



Make a Pocket LED Cube

This weekend, you can make a 3x3x3 Pocket LED Cube that you can program with your own animations!



This is one of those projects that fell together perfectly. Recently I traveled around Europe with some friends on a tour of hacker spaces and one of the clubs that we visited was Das Labor (<http://das-labor.org>). Two of the hackers there, Peter and Martin, had made these amazing LED cubes that were 5x5x5 and 8x8x8. They had even made a cube with RGB LEDs that blew our minds. These things were so cool we just had to make one! I had Mitch Altman (<http://tvbgone.com>) and fellow hacker tour adventurer George Shammass (<http://nycresistor.com>) over to make a plan to get parts and order everything we would need and quickly we realized we could hack Lady Ada's awesome and open source minipov3 to use it as a microcontroller platform and create a super simple 3x3x3 cube. You can make one too!

What you'll need:

Soldering Iron

Solder

Minipov3 (available at <http://store.makezine.com>)

47 Ohm resistor (Yellow purple brown stripes)

27 LEDs (8 come with the kit, but it will be better to them all the same)

Wire

Case for it all to go in.

Drill and a bit that is the same width as your LEDs for the jig.

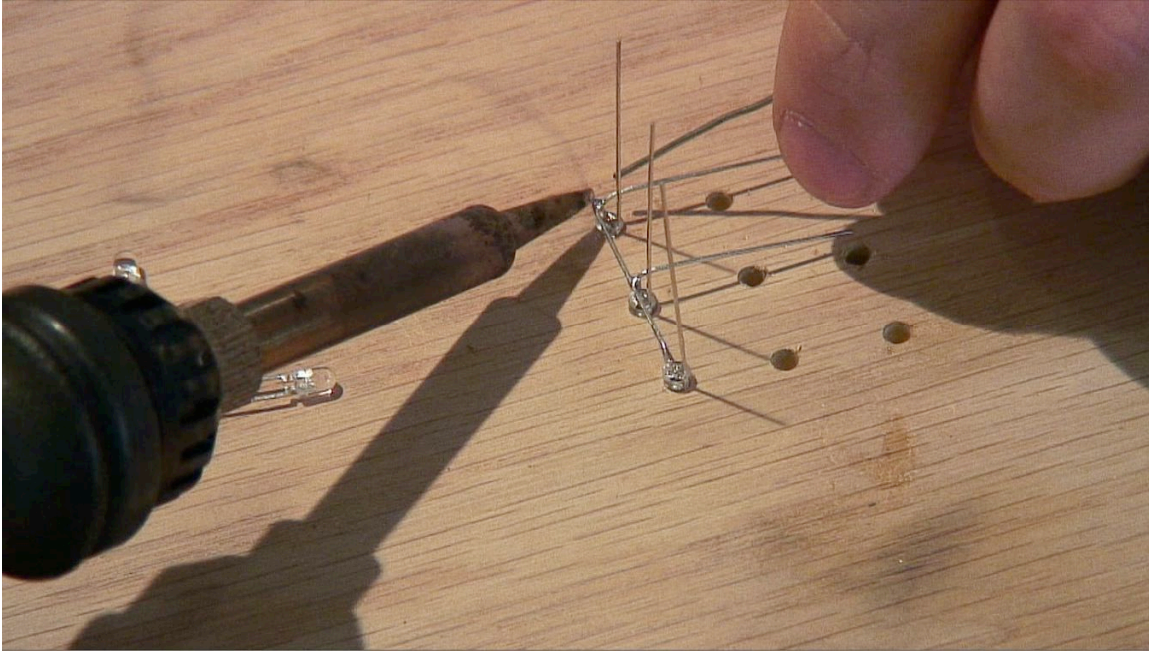
Scrap of wood to drill holes in.

