Wearable technology is futuristic. Imagine the clock maker who first made a watch small enough to be worn on the wrist. I would have been ecstatic at the thought of knowing the time just by looking at my arm. Watches that merely tell time aren’t futuristic but wearable technology is as exciting as ever. Smart watches and activity trackers, like FitBit, have replaced purely mechanical watches but the fact that people want technology at their fingertips, or a few centimeters behind them, won’t change anytime soon.

As I am making a cyberpunk (Shadowrun decker) costume I wanted to exemplify the desire to have high technology at hand. It’s a neat costume piece because the things we keep readily accessible are shown to be the things which matter to us. In the case of the costume I wanted to have a keyboard ready to go at a moment’s notice. To add the futuristic quality I wanted it to move by servo motors on a couple of four-bar linkages. Originally I had planned to use a linear slide, like a hidden blade from AC but that presented too many problems and didn’t have the look I wanted.

A single servo would probably have enough power to move my ultra-portable chording keyboard but servos are inexpensive and I am all about the symmetry. Fortunately I tested all the servo synchronizing so you don’t have to worry about that. When you’re building this contraption you should be able to move something that weights as much as a cell phone with no problem. That could be a screwdriver or dinner fork. Unless you need to kick it up a notch and have a hidden pocket knife. What do you keep close to yourself and want accessible at the flick of your wrist?

Another important aspect of this project was the method in which the rig was triggered. It was important that it NOT interfere with normal movement. The worst kind of wearable is one that reminds you that it is there or keeps you from doing ordinary actions, like picking up a book. For that reason I have made infrared emitter-receiver tubes to act as a proximity switch capable of reading at the length of a hand, 20cm or 6”. This piece is adjustable so you don’t have to worry about triggering until you fully extend your wrist back. Unless you want to trigger with a slight twitch.

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Parts

I’ve assembled a neat little package with all the files needed for this build. Half of the parts are 3D printed and the other half are ordered. The list I’ve built has links for everything which can’t be found in a hardware store. I’ll add the unlinked list here so you can see what is needed before starting.

**Wrist mounted rig**

Parts:

* 2@ #2 wood screws
* 2@ #6 1/2" bolts
* 5@ #6 4" bolts
* 4@ #6 nylon insert lock nuts
* 2@ [SG90 servo motors](http://www.ebay.com/sch/i.html?_odkw=sg90&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.H0.Xsg90+-axis.TRS0&_nkw=sg90+-axis&_sacat=0). Each comes with 2 servo mounting screws, a servo horn, and a horn screw. MG90 servos can also be used.
* Wrist band

**Servo controller and proximity detector**

Parts:

* 1@ Controller
  + [Arduino Pro mini](http://www.ebay.com/sch/i.html?_odkw=sg90+-axis&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR12.TRC2.A0.H0.Xarduino+pro+mini.TRS0&_nkw=arduino+pro+mini&_sacat=0). A [USB↔Serial adapter](http://www.ebay.com/sch/i.html?_odkw=arduino+micro+leonardo&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR4.TRC2.A0.H0.Xarduino+ftdi.TRS0&_nkw=arduino+ftdi&_sacat=0) is also necessary but not permanently installed
  + OR
  + An [Arduino Micro](http://www.ebay.com/sch/i.html?_odkw=arduino+pro+mini&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.H0.Xarduino+micro+leonardo.TRS0&_nkw=arduino+micro+leonardo&_sacat=0) could be used which doesn't require a USB↔Serial adapter
* 1@ Protoboard or [stripboard](http://www.ebay.com/sch/i.html?_odkw=protoboard&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR6.TRC2.A0.H0.Xstripboard.TRS0&_nkw=stripboard&_sacat=0)
* 1@ 10K linear potentiometer
* 6@ [Straight header pins](http://www.ebay.com/sch/i.html?_odkw=40pcs+header+pins&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.A0.H0.X40+header+pins.TRS1&_nkw=40+header+pins&_sacat=0)
* 4@ [2 position screw terminals](http://www.ebay.com/sch/i.html?_odkw=scew+terminal+pcb&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.H0.Xscrew+terminal+pcb.TRS0&_nkw=screw+terminal+pcb&_sacat=0)
* 1@ [USB micro breakout board](http://www.ebay.com/sch/i.html?_odkw=screw+terminal+pcb&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR1.TRC0.A0.H0.Xmicro+breakout.TRS0&_nkw=micro+breakout&_sacat=0)
* 4@ #6 black screws
* 1@ #6 3/4" bolt
* 1@ #6 nut
* 2@ #6 nylon washers
* 1@ [5mm RGB LED](http://www.ebay.com/sch/i.html?_odkw=rgb+led+20pcs+5mm&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR0.TRC0.A0.H0.Xrgb+led+5mm.TRS1&_nkw=rgb+led+5mm&_sacat=0)
* 1@ [TSAL6100](http://www.ebay.com/sch/i.html?_odkw=rgb+led+5mm&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR12.TRC2.A0.H0.Xtsal6100.TRS0&_nkw=tsal6100&_sacat=0)
* 1@ [TSOP4856](http://www.ebay.com/sch/i.html?_odkw=tsal6100&_sop=15&LH_BIN=1&_osacat=0&_from=R40&_trksid=p2045573.m570.l1313.TR7.TRC2.A0.H0.Xtsop4856.TRS0&_nkw=tsop4856&_sacat=0)
* Liquid tape

