Kinograph v0.1 - DIY Film Scanner/Telecine - Machine Assembly

by **mepler** on February 22, 2014

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Intro: Kinograph v0.1 - DIY Film Scanner/Telecine - Machine Assembly

This is a set of assembly instructions for the Kinograph (http://kinograph.cc), an open source film scanner for digitizing 35, 16, and 8mm film. This project is in active development and is in its very beginning stages. The v0.1 is the first released version and is considered experimental. Please visit the website for the most up-to-date information and to join the community to help improve the project.

While living and teaching in Jordan, I discovered a collection of 850 orphaned film canisters. With no financial support for their digitization and no equipment in Jordan to view the films, I decided to make a machine that could be built there with parts easily purchased online and with cameras that my students had available. The result is the Kinograph, which was made while I was a student at NYU's Interactive Telecommunications Program. More information the collection of films found in Jordan can be found here. I plan to return to Jordan with the Kinograph in 2014 to digitize the films and make them available online.

This scanner is made to work with consumer cameras such as a DSLR, micro-4/3, etc. The one requirement is that the camera you plan to use has a remote shutter cable. Here is an example. PLEASE NOTE that consumer cameras have mechanical shutters (that clicking noise you hear when you take a picture) that will wear out. If you use your camera to digitize large amounts of film, it will need repairing. As a reference, the Canon 5DmkII has a shutter life of ~300,000 shots. This means you could comfortably capture 200 minutes of film before repairing the shutter. Obviously, this is not ideal. Kinograph is an ongoing experiment and designs are in the works for a more robust camera system that does not require mechanical shutters.

Kinograph also comes with software which is discussed later in this Instructable. It too is going through constant development and the latest version can be found on Github.

The work currently being done on the project includes:

1. Development of software application for Mac OSX, Windows, and Linux.

2. Design of separate 8mm capture machine and accompanying Kickstarter campaign.

3. Lab tests on an industrial version that uses a camera with a global shutter.

4. Building a community portal where users can share their progress and design changes.

5. Making a kit of parts and/or fully assembled Kinographs available for purchase.

If you have questions regarding this Instructable or the project in general, please contact me via email: info@kinograph.cc

Step 1: Parts List

The materials used in this build are suggestions. You could build the frame out of other materials, use different motors, etc. This build has been tested and works reliably.

Any item with a star next to it could be replaced with another part of your choice for a cheaper build. I chose to go with these parts because when I was building it, I didn't have a fully realized design yet and these 80-20 compatible pieces allowed flexibility and ease of ordering so I could get to the first build quickly and modify it from there. They're definitely overpriced and can be replaced with other parts but I have not had the time yet to try other parts. Let me know if you do!

NOTE: prices do not include tax or shipping.

TOOLS

5/32" allen wrench

Hacksaw or chop saw with metal blade

1/4-20 tap

screwdriver

acrylic cutter or bandsaw

assorted drill bits

optional: step-up bits for drilling acrylic

small level

soldering iron + solder

hook-up wire

PARTS (total cost ~ $1,075)

1" 80-20 T-Slot Aluminum -18 ft. total (3x 6ft. @ McMaster Carr = $59.37)

T-Slot bolts and nuts - 60 total (15x 4packs @ McMaster Carr = $34.50)*

3-way T-Slot corner connectors - 12 total (McMaster Carr = $118.32)*

Adjustable leveling feet w/ 1/4-20 thread bolt - 12 total (Amazon or other = $12.12)

Panel holders - 22 total (McMaster Carr = $108.90)*

Sheet Acrylic - 2x 12"x12" colored (orange), 2x 12"x12" black, 1x 6"x12" colored (orange) (McMasterCarr or other = $47.10)

9x 1.5" standoffs, 10-32 thread (McMasterCarr = $11.44)

16x 10-32 bolts, 3/4" (pack of 25 @ McMasterCarr = $5.61)

Size 10 flat washers (pack of 100 @ McMasterCarr = $2.28)

2x Gear Motor (Surplus Sales = $69.90)

2x flexible shaft couplers - one side should match your motor shaft size and the other side needs to be 8mm (I got mine at RW couplings for approx. $125)

