The Camera-Shy Hoodie

An adversarial wearable for anonymization within the recording of a night vision security camera.

Instructions on how to assemble The Camera-Shy Hoodie.

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Section 0 – Readme

A Note on DIY…

Do it yourself can mean vastly different things depending on the reader.

To put it simply, The Camera-Shy Hoodie, made from scratch, is an easy textiles project and a moderately difficult electronics project. Materials costs are about $250.

The design of this project was a balancing act between minimizing technical complexity while maximizing ease of construction, with favor given to making it effective. One concession given to that end was the surface mount IR LEDs. They are a specialized component of which an easier-to-fabricate through hole version was not available. To make the LED boards from scratch you'll need to reflow surface mount components, which requires specialized tools to do correctly. To mount the breakout boards to the control circuit board, you'll need to be relatively proficient with a soldering iron. Those aspects are a drawback of the design, and at the time of writing (January 2023) I'm looking into producing the fully populated circuit boards as a kit.

That said, for the motivated, this can still be a project you do entirely yourself or with the help of friends. If the surface mount components are an issue, you can order the PCBs pre-populated from a board house, or even seek out a local makerspace with an electronics lab. Don't be afraid of trying something new, and if you're stumped, try looking up a tutorial.

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A note on safety upon use…

This project includes the use of high-powered IR LEDs. While not immediately dangerous to humans as UV radiation, high power IR light may still have negative effects if stared at directly for extended periods of time. Like any bright LED, it's not a good idea to stare directly at them for extended periods of time.

In addition, while mitigated by the Aluminum PCBs used to mount them, the IR LEDs still

consume a fair amount of power and could potentially heat up to the point of being uncomfortable. This is related to how much light is needed to effectively blow out the view of the security camera. It's a good idea to wear another layer underneath the hoodie that will insulate the LED PCBs from direct skin contact.

Efficacy and being sneaky...

The Camera Shy Hoodie is not an end-all-be-all for hiding your identity. It's good for one thing, blowing out the view of night vision (IR) cameras in low light environments.

It's not effective in sunlight, most indoor lighting, or against conventional cameras. In fact, you will draw attention to yourself if you wear this in a context in which the security cameras are actively monitored. In the view of an IR camera, it'll look as if you're flashing a light directly at the lens. In addition, the LEDs need to be a minimum distance from the camera to be effective, as the cone of light from them needs to be wide enough to overlap with the cameras view of the wearers head. In practice, this is about 12ft (~3m).

The best way to not be identified through a security camera is to never be captured in its view in the first place.

Finally, this guide and all associated materials are published with absolutely no guarantee of effectiveness of the instructions or of resulting product. I've tried to make these instructions as easy as possible to follow, but whatever you make is up to you. **You take full responsibility of what you make, how it works, and how it's used.**

And remember, use for good 😊

Section 1 – Materials and Tools

To assemble *The Camera-Shy Hoodie*, you'll need the following materials and tools:

1. **A Hoodie** - ~$25 new
   Where to Source – Big-Box Stores, Online, Thrift Stores
   Alternatives – A jacket
   Notes – A thick hooded sweatshirt without branding and with a front pouch pocket is recommended. Thicker cloth allows for the snaps to sit better when sewn to the cloth. Glidan hoodies are cheap and plentiful on eBay and are only branded on the tag. They're about as unremarkable as a hoodie can be. An alternative is a locationally relevant hoodie, like that of a local sports team. Something that can be readily found at a thrift shop. Using a piece of clothing that points to a place you've never been is an effective way of re-directing anyone trying to identify you based off of what you're wearing alone.
   eBay - Glidan hoodie - https://www.ebay.com/itm/302084426995

2. **A USB-C PD Battery Bank – 15v / 15w output capable** - $30+
   Where to Source – Electronics strores, Online
   Alternatives – 15v barrel jack battery pack
   Notes – For ease of assembly and use, A USB-C PD battery bank is recommended. USB-C PD can negotiate the power needed between the controller and the battery bank. As the electronics in the hoodie needs 15 volts DC @ < 1 amp to properly function, it fits within the USB-C PD spec. A barrel jack battery back could instead be used, but the wiring into the controller will need to be changed. This part more than any other is a matter of personal preference.

3. **Basic sewing supplies – Needle and thread -** $5
   Where to Source – Fabric / Craft Stores, Online
   Notes – For the sewing of the wires and snaps into the hoodie, select a thread that matches the color of the hoodie, as some of the stitching will be visible from the exterior.