Make a jig for the LEDs

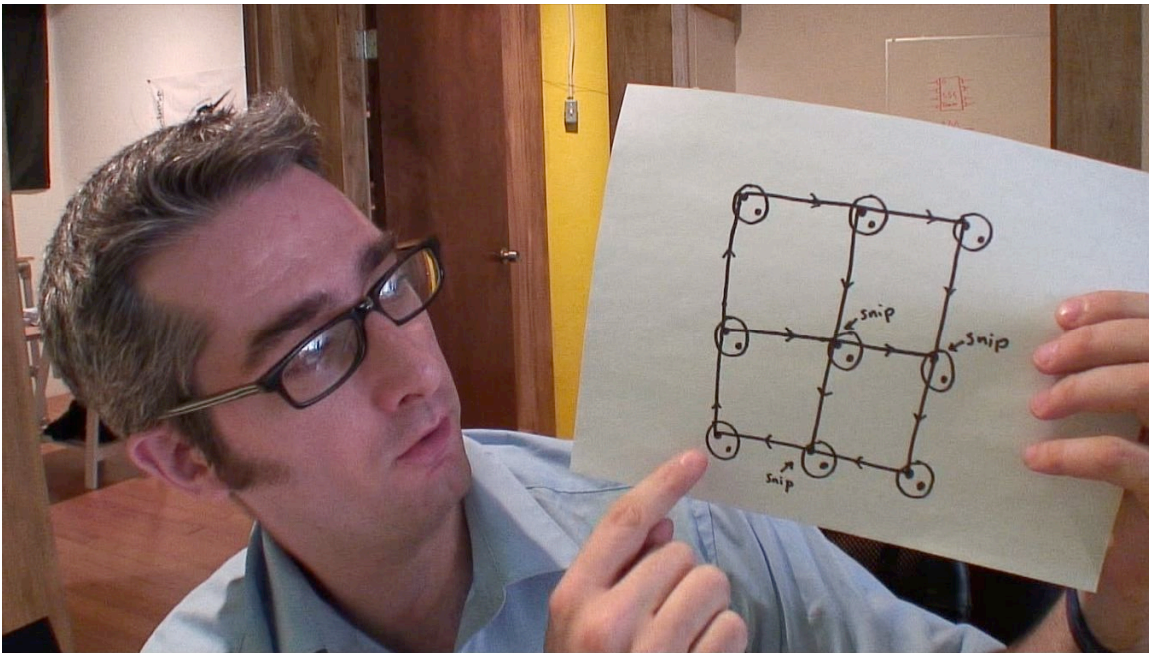


In order to get the LEDs to be in a perfect grid, make a simple jig. Use a 9/64 inch drill bit for 3mm LEDs. First draw out a simple pattern on graph paper and then drill 9 holes in it. You're ready to solder up a level of the cube!

Solder together the 3x3x3 cube



Put your LEDs into the grid diagonally in the same configuration. This will help later when you stack the layers. Then bend the cathodes over so that they all overlap.

