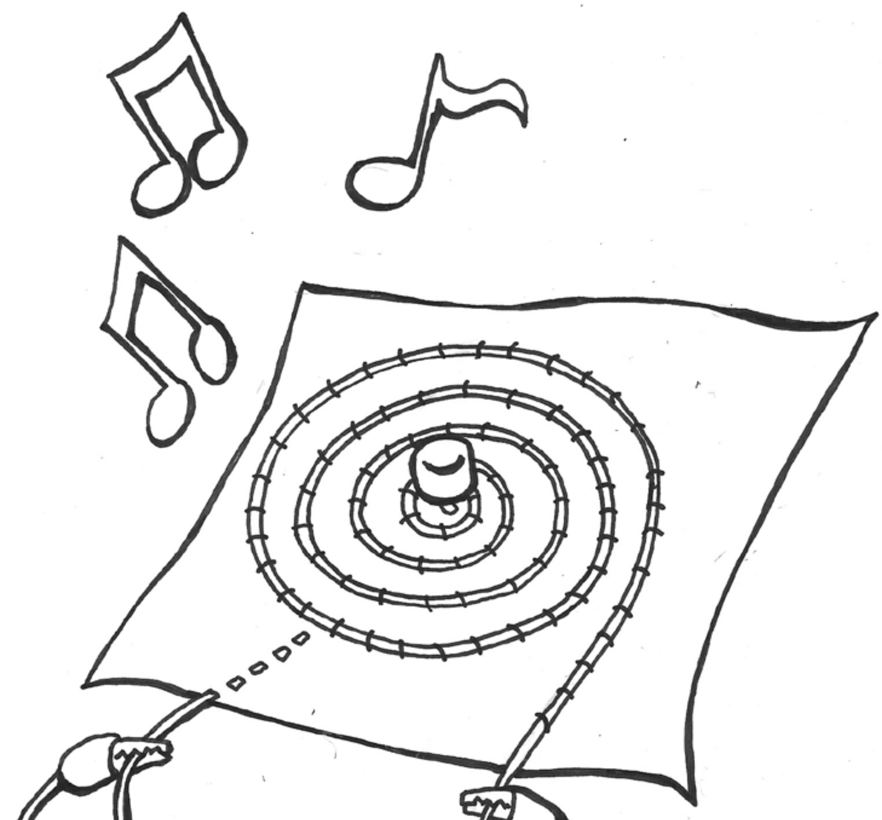
- ***Base** connects to the connection point of the 10k and 4.7k resistors*
- ***Emitter** connects to the GND of the circuit*
- ***Collector** connects to one speaker lead (the other speaker lead connects to 9V)*



2

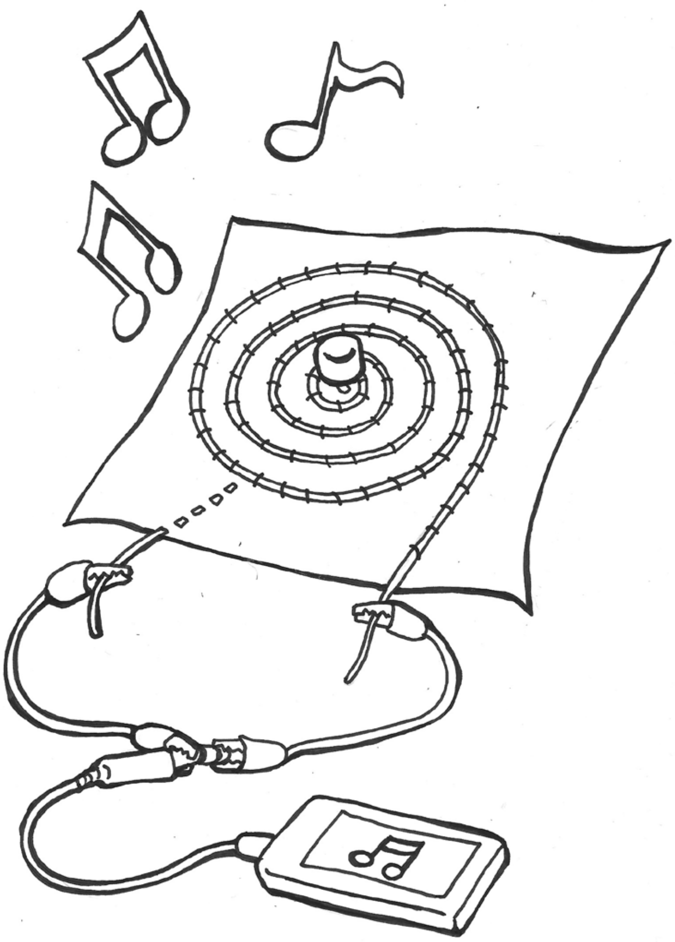
Playing Sound through Textiles

Coiling electromagnets from conductive fabrics and threads, embedding and attaching these to textiles, creating membranes capable of translating digital signals into audible sounds.