4. **Electronics –** ~$200
   Where to Source – Adafruit, Sparkfun, and Digikey
   Note – I've designed the electronics around these components, and the plans as written will only work with these specific items.

   a. **LumiLED L1I0-0850090000000** – x12 needed, x16 recommended if producing from scratch, $2.32 each, for $37.12 for 16
      Note - This is the best LED for this design. It's got a high 850nm radiant intensity for its size, a 90-degree beam angle, and forward voltage that plays nice with the LED controller. Only problem is that they're not cheap.
      Product datasheet - https://lumileds.com/wp-content/uploads/files/DS191-luxeon-ir-domed-datasheet.pdf
      Digikey product page - https://www.digikey.com/en/products/detail/lumileds/L1I0-0850090000000/7243413

   b. **Adafruit QTPY RP2040**- x1 - $9.95
      Note - This cute little microcontroller board is easy to program with basic coding knowledge and it has the needed number of PWM outputs. **Adafruit product page** - https://www.adafruit.com/product/4900
      Digikey product page - https://www.digikey.com/en/products/detail/adafruit-industries-llc/4900/16680568
      Adafruit learning page - https://learn.adafruit.com/adafruit-qt-py-2040

   c. **Adafruit MPM3610 Buck Converter Breakout** – x1- $5.95
      Note - This buck converter takes in the 15 volts of from the battery and steps it down to the 5v that the RP2040 board uses.
      Adafruit product page - https://www.adafruit.com/product/4739
      Digikey product page - https://www.digikey.com/en/products/detail/adafruit-industries-llc/4739/13175530

d. **SparkFun PicoBuck LED Driver** – x1 - $17.50
Note – This breakout board drives the current to the LED strings. This part has been relatively difficult to source recently directly from SparkFun, so Digikey may be a better option.
SparkFun product page - https://www.sparkfun.com/products/13705
DigiKey product page - https://www.digikey.com/en/products/detail/sparkfun-electronics/COM-13705/5958859

e. **A few loose 2.54mm JST Connectors** – $24.95 for a kit
Note – You'll need x2 2-pin and x2 3-pin male/female sets, which are used to connect the control board to the sewn-in cables. These are also just handy to have around.
Adafruit kit - https://www.adafruit.com/product/4423
Digikey Product Page - https://www.digikey.com/en/products/detail/adafruit-industries-llc/4423/11497503

f. **Pre-crimped JST connectors** – x12 of both types - $0.75 each
Note – While these aren't strictly needed, especially if you already picked up a JST kit, pre-crimped connectors are tested to have worked and are better attached than most hobbyists will able do. You'll need a dozen of both the male and female connectors.
Adafruit product pages –
Male - https://www.adafruit.com/product/3814
Female - https://www.adafruit.com/product/261
Digikey product pages –
Male - https://www.digikey.com/en/products/detail/adafruit-industries-llc/3814/9380221
Female - https://www.digikey.com/en/products/detail/adafruit-industries-llc/261/5353586

g. **Silicone Wire** – Stranded, at least 26AWG, 2 colors, 25ft of each - $4.95 a roll.
Note – This is the wire that is permanently sewn into the garment, and as silicone wire is much more pliable than traditional PVC-Coated wire,

it holds up much better to the sort of movement that goes on in a wearable. Pick up 2 colors of wire, each 25ft, for 50ft total.
Adafruit product page – multiple colors - https://www.adafruit.com/product/2513
DigiKey product page – red - https://www.digikey.com/en/products/detail/adafruit-industries-llc/2513/5975011
DigiKey product page – black - https://www.digikey.com/en/products/detail/adafruit-industries-llc/2517/5975015

h. **USB-C PD to Barrel Jack Cable** - 15V 5A Output – x1 - $7.95
Note – This magical piece of kit takes a USB-C output and negotiates the power used to drive the controller and run the LEDs.
Adafruit product page - https://www.adafruit.com/product/5451
Digikey product page - https://www.digikey.com/en/products/detail/adafruit-industries-llc/5451/16592510

i. **Female Barrel Jack** – with leads - $1.95
Note – Used to connect the USB-C power cable to the controller board.
Adafruit product link - https://www.adafruit.com/product/1328
Digikey product page - https://www.digikey.com/en/products/detail/nte-electronics-inc/69-A1/11650680

j. **Heat Shrink Tubing** – various sizes - ~$5
Adafruit product page - https://www.adafruit.com/product/1649
Digikey - https://www.digikey.com/en/products/detail/adafruit-industries-llc/1649/10670039

k. **SPST Switch** – latching - ~$3
Note – This button lives in the cuff of the sleeve and acts as the main on/off for the whole system. A good tactile button is a good idea, so you can feel when it's turned on. The Judco button linked is great for this.