2x 8mm steel shaft (McMasterCarr = $11.56)

3mm x 3mm key stock (McMasterCarr = $13.92)

2x 9" lazy susan bearing (McMasterCarr = $13.56)

1/4-20 threaded rod, at least 16" (McMasterCarr = $ 2.62)

1/4-20 nuts (pack of 20 @ Home Depot = $1.18)

1/4-20 washers(pack of 25 @ Home Depot = $2.46)

Bearing shims (pack of 25 @ McMasterCarr = $9.48)

Assorted small screws and nuts. If you don't have any laying around, a small kit will do the trick. (Amazon = $3.77 + shipping)

Circuit board (Radio Shack = $3.49)

4x 0.75" standoffs + screws (Radio Shack = $1.99)

4x 1.5" 1/4-20 bolts (Home Depot = $2.36)

Magnetic Strip (Home Depot = $3.98)

5-min epoxy (Home Depot = $5.28)

2x 90-degree 0.75" bracket (Home Depot = $1.97)

LED diffusion material (Amazon = $19.00)

2" T-slot extruded aluminum, 12" (McMasterCarr = $12.85)

2x 8-hole t-slot compatible plates (McMasterCarr = $14.60)*

1x 4-hole t-slot compatible 90-degree brace (McMasterCarr = $5.58)*

Microscope (for parts), should have a vertical adjustment (coarse + fine) and a horizontal plate for mounting additional camera plates. (Amazon = $107)

2" t-slot compatible sliding bearing (McMasterCarr = $46.16)

Hand-brake for sliding bearing (McMasterCarr = $10.17)

Roller Switch (Jameco = $1.95)

Relay Switch (Jameco = $2.75)

Arduino + USB cable (Amazon = $33.99)

Camera shutter cable - see description and link in previous step (est $50)

Jumper wire, hookup wire (available on Amazon or Radio Shack, est. $5.00)

12V power supply (buy a plug-in power supply that can run at XXamps -to complete- or buy a bench power supply which I recommend having around: Jameco = $99.95)

2.2K resistor (Amazon = $1.49)

TIP120 transistor (Amazon = $2.59)

Mini breadboard w/ jumper wires - optional - (Amazon = $6.49)

Alligator clip wires (Amazon = $6.78)

Step 2: Reel Platforms

The reel platforms support the reels on a flat surface and are used to mount the motors for advancing the film. You will need to build TWO of these.

1: Cut the following pieces of 80-20 T-slot aluminum and tap each end with a 1/4-20 tap. You should tap them to a depth of about 1/2". See step 3.

8x 12" (arms - positioned horizontally)

8x 3.75" (legs - positioned vertically)

2: Slide two nuts into each 12" piece. The side you put them in will face down.

3: Connect the pieces with the 3-way connectors. NOTE: I cut the bolts that were included with the connectors to half of their length so that I didn't have to tap the aluminum more than 1/2".

4: Attach the panel holders, 2 per 12" bar. This will hold the acrylic sheet. Don't tighten them all the way so that you can adjust them when you place the acrylic in.