Sorry it’s not a smaller list. All the Arduino code is included so if you want to replace the proximity detector with a physical switch it would be possible with only a few code tweaks. If you’re tweaking the code you may want to have some fun with the RGB LED. I didn’t do much with it other than fade red ↔ green as the servos move so you can have some fun with that.

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Printing

Print at 100% scale.

Hopefully you don’t need my help to print the parts. All the STL files are necessary to build the whole project. If you’ve decided to use alternate parts, such as a physical switch in place of the proximity sensor print only what you need. All the OpenSCAD code is included so you can add holes to the enclosure or whatever or make the emitter-receiver tubes a different length. There is also my home-brew enclosure module if you want to make custom enclosures with maximum internal space.

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Soldering

This will not be a soldering lesson. Instructables has many good soldering instructions so another set simply doesn’t belong here. Schematics have been included to make this as simple as possible.

I recommend making a terminal board, which is just a segment of protoboard or strip board that has space for all the terminals and a potentiometer. This isn’t strictly necessary but may keep you from tearing your hair out. I used 26AWG copper wire. Most of it was stranded but I wish I had used solid.

It is worth noting that the wires going between the controller enclosure and the proximity detector used a salvaged Ethernet wire. I needed seven wires and Ethernet has eight so it worked out well. These wires were put into the screw terminals on the controller side. On the emitter-receiver tube side they were soldered to another piece of protoboard. This allows you to replace the emitter-receiver tube if you want to try different hardware like a reed switch or a commercial proximity detector.

The servos are connected to three position header pins so they can also be removed or replaced. These could be soldered directly but that makes servicing difficult.

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Programming

If you chose the Arduino Pro Mini you will need a USB ↔ Serial adapter. I don’t want to go into how to program Arduinos because that is covered by lots of fellow makers here on Instructables and they have done great jobs of explaining all of it.

To get fancy you can check out my code on Codebender.cc and edit/upload right from your browser. I love this site and have donated to them because they do a great job and don’t charge for their service.

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Assembling

Some of the spacers look similar in height but if you group them in the order they printed you won’t have any trouble assembling them correctly. The Wikipedia page on four-bar linkages will also give you an overview of how the machine works but when you see it in action it will all make perfect sense.

The labeled image included with this step shows where everything goes and gives it a name. Many of the pieces have an identical twin and they can be swapped around freely without a problem.

The tricky part is attaching the servo motors to the servo arms. The servo arms were modeled to have the servo horns go through the servo arms. This was done to reduce clearance and provide stability. A picture above shows how the servo arm attaches. Don’t forget to add the screw to keep the servo horn in place.

Everything should be ready to receive power now! Be sure to use a large enough USB power supply or your servos won’t go. The voltage regulator on the Arduino won’t have enough power.

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Thank you for reading. This Instructable was over 1200 words yet the whole process took over THREE MONTHS to complete and I posted in my blog daily so there’s a lot more to read if you like details. There were a bunch of instances where I took a time gamble and lost but I report my failures too so that people like you can observe the whole process.

My decker costume will continue. This rig will bring a keyboard to my right hand but my left arm will hold a set of lock picks. The twist is that the lock picks will be held on over-engineered cases meant for quick retrieval. These costume pieces were designed to be functional as well as look futuristic.

Demonstration video

<https://www.youtube.com/watch?v=ZEqZ_gmpBL4>

Package

<https://dl.dropboxusercontent.com/u/83724170/drawingsprints/ChordingKeyboardPackage/WristRigAndProximityDetector.zip>