Adafruit product page - https://www.adafruit.com/product/1092
Digikey product page - https://www.digikey.com/en/products/detail/judco-manufacturing-inc/40-3979-00/523397

l. **A Through-Hole Diode** – Rated for > 15v - x1 - <$2 for a pack
Note – A polarity protection diode for the control board. Protects the RP2040. I used the 1N4001, which worked well.
Adafruit product page - https://www.adafruit.com/product/755

m. **Circuit Boards** – x12 of the LED boards, x1 of the control board - $5-$40
Note – The LED boards should be made on an aluminum substrate to help with heat dispersion. The control board can be a standard circuit board. These are custom parts, so you'll need to either make these or have them made. Recommended manufacturers are Oshpark (US) and JLCPCB (China). If ordering custom, I'd suggest getting a few extras
Oshpark - https://oshpark.com/
JLCPCB - https://jlcpcb.com/

n. **Solder Paste** - ~ $20
Note – This is used to set the LEDs on the carrier boards. Use whatever mix works best for you. I used pure silver solder, but it made it much more difficult to re-flow the solder. A leaded solder will likely be far easier to work with.
Microcenter – https://www.microcenter.com/product/658019/chip-quick-t3-solder-paste-no-clean-lead-free-in-5cc-syringe

5. **Sewable Snaps** – Silver @ 5mm – 3 for each LED board – x2 24-packs - $3.95
Note – These snaps are soldered onto the LED boards and sewn onto the interior of the hoodie. Use only the silver snaps, as the other coatings may not properly adhere with solder.
Adafruit product link - https://www.adafruit.com/product/1126
AliExpress - https://www.aliexpress.us/item/2255801030345981.html

Optional Materials – These items are nice to have, but not strictly necessary

6. **Braided Cable Sleeving** – ¾” (2cm) width or greater, < 3ft (~1m) linear ft – $7+
   Note – This product is helpful for sewing in the wires, as the braided sleeving can be sewn-in with the wires inside instead of directly sewing in the LED wire harness.
   Ebay - https://www.ebay.com/itm/303444590571

7. **Enclosure for the Controller**
   Note – The files for the project includes .stl’s for a 3D–printable enclosure. This part though does not need to be 3D printed, and could instead be anything that would protect the electronics from damage.

8. **Flathead M3 Screws** – 12mm, x4 - <$1
   Note – 4 of these are used to close the printable controller enclosure.

Tools

The following tools are needed to assemble The Camera-Shy Hoodie -

1. **Soldering Iron with Solder of Choice**
   Note – Used to solder the control board, the LED wire harness, and the leads to the LED boards. Use whatever solder works best for you. Also used to make the

2. **Reflow Oven or Hot Plate**
   Note – Used to set the IR LEDs on the LED boards with the solder paste.

3. **Wire Strippers / Cutters**
   Note – Use sharp wire strippers, as the silicone wire is much more difficult to cut through without taking out a lot of the stranded wire.

4. **Multimeter**
   Note – You’ll need this to verify continuity of the LED wire harness and that your power supply is giving 15v DC.

5. **Heat Gun / Lighter**
   Note – Used to set the heat shrink tubing.

6. **A Computer**
   Note – Used to program the controller board. Needs to be able to download the drivers for the QTPY RP2040 board. Included in this package is a firmware package that will natively install on that board, but if this doesn't work firmware can instead be installed using the Arduino IDE.

7. **USB-C cable**
   Note - Used to program the QTPY RP2040

Optional Tools

The following tools are not strictly necessary, but will make assembly dramatically easier –

8. **Nail Polish**
   Note – Used to insulate exposed contacts on the LED boards

9. **Variable Voltage Power Supply**
   Note – Extremely helpful in testing the LED boards and the control board.

10. **Super Glue**
    Note – Used to hold the hoodie side snaps in place in preparation for sewing, and to set the holes through the hoodie from fraying.

11. **A Small Embroidery Hoop**
    Note – Used to hold the cloth of the hoodie taut for the sewing of the snaps.

12. **Masking Tape / Scotch tape / Spike tape**
    Note – A thin tape is used to measure the lengths for the LED wiring harness. Also very helpful for marking out where the LEDs will be located.