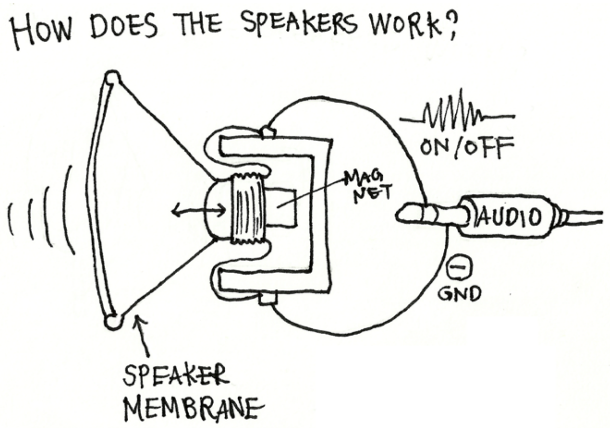


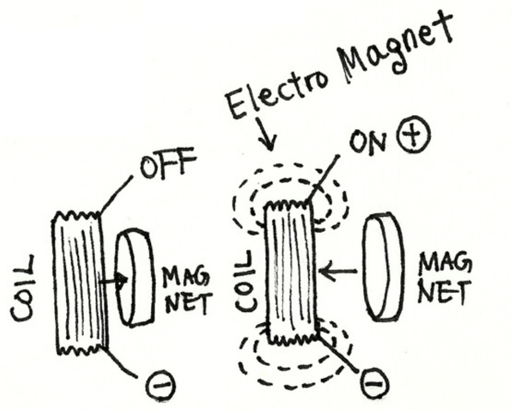
Embroidered Speaker

Before embroidering your own speaker, it's probably not a bad idea to understand how a speaker works. One good way to understand is to take apart an existing speaker.



When you look inside a speaker you will see tha it is made up of: a plastic membrane, a very tightly wound coil of very thin wire (magnet wire/enameled wire) and a magnet. The speake has two contacts, and theseare connected to either end of the wire coil. The wire may look like it is uninsulated and thus all touching, but in fact the wire is insulated, forcing the electricity to flow through the whole coil to reach the other end. The flow of electricity through the coil creates a magnetic field arounc the coil, making it an electromagnet. This magnetic field fluctuates with the frequency of the audio signal. Every time the signal is low the coil looses it's magnetic field and is not attracted to the permanent magnet, every time the audio signal is high, electricity flows and the coil is attracted to the permanent magnet. Thus the coil and the magnet are constantly repelling and attracting each other very very quickly. Because the coil is connected to the plastic membrane every time it moves (repel/attract), it moves the membrane and the membrane moves air, creating the sound waves that our ears can hear.



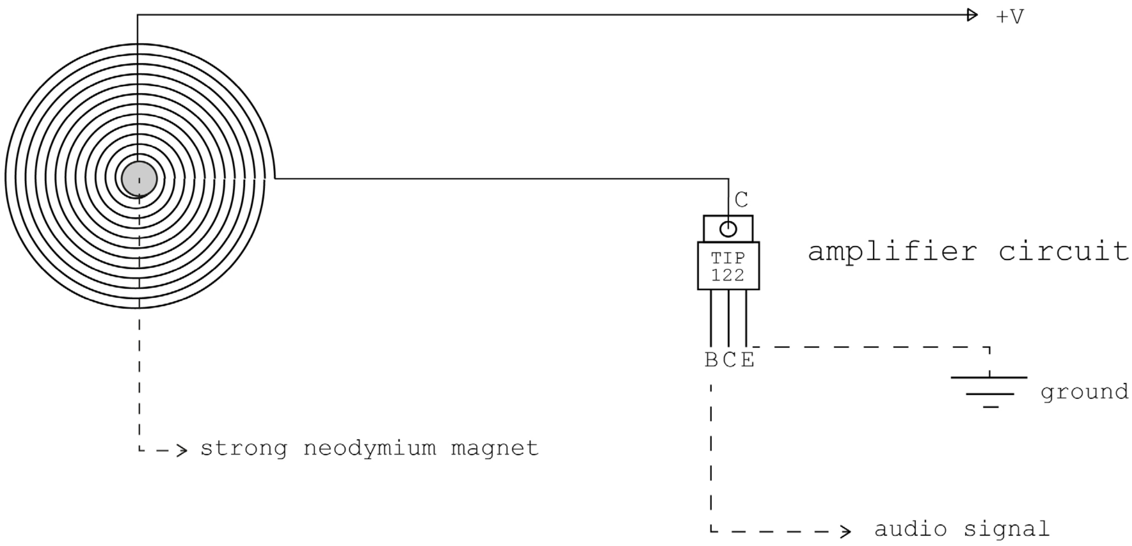


An embroidered speaker will work the same way, but instead of winding the coil around a cylinder it is embrdoiered on to fabric. The strength of the speaker depends on a few things: the strength of the electromagnet (conductivity of the coil, how many turns the coil has...), the material of the membrane (stiff vs. soft), the strength of the permanent magnet, and the amount of power running though it.

