Adding Electronics to 3D Printed Action Heroes

Anna Gerber
Outline

• Previously: 3D Sculpting Action Heroes
  – Generating base models
  – Slicing into parts & adding joints
  – Customizing via 3D sculpting tools

• Last week: 3D Printing Action Heroes
  – Recap Meshmixer & finish models
  – Preparing parts for 3D printing
  – 3D printing
  – Cleaning up 3D printed parts

• Today: Adding electronics to 3D printed Action Heroes
  – Make them interactive
  – Electronics & coding
  – Assembly
Outline

• Clean up 3D printed parts
• Soldering
• Micro-controller programming
• Design & test the circuits
• Assemble the action hero
• Decoration
• Discussion of painting / finishing techniques
Clean up parts

• Remove raft
• Remove support using pliers and cutters
• Test that parts fit together
• Optional: use hobby knife or fine sandpaper to tidy up / adjust fit
Breadboard

- Use to prototype circuits without soldering by plugging in components and jumper wires
- Numbered rows are connected
- Ours have power rails along the sides
IC test hooks

- We'll use IC test hooks to prototype our circuits without needing to solder onto the Digispark
- Solder jumper wires onto the test hooks
Soldering

From Soldering is easy by Mitch Altman, Andie Nordren and Jeff Keyzer

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Electricity

- Electricity is a form of energy
- We can connect components that convert electrical energy into other forms of energy: light, sound, movement, heat etc, into a circuit
- In a Direct Current (DC) circuit, current flows from positive to negative
- We will use the 5V pin on the Digispark for power
Electrical concepts

• **Current** (Amps): measures the flow of electrical energy through a circuit

• **Voltage** (Volts): measures difference in potential energy between the positive and negative sides of a circuit

• **Resistance** (Ohms): measures a material's opposition to the flow of energy

• **Power** (Watts): the rate at which energy is converted from one form to another
Digital vs Analog

• Digital
  – discrete values (0 or 1)
  – Examples: tilt sensor, push button

• Analog
  – continuous values
  – typically values for analog sensors are constrained within a range e.g. 0 – 255, 0 – 1023
  – Example: photo resistor

• Some sensors and actuators support both digital and analog modes
LEDs

- Light Emitting Diode
- Polarized: diodes act like one way valves so must be connected in a certain direction
- Emits light when a current passes through

Anode (+) longer lead connects to power
Cathode (-) connects to ground
Resistors

- Introduces resistance, so restricts the amount of current that can flow through a circuit
- Can be connected in either direction
- Bend and trim the leads to approx 1cm each make it easier to use with the breadboard
**Resistor Color Code**

**Examples:**
- green-blue-brown - 560 ohms
- red-red-red - 2200 ohms (2.2k)
- brown-black-orange - 10000 ohms (10k)

**Colors:**
- Black: 0
- Brown: 1
- Red: 2
- Orange: 3
- Yellow: 4
- Green: 5
- Blue: 6
- Purple: 7
- Grey: 8
- White: 9

**Tolerance Codes:**
- Black: 20%
- Silver: 10%
- Gold: 5%
Digital Write - Blinking an LED

- Unplug the Digispark from the computer!
- Include a 330 ohm (orange, orange brown) current limiting resistor to avoid damaging the LED
- Attach long lead (+) of LED to pin 1 of Digispark
- Connect short lead of LED to 330 ohm resistor and then GND

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3D Action Heroes
Loading programs onto the Digispark

- Use Arduino Integrated Development Environment (IDE) to write and send programs
- The programming language is C++
- Open File > Examples > 01.Basics > Blink and change pin to 1
Uploading to Digispark

• Plug in Digispark and select board (Digispark Default 16.5 Mhz) & port from the Tools menu
• Unplug Digispark
• Click on upload
• Plug in the Digispark when prompted (watch the messages at the bottom of the editor window)
Piezo Buzzer

Open File > Examples > 02.Digital > toneMelody
Change piezo pin to pin 0
Neopixels

• WS2812B light source
  – Chainable, individually addressable RGB LEDs
  – Many formfactors (pixel, ring, bar, strip etc)
  – Each unit is connected via 5V, GND and data pin
  – Use external power if working with more than a few LEDs

• See
  https://learn.adafruit.com/adafruit-neopixel-uberguide/overview
Install the Neopixel library

• Download library files from:
  – https://github.com/adafruit/Adafruit_NeoPixel
• Copy files into your Arduino Libraries folder
• Open
  File > Examples > AdaFruit Neopixel > buttoncycler and change pin to pin 2 and number of pixels to 2
Connect the Neopixels

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Push Buttons

- Add a button to the circuit with a 10K resistor
Action Hero Base

• Base holds the batteries and includes a switch and power indicator light
• Metal pads connect to wires on bottom of feet to power electronics inside figure
Base circuit
Solder the base circuit

680ohm resistor goes here
Assemble the base

Attach LED mount & switch to case
Assemble the base

Put some tape over the tabs to hold them in place
Assemble the figure

• Solder leg wires (thicker wire to go through legs, thinner wire through torso)
• Solder wires onto button for back
• Solder neopixels for eyes together & attach short wires
• Legs:
  – Run wires up through leg parts
  – Run elastic down through each leg across cross-beam inside torso
  – Use fishing line to attach feet
  – Tighten and tie off elastic
• Thread button wires through back (don't push button in yet)
Assembly (continued)

- Use sticky tape to gather four wires (from legs and button) and make a pointed end. Thread up through neck
- Thread fishing line down around cross-beam in head and through neck, use pliers to grab through arm hole to bring to the side
- If you can manage it, tie fishing line around body cross-beam (use pliers through button hole) – this is tricky. Alternative is to tie off fishing line around arm elastic
- Thread elastic through arms – fishing line for hands
- See https://youtu.be/6Qlx_XImcxc for how joints are threaded with elastic
Assembly (continued)

- Use putty to secure neopixels
- Solder power leads, neopixels and button to digispark
- Optional: solder leads to piezo and secure inside head with putty
- Upload your program to digispark & unplug USB cable
- Secure digispark under headcap with putty – to make it easy to remove for updating the program
- Place figure on stand and test!
Hair

• Use faux fur to create wild hair
• Hot glue onto head cap or sew together for changeable wig
Clothes

• Hero tunic:
  – Cut a rectangle of lycra about 2 cm wider than torso on each side, and twice as long as desired tunic length
  – Fold in half longwise and cut out a hole in the middle for the neck
  – Staple, safety pin or sew along the sides around body
  – Take off and trim off excess fabric from sides (leave at least 0.5cm for seams)
  – Turn inside out
  – Use a ribbon for a belt
Finishing

- "Lines" in print will be obvious under paint, smooth your print by:
  - Using fine grit sandpaper (the slow way)
  - Use acetone vapour smoothing (very shiny surface)
    • See https://youtu.be/9qByAGrbmS8
  - Use XTC-3D epoxy to smooth out surface (easiest way)
- Prime the surface with brush on acrylic primer (used for gaming miniatures) or spray on undercoat
- Use acrylic paints, water colour pencils, pastels, sharpies etc to draw face and decorate.
- Use a thin coat of matte clear spray to waterproof
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