13. **A permanent marker / Pen**
    Note – used for marking the tape

14. **A tailors tape / tape measure / Ruler**
    Note – Used for laying out laying out the wiring harness.

15. **A Working Night-Vision Security Camera**

    Note – The best way to test if the hoodie is working is to put it to the test. By using an IR camera you have access to, you can test your assembly work and learn some of the intricacies of how to best use The Camera-Shy Hoodie.

Section 2 – Assembly

Upon collecting the required tools and materials, follow these steps to make the Opt-Out Cap.

1. **Assemble the LED Boards. (x12)**
    - **Attach the IR LEDs and Snaps to the LED boards**.
        - Flow the solder to attach the LumiLED LEDs to the LED carrier boards. Match the heat curve to your selected solder paste. Be sure not to over-bake the LEDs, as they can be damaged if exposed to too much heat for too long.
        - Remember, the LEDs are directional. The LEDs indicate their orientation via a small notch on the pads on the underside. Reference the data sheet and repeat that orientation for all boards.
        - The snaps are also attached by flowing solder underneath them. Apply a generous bead of solder paste for each snap, and then squish it down.

    - **Solder on the LED Board Leads.**
        - Feed the wires of the female pre-crimped JST connectors from the back of the board to the front through the infinity-symbol shaped hole in the board.
        - Solder on the leads to the exposed pads on the LED boards.
        - Remember to use the same orientation for all boards. The JST connectors are directional, so if these leads are reversed, the LEDs will not work.
        - *OPTIONAL:* Cover the exposed solder pads with nail polish (or a proper conformal coating) to insulate them. As these boards are the closest to the outside of the hoodie, they'll be the electronics most subjected to the elements.

2. **Assemble the Control Board.**
    - **Solder pin headers to the breakout boards.**
        - Attach the male pin headers to the 3 breakout boards of control board, facing the long leg of the boards to their undersides.
    - Solder in the diode to the board.

  - Reference the wiring diagram, making sure to orient the diode in the correct direction.

- Solder the 4 loose male JST connectors onto the board.
  - Orient so that the two 3-pin JST connectors are on the left, with the two 2-pin connectors to the right.
  - The legs should be flat against their exposed pads, allowing the JST connectors to point off the edge of the board.
  - Orient all of the connectors with the notch facing the top of the board, the side where the breakout boards attach.
- Enable 660 mA output on the PicoBuck LED driver.
  - Using a small bead of solder, bridge the 3 exposed pad pairs marked ‘SJ1’, ’SJ2”, and ‘SJ3’ on the PicoBuck driver.
  - This dramatically increases the IR light output of the LEDs and is well within the tolerance of the selected diode.
- Fix the breakout boards to the the control circuit board.
  - Push the pins previously soldered to the breakout boards through the through-holes of the control board and then use solder to attach them in place.
  - Make sure to solder the RP2040 board so that the USB-C connector point towards the outside of the board.
  - Point the voltage converter board towards the interior of the board.
  - The LED driver board will cover the diode when installed.
  - Reference the photos.
- Optional: Test it
  - If everything has gone correctly, you should be able to apply 15v DC to button return pin – The inner pin of the inner 2-pin JST connector – as well as connecting ground to the supply ground pin – The outer pin of the outer 2-pin JST connector – and have the RP2040 board turn on and illuminate its LEDs.
  - By attaching to these two pins, this test skips needing to have the button already wired.
- Note: leave the control board un-enclosed for now.

- Access to the top of the RP2040 board is necessary for programming.

3. **Position and Sew in the LED Board snaps.**
    - **Layout the positions of the LED boards**.
        - Using tape or clothing pins, mark the 12 locations of the LEDs, encircling the neck and landing on the upper chest, top of shoulders, and upper back.
        - This should land about where a very loose scarf should fall and should be evenly spaced. No LED should be more than 7” from the hemline of the opening for the neck. Refer to the images for reference.
        - The goal of this step is to position all of the LEDs so that no matter what view a camera has of the wearer of the hoodie, at least 3 of the LEDs arcs of light will intersect the view of the wearers face. To check this, wear the hoodie and look in a mirror. From every standing angle at least 3 LED points should be clearly visible.
    - Make holes for the LEDs.
        - This next step can be cause a fire if done incorrectly, and will mar the soldering iron. Do this carefully, especially if the material of the hoodie is synthetic. Keep water on hand, and test doing this in a non-visible area of hoodie material (like the interior face of the hood).
        - Using the soldering iron at a low temperature, melt/burn a 3/8” (about 10mm) hole through the material of the hoodie at center of each of the 12 LED locations. These holes are how the LEDs will show through to outside the hoodie.