AMPLIFICATION

Darlington Transistor (Tip122)

The Darlington transistor consists of two bipolar transistors connected in such a way that the current amplified by the first transistor is amplified further by the second one. This configuration gives a much higher common/emitter current gain than each transistor taken separately.



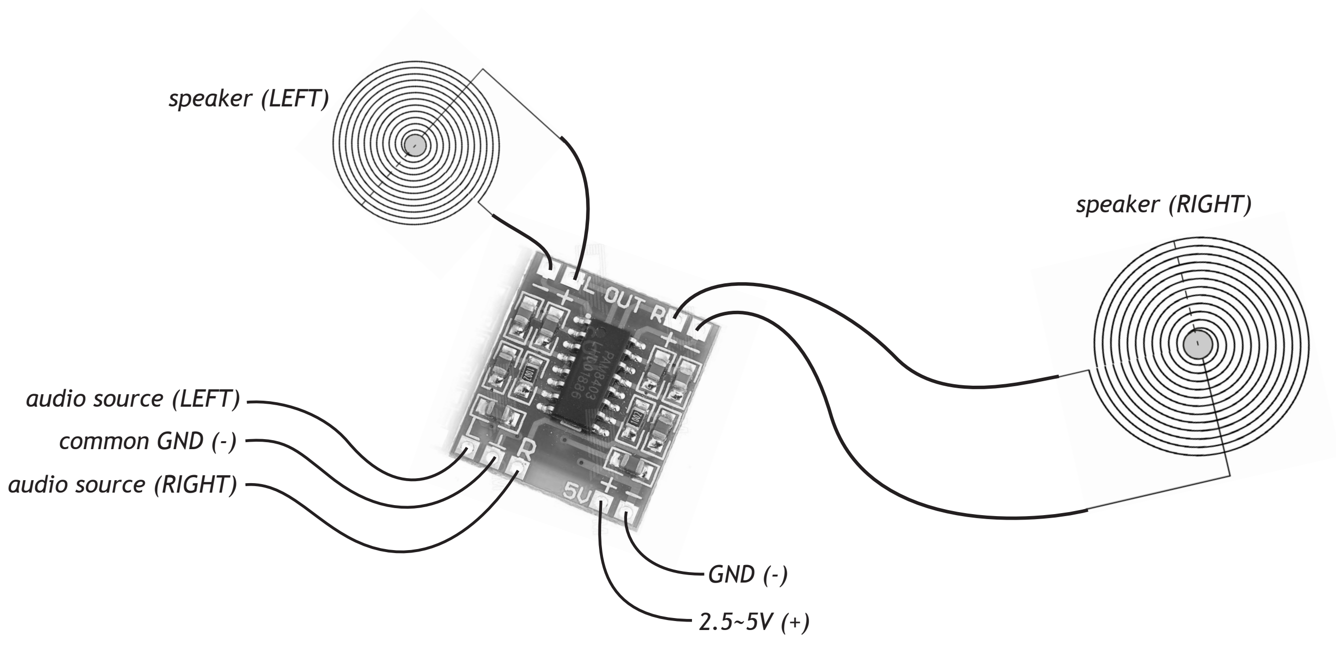
Mini Digital Audio Amplifier Board (GF-007)

Two channel stereo, 5V power supply, it can output 3W+3W power and can drive 4 ohm, 8 ohm small speakers directly. Input voltage: 2.5~5V, can be powered by USB.

Warning: *the negative of the left and right channel's output can not be connected together, otherwise it will burn IC!!!*

Note: *connect the speaker before power is switched.*

>> http://www.dx.com/p/gf-007-mini-digital-audio-amplifier-board-green-218365#.VQvOiYVJ_w9



Resources:

LessEMF >> *www.lessemf.com*

Plug and Wear >> *www.plugandwear.com*

Karl-Grimm >> *www.karl-grimm.com*

Statex >> *www.statex.biz*

Bekaert >> *www.bekaert.com*

Grobotronics >> *www.grobotronics.com*

Farnell >> *www.farnell.com*

RS >> *www.rs-components.com*

Conrad >> *www.conrad.nl*

Pieter Floris >> *www.floris.cc*

Sparkfun >> *www.sparkfun.com*

Adafruit >> *www.adafruit.com*

Arduino >> *www.store.arduino.cc*

Thank you for participating in the Sounding Textiles workshop!