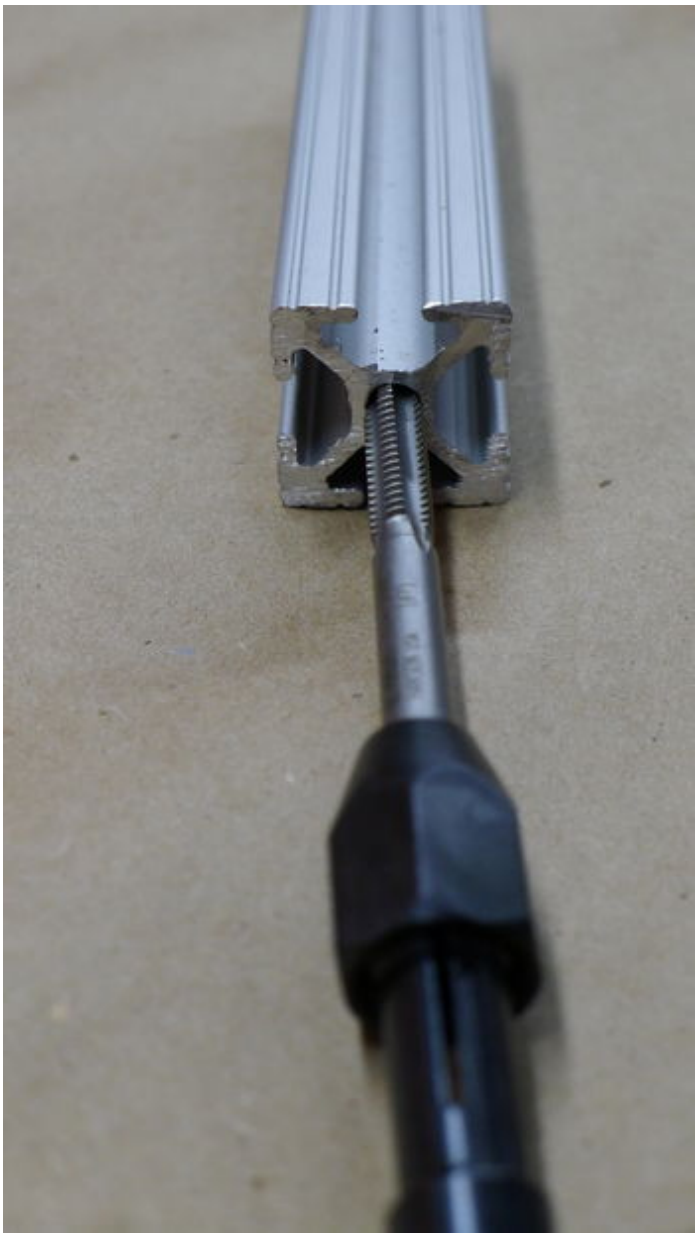
5: If you have access to a laser cutter, you can laser cut the acrylic for the platform with this file. If not, you will need to drill holes as labeled in the file. One way to do this is to print out the file onto paper (may have to split it between two sheets and tape them together), and tape it to the acrylic and drill where you see marks for holes. I recommend using step-up bits for drilling acrylic, or you can just go really slow on your regular drill/press.

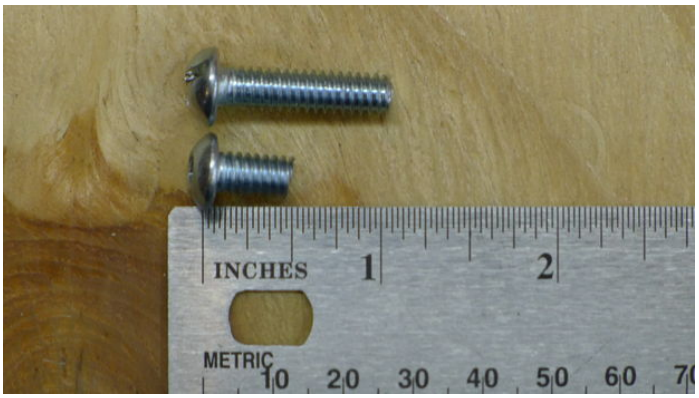
6: Insert the acrylic. Slide the panel holders into position and tighten them underneath. Bolt it to the panel holders using the 1/4"-20 80-20 flat-head bolts. If the holes don't quite line up, bore them out as necessary.

7. Locate the four outermost holes in the middle of the acrylic. Insert a 10-32 machine screw from underneath with a 10-32 flat washer to match and slide another washer onto the bolt from the top. Screw on the 1.5" stand-offs.

8. Solder lead wires onto the terminals of your motor.

9: Mount the motor with 10-32 machine screws. It's a good idea to affix the shaft coupler to the motor shaft at this point. In the picture only the bottom half of the coupler is shown. NOTE: If you were unable to source the motor I used (see parts list), then the mounting holes in the acrylic will be different and you will need to drill them yourself. The center of the shaft will need to be aligned with the center of the large hole in the middle of the acrylic.