Section 2 Continued...

        - The material should melt or char away from the iron, and not catch fire.

    - If the edges of the holes are heavily frayed or otherwise need to be set, dab a small drop of superglue around the perimeter of the hole and allow it to set. This will prevent further fraying.
- **Sew in the snaps.**
    - Turn the hoodie inside out, and using an LED board as a template, position the female side of the 3 snaps around each of the through holes on the inside face of the hoodie fabric so that the LED on the board is centered on the holes made in the last step and that the tail from the LED boards is oriented towards the opening for the neck on the hoodie.
    - To temporarily hold the 3 snaps in place, apply a small dab of superglue to the back of the snaps and then apply pressure to let the glue set. You can also use a small embroidery hoop to keep the fabric around the hole taut, which is very helpful for sewing.
    - When the snaps are in position, use needle and threat to sew the tabs of the snap into the hoodie material underneath. Sew through all 4 openings on the snap so the snaps will not torque away from the forces applied when unsnapping.
    - Repeat for all 12 LED locations on the hoodie.
- Test the positioning.
    - Snap in an LED board to each of the LED board locations and confirm that the LED on the board is not partially covered or otherwise occluded by the opening in the hoodie. If any LED are covered, either re-position the snaps or expand the hole in the hoodie.

4. Prepare the wiring harness.

- Make a template.
    - While the hoodie is inside out, use masking tape to trace a line along the bottom seam of the hoodie, above any banding or elastic, from the bottom middle of the hoodie pocket to the side seam of whichever arm you'd like them cuff-mounted switch to be.

    - Connecting to the seam side of the previous piece of tape, lay more tape tracing along the side seam to the armpit of the hoodie.
    - Attaching to the end of the side seam tap, lay tape along the sleeve seam from the armpit to the cuff.
    - From the end of the side seam tape, trace with tape along the back side of the sleeve to body seam to the top of the shoulder, oriented so that the tape, if worn, would be on the back of the joint. Continue this tape along the top of the shoulder, tracing a seam if present, and stopping at the side of the neck opening, before any banding or prior to the hem.
    - Following the seam around the neck, trace with tape around the back of the neck to the front of the throat, so that the tape surrounds 3/4's of the neck from shoulder to throat.
    - Make a mark on the tape around the neck at the point closest to each of the 12 LED board locations. These are where the JST connector tails of the wiring harness be soldered will connect the boards to the harness.
    - Carefully remove the masking tape from the hoodie, making sure to keep all pieces of tape attached to one another at the points they intersect.
- Measure and note the wiring lengths.
    - Using a measuring tape, measure the length of tape from the center bottom of the hoodie pouch to the intersection of the sleeve seam, tracking along the masking tape the whole way. Make a note of this distance and label as side seam.
    - Measure and note the length of the sleeve seam tape, measuring from the intersection at the armpit to the side seam to the cuff. Label this as Switch.
    - Trace and note the distance from the end of the side seam to each of the 12 marks on the tape, ending at the tape terminus above the throat. Label these LED 1 through LED 12.

    - To determine the overall length to cut the wires for each of the 3 LEDs series, add the side seam length to the for distance for LED 10 (noted as 1-Overall), LED 11 (noted as 2-Overall), and LED 12

(noted as 3-Overall). These are the lengths for the ground wire of each LED series.
    - Also sum and note the lengths of the following:
        1. Side seam + LED 1, note as 1-1
        2. LED 4 minus LED 1, note as 1-2
        3. LED 7 minus LED 4, note as 1-3
        4. LED 10 minus LED 7, note as 1-4
        5. Side Seam + LED 2, note as 2-1
        6. LED 5 minus LED 2, note as 2-2
        7. LED 8 minus LED 5, note as 2-3
        8. LED 11 minus LED 8, note as 2-4
        9. Side Seam + LED 3, note as 3-1
        10. LED 6 minus LED 3, note as 3-2
        11. LED 9 minus LED 6, note as 3-3
        12. LED 12 minus LED 9, note as 3-4
    - For each of the overall lengths (1-Overall, 2-Overall, and 3-Overall) and the switch length, add 8in for 5in of additional wiring in the hoodie pocket and 3in of spare wire. This is the final cut length of the ground wires.
    - For the first measurements in the positive wires of each series (1-1, 2-1, and 3-1), add 6in for 5 inches in the hoodie pocket and 3 inches spare wire. This is the final cut length of the positive lead wires.
    - Add 1 inch to the rest of the measurements (1-2, 1-3, 1-4, 2-2, 2-3, 2-4, 3-2, 3-3, and 3-4). This is the final cut length of the jumper positive wires.
- Cut the wires
    - Using the silicone wires, assign one color as positive and the other as negative. Red and black tend to work well for the respective roles.
    - Label these wired with masking tape as you go, as it makes the assembly a lot easier to follow
    - Cut a length of the ground wire for each all the following lengths:
        1. 1-Overall
        2. 2-Overall