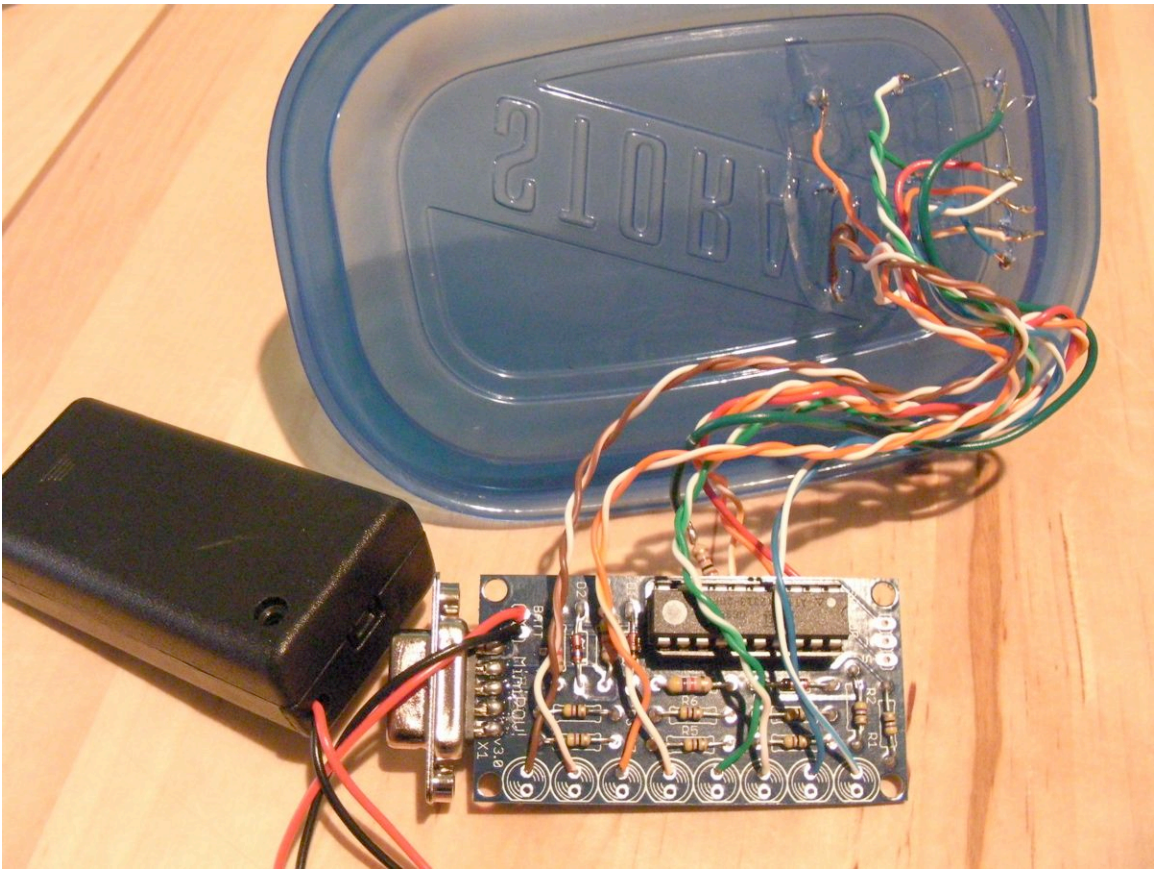


I made my pattern as shown in this diagram, but you can do it however you like! The goal is to have all the cathodes on a level connected. In order to light up an LED your going to send power to on of the 9 anode leads and you'll put a lead that goes to all the cathodes to ground. An LED will light up!

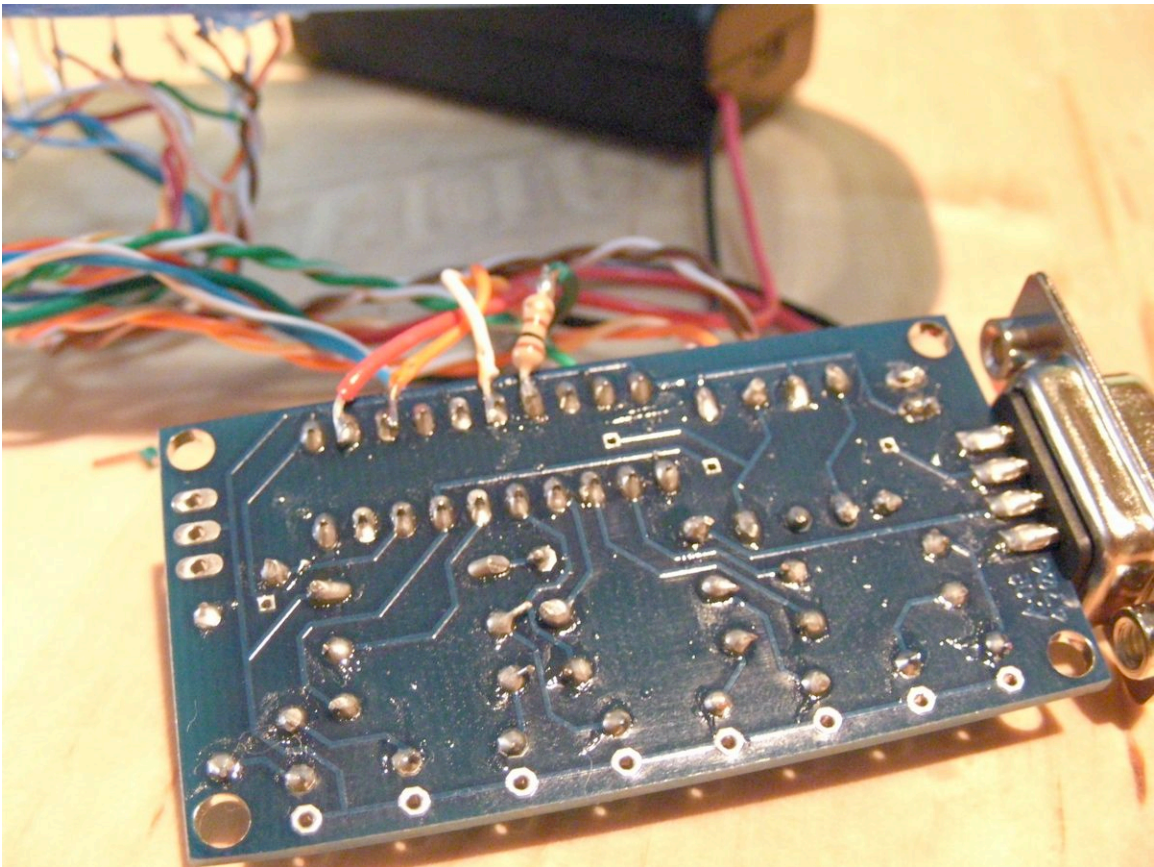
If you need help soldering, go check out my soldering video:

http://www.makezine.com/blog/archive/2007/01/soldering_tutor_1.html

Put together the MiniPov3 kit and mod it for the LEDs



Top of the board



Bottom of the board.

We built our LED Pocket Cube on open source MiniPov3 kit. You don't need the kit to make this, but it makes it easier and more organized to have a board to build on.

Lady Ada created this persistence of vision kit and put up a great instructable for you to go to and learn how to put it together!

<http://www.instructables.com/id/E08O6GY3PEZ7BGM6J?ALLSTEPS>

Instead of installing LEDs on the board, run wires to the bottom of the cube. You'll connect 9 of them to the 9 anode columns and a wire to the cathodes that are all connected on each level of the cube.

Since all of the cathodes of a layer are connected together, and all of the anodes of a column are connected together, to light up one LED you ground it's cathode (shared with all LEDs on its layer), and put +3v on its anode (shared with all LEDs in its column). But what happens if we want to light up two LEDs? Let's say that we want to light up the one on the top layer in the rear-right corner, and the one on the bottom layer in the front-left corner. To do this, we ground the cathodes on the top layer and bottom layer, and put +3v on the rear-right column and on the front-left column. Unfortunately, this lights up 4 LEDs! Here's the 4 that light up: the rear-right corner LED and the front-left corner LED on both the top and bottom layers.

We can use Persistence of Vision (POV) to allow us to make it appear that we can light up any arbitrary LEDs at once. Any light that hits our eyes remains there for several milliseconds after the light goes away. This is why we perceive movies as moving images rather than a series of still pictures, and it is also why we perceive images on computer monitors rather than a whole bunch of lines and dots lighting up in sequence.

To make use of POV on the firmware, we only light up LEDs on one layer at a time (by only ground the cathode of one layer at a time): first the top layer, then the middle, then the bottom layer, and then repeat. If we cycle through the layers quickly, then it can look as if we are seeing LEDs on all of the layers being lit up at once.

Program the microcontroller

You have to download and install some software. Go to Lady Ada's Site and read these instructions on dealing with the software and install what you need to install for your operating system.

<http://ladyada.net/make/minipov3/software.html>

That wasn't hard because Lady Ada is a tutorial ninja! After getting your computer all set up, you'll need the firmware made for this cube.

Download and unzip this file: <http://cachefly.oreilly.com/make/LEDcube.zip>

In this folder are 3 files. Makefile is the program that lets you program the chip and ledcube.c and ledcubetest.c are both firmware to load onto the chip with different animations. Ledcube.c is the animation that you can see in the video and ledcubetest.c is a program that turns each LED on one at a time in turn.

In windows, in the software's command window you'll type: make
ledcube.hex

Then you type in: make program-ledcube.c

If you don't have a serial port, you need a usb to serial converter and you'll have to adjust the delay as per the instructions on Lady Ada's site.

This all sounds rather confusing, but when you've got it all set up it'll just take you a moment to reprogram it with your new program.

Make your own animations

If the ledcubetest.c and ledcube.c get boring, you can make it do whatever you want! I'm hoping someone will make an animation of a plus sign twisting and turning.

It's not hard to make new animations. In the part of the code that looks like this, you'll see that each bit looks something like 0b000 the first 0b is to say "this is a bit" and the other three are there to show which LEDs in a row are on. Here's the test program:

```
{ 0b001, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b010, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b100, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b001, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b010, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b100, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b001, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b010, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b100, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b001, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b010, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b100, 0b000, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b001, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b010, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b100, 0b000, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b001, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b010, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b100, 0b000, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b001, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b010, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b100, 0b000, 0b000, 50000 },
{ 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0b000, 0 }
```

You can see that each line only has one "1" in it. That's because it's only lighting one LED up at a time.

I can't wait to see what kind of animations you make up. Send me an email with any animations you make to bre@makezine.com.

Make sure to take pictures and upload them to the Make: flickr pool. If you can take video, do that too!