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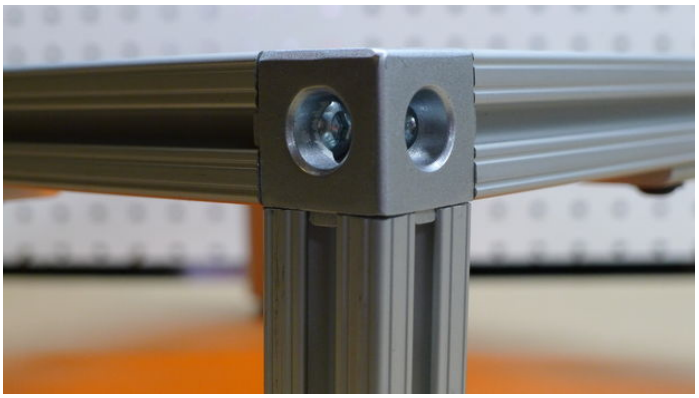

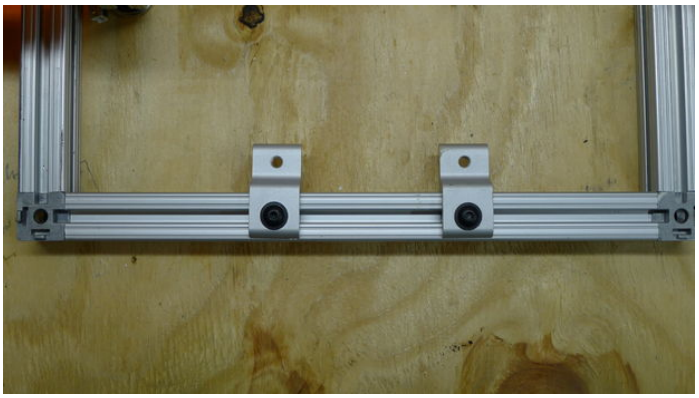

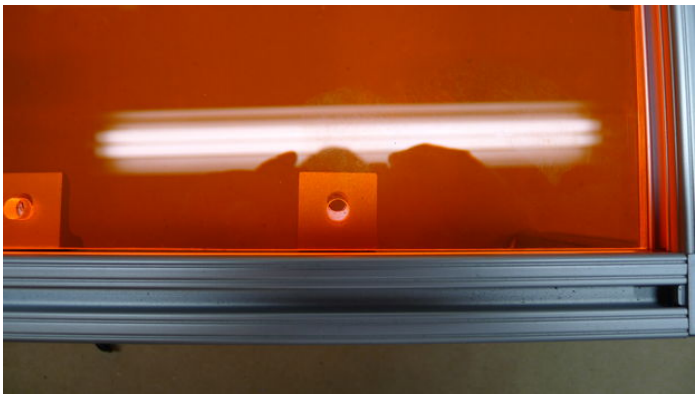

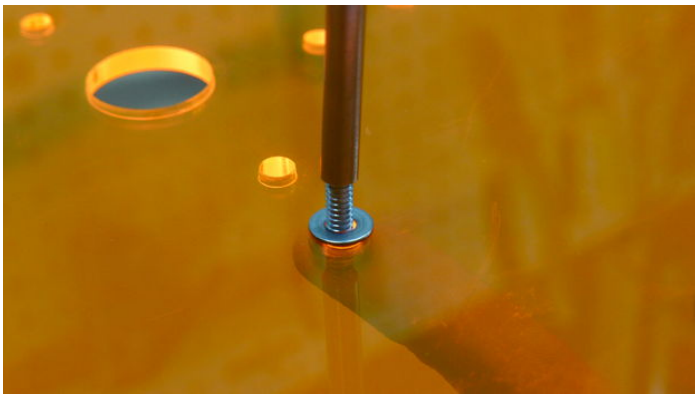

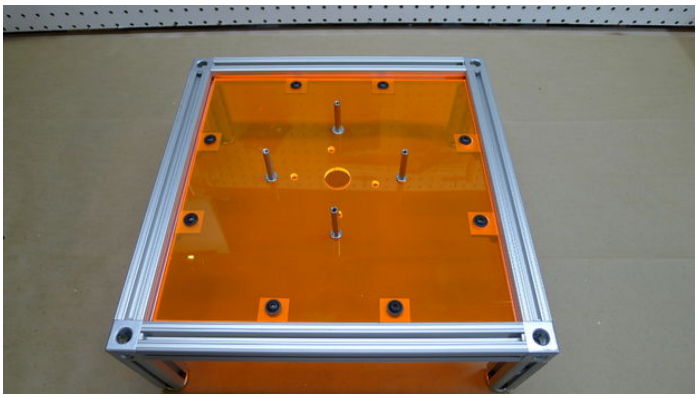

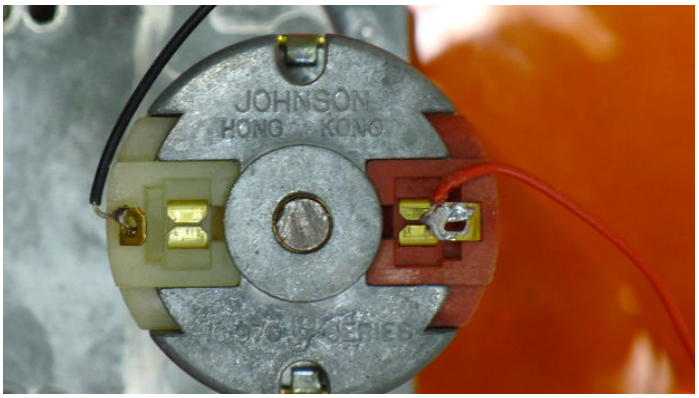
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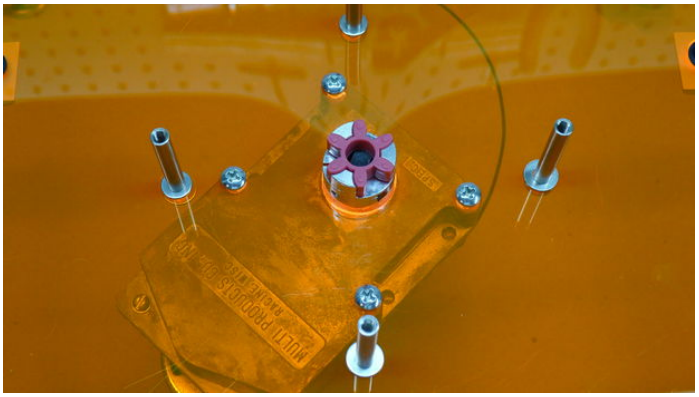