3. 3-Overall
4. Switch

- Cut a length of positive wire for each of the following lengths:
    1. Switch
    2. 1-1
    3. 1-2
    4. 1-3
    5. 1-4
    6. 2-1
    7. 2-2
    8. 2-3
    9. 2-4
    10. 3-1
    11. 3-2
    12. 3-3
    13. 3-4

5. **Assemble the wiring harness.**
    - Lay out the 3 sets of LED positive wires so that they go end to end.
        - For example – 1-1 is abutted to 1-2, 1-2 to 1-3, and 1-3 to 1-4.
    - Add a ground wire to each set.
        - The negative 1-Overall would go with the set of 1-x wires.
    - Pair the switch positive and negative wires together.
    - At each of the areas on the positive wires in the LED series abut, solder in a male pre-crimped JST connector in series.
        - Strip off about 3/8 inch from the two sides of the abutting wires (for instance, one side of 1-1 and 1-2).
        - Slip on a 3/4“ length of heat small diameter shrink tubing to each wire prior to soldering. Use whatever diameter has an easy slip fit over the wire used.
        - Align the leads of the male JST connector so current will flow through the diode when connected. If the LED boards were soldered with the red leads of the female JST connectors attaching to the positive terminal of the boards, the Male JST connectors should attach the red lead to starting wire in the

connection. For example, to connect to LED 1, Wire 1-1 should connect to the red lead, and 1-2 to black lead the of the male JST connector.

- The positive lead of the JST connector should be aligned so that the solder joint will be inline with the wires. Solder this joint and then slip the heatshrink tubing up the wire and set it in place using heat.
- The negative lead of the JST connector should be aligned parallel with the wire that leads to the next connection in the series. The solder joint will then be at the acute angle where the wires within these conductors meet. Solder this joint and then slip a length of heat-shrink tubing over the joint so no wire is exposed.
- By varying the way the 2 wires are soldered, it allows for better strain relief of the JST lead wires coming off the harness.
- Using a zip tie or larger section of heat shrink tubing, secure the soldered sections together with the ground wire so that each connection stays together with its ground wire.
- Complete these steps for all 12 JST connections, connecting the positive of the last wires in the chain so that the negative lead of the JST goes to the ground wire. For example, LED 12's matching male JST connector positive leads should tie to the end of wire 3-4, and the negative lead should connect to the end of the negative 3-Overall ground wire.

- Test these connections using a multimeter. There should be continuity between the positive and negative pins of sequential JST connectors.
- Bundle all the wires together at the end closest to where the hoodie wires will enter the hoodie pocket. Keep the wires together using sections of larger heat-shrink tubing, zip ties, or braided cable sleeve.
    - Bundle this area for the length of the side seam + 5in, so that the switch wires can split off and run down the sleeve.
- Bundle the wires beyond the side seam so that they stay together while allowing the JST connector leads to branch off the harness.
- Attach the JST loose female JST connectors to the wires of the wiring harness.

    - Trim any longer wires on the pocket side of the wiring harness so that all wires are a consistent length.
    - Separate the wires on the harness into 3 bundles-
        1. LED-Overall-1 +, LED-Overall-2 +, LED-Overall 3+
        2. LED-Overall-1 -, LED-Overall-2 -, LED-Overall 3-
        3. Switch + and Switch -
    - Crimp on the female JST connectors to the exposed ends of the wires
    - Insert the female JST receptacles of Bundle-1 into one of the 3 pin female JST housings. Match the order of the pins to the receptacle (for example - LED-Overall-2 connector goes into the JST housing's second slot).
    - Insert the female JST receptacles of Bundle-2 into the other 3 pin female JST housing. Match the pin order to last step.
    - Insert the female JST receptacles of Bundle-3 into one of the 2 pin female JST housings. Orientation is not critical for this connector.
- Before testing, attach a JST connector to the leads of the switch.
- Test the connections with a multimeter.
    - Using the continuity check of the multimeter, check that the following have continuity before sewing in the harness –
        1. LED Harness JST 1-1 Positive to Pin 1 of the LED Positive JST connection to the board.
        2. LED Harness JST 2-1 Positive to Pin 2 of the LED Positive JST connection to the board.
        3. LED Harness JST 3-1 Positive to Pin 3 of the LED Positve JST connection to the board.
        4. LED Harness JST 1-4 Negative to Pin 1 of the LED Negative JST connection to the board.
        5. LED Harness JST 2-4 Negative to Pin 2 of the LED Negative JST connection to the board.
        6. LED Harness JST 3-4 Negative to Pin 3 of the LED Negative JST connection to the board.
        7. LED Harness Switch Positive to either pin of the switch connector side JST connector

8. LED Harness Switch Negative to either pin of the switch connector side JST connector
9. Attach and toggle the switch and test continuity between LED Harness Switch Negative and LED Harness Switch Positive

6. Prepare the hoodie and sew in the wiring harness.

- Cut a 1” long slit in the interior fabric of the hoodie pocket, positioned so that it’s in the middle of the area covered by the front fabric of the pocket.
    - Treat the edges of the cut superglue or a hem so that it wont fray over time.
- Insert 5” the crimped JST connector end of the wiring harness into the pocket through the 1” opening.
- Following the path originally laid out by the template, stitch in the wiring harness to the hoodie.
    - Attach the harness along the bottom hem seam of the hoodie to the selected side seam. Follow the side seam to the armpit, remembering to split off the switch wires to follow the sleeve seam. Attach the harness around the back of the seam connecting the sleeve to the body, ending at the shoulder. Follow the seam along the shoulder to reach the neck, and then loop around the back of the neck and hook to the middle of the neck, ending above the sternum.
    - Using needle and thread, loop around the diameter of the wiring harness to tie it to the hoodie. Make sure to not pierce the wires using the needle, as this could ruin the wire.
        1. If braided cable sleeve was used, press the sleeve flat against the fabric and stitch along both side of the sleeve instead of looping the wire around the harness completely.
    - Make sure to split out the switch wires at the armpit.
    - Leave the LED JST connectors that branch off the harness loose as the extra length is needed to reach the LEDs.

    - When sewing in around the neck seam, keep the loops around the wiring harness loose, as a bit of stretch at the neckline is helpful when putting on or taking off the hoodie.
- Connect all the LED boards and switch to their relating JST connectors.

7. Make the barrel plug adapter.

- Crimp the female barrel plug to the remaining 2-pin female JST connector, aligning it so that the ground line of the barrel plug will face towards the outside of the controller board when connected.
- This joint will receive the most strain on the board, so you can strain relieve this joint with a bit of heat-shrink tube.

8. Program the controller

- Make sure that the controller board is disconnected from any of the other wiring, use a USB-C cable to connect the QT RP2040 on the controller board to a computer.
- Upload the firmware.
    - While the QTPY RP2040 is powered and connected to the computer, it should display as a small flash drive.
    - If the QTPY RP2040 doesn't automatically register as a storage device upon being connected, you can manually set it into boot mode by following these steps:
        1. Make sure that the USB-C connector is firmly seated, and that the board is receiving power.
        2. Press and hold the BOOT button.
        3. Press and release the RST button.
        4. Release the BOOT button.
    - Once the drive registers, drag and drop the precompiled binary file "CSH_v1-00_Release.ino.adafruit_qtpy.uf2" into the RP2040 storage device.
    - Once the file transfer is complete, the QTPY RP2040 should automatically adopt the firmware, finishing this step. The large LED on the top of the board (the NeoPixel) should turn on and stay red.
    - In case the binary upload fails, try uploading the attached sketch (CSH_v1-00_Release.ino) via the Arduino IDE, a full guide for

which can be found here: https://learn.adafruit.com/adafruit-qt-py-2040/arduino-ide-setup

- Cycle the power to the board and verify that the firmware has been successfully installed.
    - Unplug and plug back in the QTPY RP2040 to the USB cable or press the RST button on the board.
    - The large LED on top should remain red upon gaining power. It should not show up again as a flash drive.
    - In case of any other issues in the programming, refer to Adafruit's guide on getting started with this board, which can be found attached to this document and linked here: https://learn.adafruit.com/adafruit-qt-py-2040/overview
- Disconnect the controller board from the computer's power by unplugging the USB-C cable from the QTPY RP2040.
- Attach the female barrel plug assembly to the controller board by plugging it in to the 2-pin male JST connector closest to the board edge on the controller board.
- (Optional) Verify the polarity of the power input. Inverted positive and negative feeds to the controller board may damage it.
    - Use a multimeter to verify that the positive pole of the barrel plug (the center lug) is connected to the outermost pin of the inner 2-Pin JST connector (where the switch connects.
- Install the enclosure around the controller board.
    - Use x4 screws to attach the top half of the enclosure to the bottom, sandwiching the controller board between the two so that the JST connectors emerge through one end.