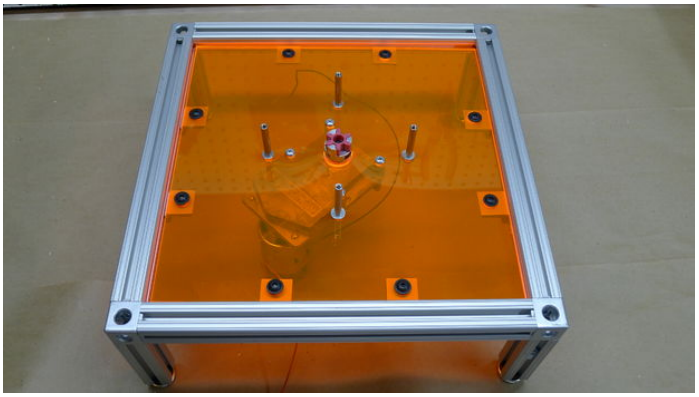




Step 3: Lazy Suzan Platform and Shaft Assembly

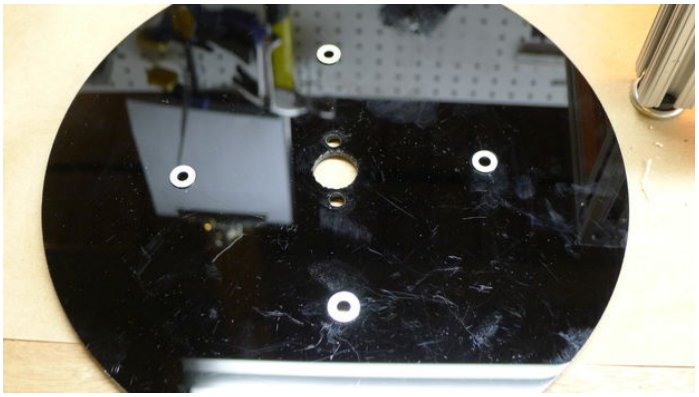
The lazy susan platforms allow the reels to rotate smoothly while the machine is running. It is raised up from the platform by the standoffs to allow for the shaft coupler. These instructions are for both platforms built in the previous step, so you will need to do everything twice.