9. Attach the controller board to the wiring harness.

- Disconnect the controller board from the computer's power by unplugging the USB-C cable from the QTPY RP2040.
- Attach the female barrel plug assembly to the controller board by plugging it in to the 2-pin male JST connector closest to the board edge on the controller board.
- (Optional) Verify the polarity of the power input. Inverted positive and negative feeds to the controller board may damage it.

    - Use a multimeter to verify that the positive pole of the barrel plug (the center lug) is connected to the outermost pin of the inner 2-Pin JST connector (where the switch connects.
- Feed the controller board into the pocket of the hoodie, and connect the loose female JST connectors of the wiring harness into the male JST headers on the control board
    - LED Negative attaches to the outermost 3-Pin JST header.
    - LED Positive attached to the innermost 3-Pin JST header.
    - Switch attaches to the innermost 2-pin JST header.
    - Power should already be connected into the outermost 2-pin JST header.

10. Power it all up!

- Power the controller board via the battery bank
    - Connect the USB-C - Barrel plug cable (15v) to the female barrel plug, and then connect the USB-C to the portable battery bank.
- If everything is correctly attached, toggle the switch in the cuff of the hoodie and the LEDs should begin strobing. This will be mostly invisible, but the IR LEDs should be faintly red, indicating their operation.
- Check each LED location to make sure the LEDs are strobing. If everything is working, they should all be strobing in unison.
    - Doublecheck the JST connectors if anything isn't working.
    - If in doubt, check against the wiring diagram.

Done.

Section 3 – How to Don and Use the Hoodie

- **To use the hoodie, follow the following steps to put it on**
    - Make sure the USB-C PD cable is unplugged from the battery bank
    - Carefully put it on, making sure to not roughly pull at any of the fabric while donning.
        - If any area of the fabric around where the LEDs are snapped in is pulled too hard, the LED boards can disconnect from their snaps on the fabric or the JST connector that ties them in could disconnect.
    - Once on, connect the USB-C PD cable to the battery bank and put the battery bank into a pocket. Preferably one it can sit in comfortably without torquing the USB connector.
    - Test that it's then powered by switching on the enable switch and visually confirming that the LEDs are lightly strobing.
- **And with that, you should be good to go.**
    - When taking off the hoodie, follow those same steps in reverse, making sure to gently remove the hoodie.

- **Points to keep in mind while in use…**
    - THE HOODIE WILL NOT MAKE YOU INVISIBLE TO SECURITY CAMERAS, only unrecognizable in the view of night vision cameras in low light.
    - Daylight, normal indoor artificial lighting, and standing too close to the camera (<12ft) will negate the effects of the hoodie.
    - Other identifying factors can still be used to trace you.
    - It's a good idea to only toggle the hoodie on and off when it's needed, as the battery selected is the limiting factor on its use.
    - Using the hoodie will draw attention if the feed from the security camera is actively monitored.

Have fun!

Section 4 – Closing Notes

While the *Camera Shy Hoodie* isn't an end-all be-all for opting-out of surveillance technology, it is a way of reclaiming some space claimed by these technologies. This kind of solution is called an adversarial approach, where you undermine the technology that allows the action to happen by creating something that directly causes it to fail.

There are a lot of different forms adversarial technologies can take, including things like Adam Harvey's *CV-Dazzle*, a face paint scheme that can be used to subvert some older forms of facial recognition. There are many projects in this vein, each with varying targets and degrees of efficacy.

If you like this project, you may enjoy one of my other projects, the *Opt-Out Cap*, a DIY adversarial wearable that allows you to quickly misdirect facial recognition systems by substituting someone else's face. A full guide on how to make your own can be found here: https://www.macpierce.com/the-optout-cap

The Camera-Shy Hoodie was designed and published by Mac Pierce in over the course of 2022-23. You can find more of his work at: https://www.macpierce.com

If you found this guide helpful, consider supporting the open-source publishing of my work by donating at: https://www.ko-fi.com/macpierce