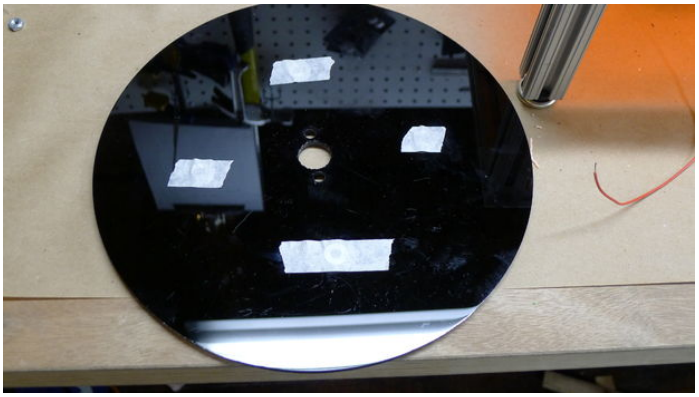
1: Cut out the acrylic support disc using this file. If you do not have access to a laser cutter, a round shape is not necessary, just the holes.

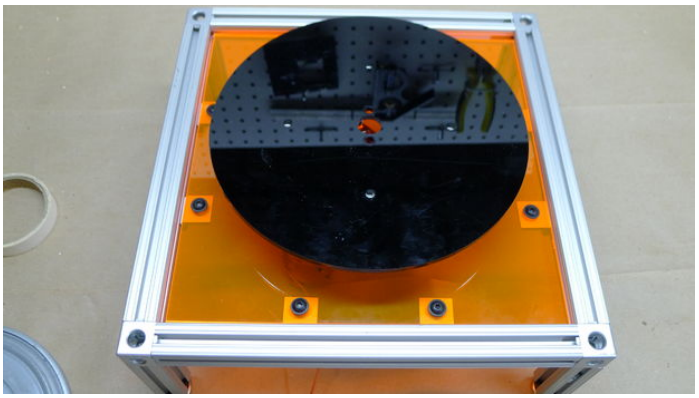
2: Place 10-32 washers on top of each of the four holes and hold them in place with masking tape.

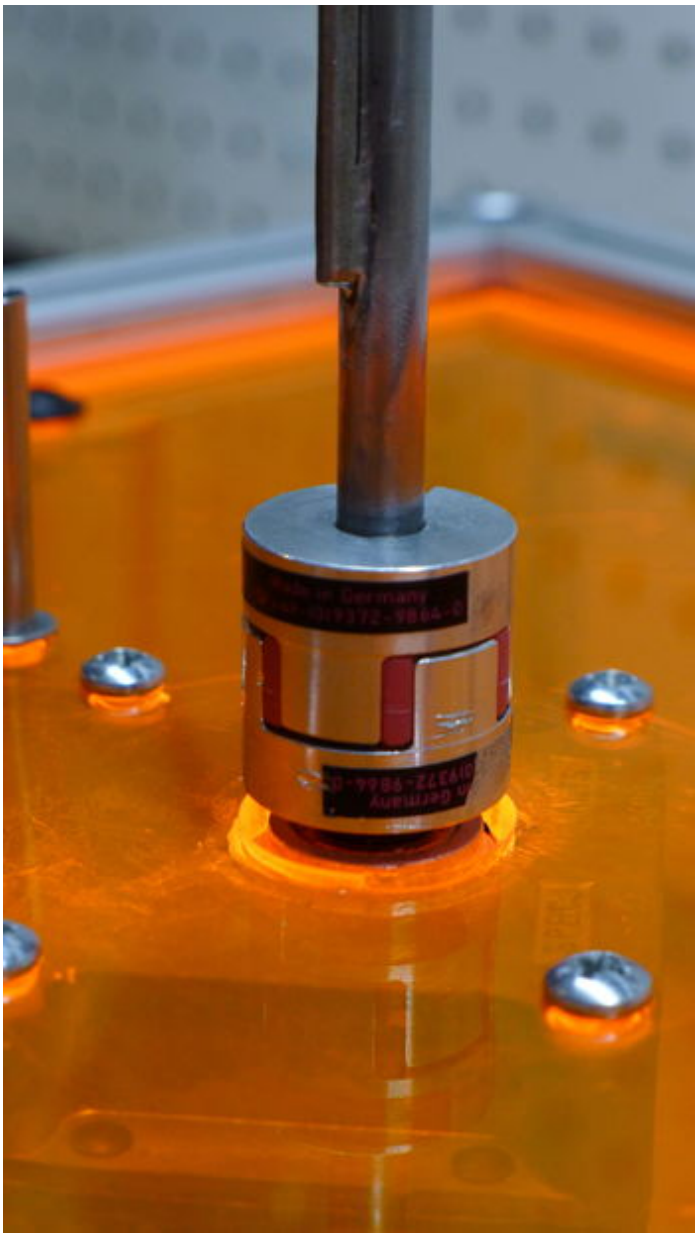
3. To make the shafts, you will need two 8mm steel shafts and 3mm x 3mm key stock. The key stock is cut into 2x 2.25" lengths and welded (by a local shop) onto the steel shafts approx. 1.5" from one end. Insert the short end of the shaft into the other end of the coupler and tighten.

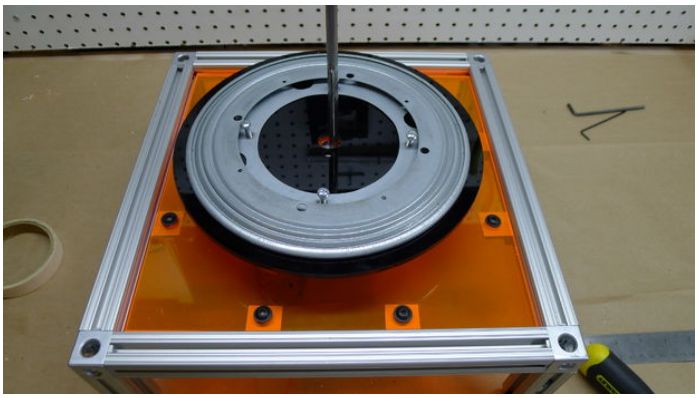
4. Flip the acrylic plate over so that the washers meet up with the four standoffs on the platform. Line up the lazy susan bearing with the four holes and use 10-32 screws to tighten everything down. Also tighten the screws on the bottom of the platform. NOTE: the alignment of everything will be easier if you loosen the screws on the bottom of the platform attached to the standoffs so that they can wiggle around a bit. Once you have screws going into the standoff from both sides you can start tightening.

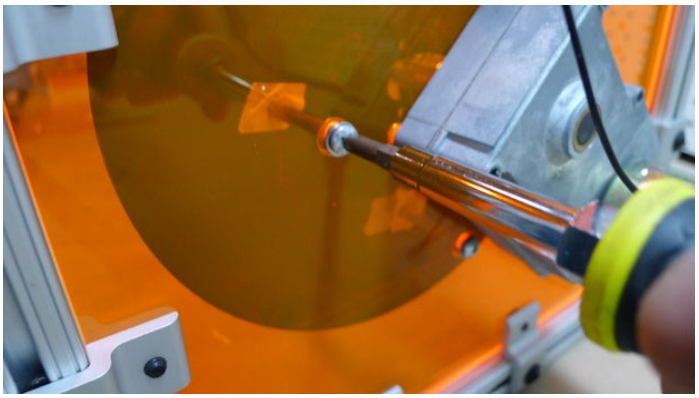












Step 4: Gate Platform Assembly

The gate platform will support the gate and rollers.

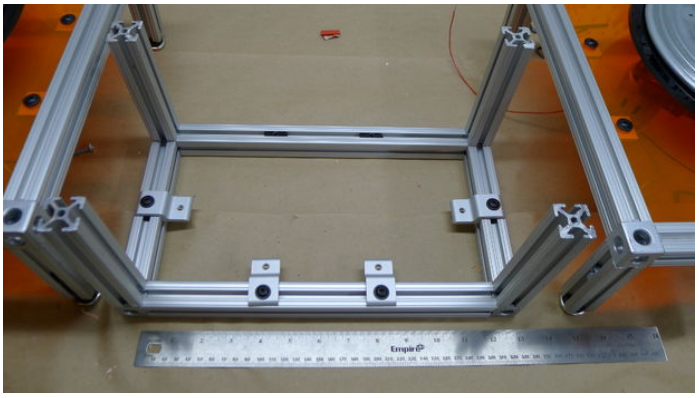
1: Cut 2x 12" and 4x 5.25" lengths of 80-20 T-slot aluminum and tap both ends of each piece with the 1/4-20 tap.

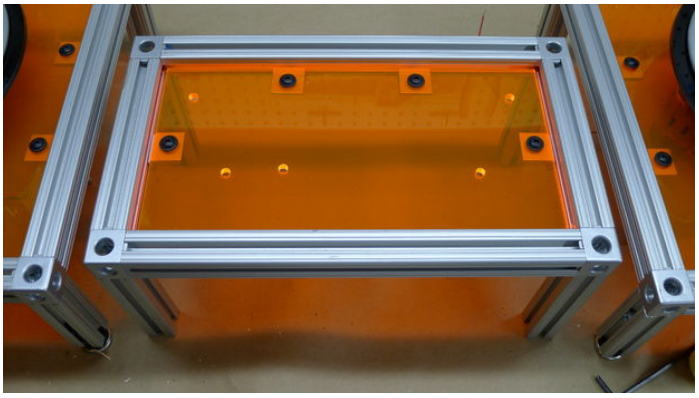
2: Attach the panel holders, 2 per long side and 1 per short side of the platform as shown (you'll see I was missing two on one side but the parts list has been updated and you should have all 6). Do not tighten all the way.

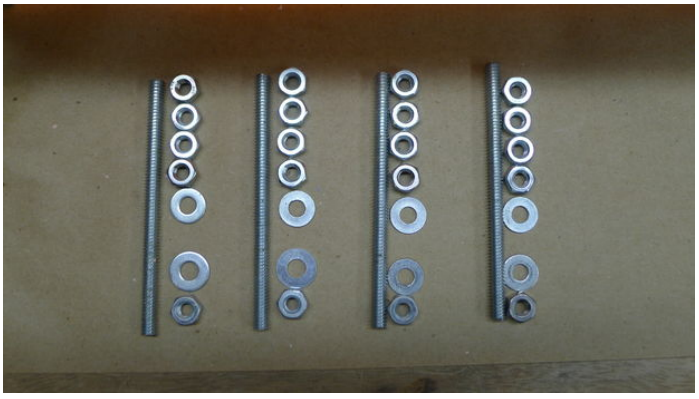
3. Attach the pieces of 80-20 using the 3-way connectors.

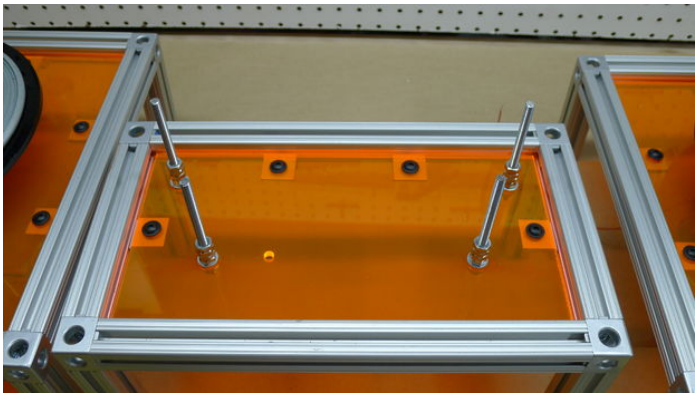
4. Cut the acrylic platform using this file and attach it to the platform holders and tighten everything down.

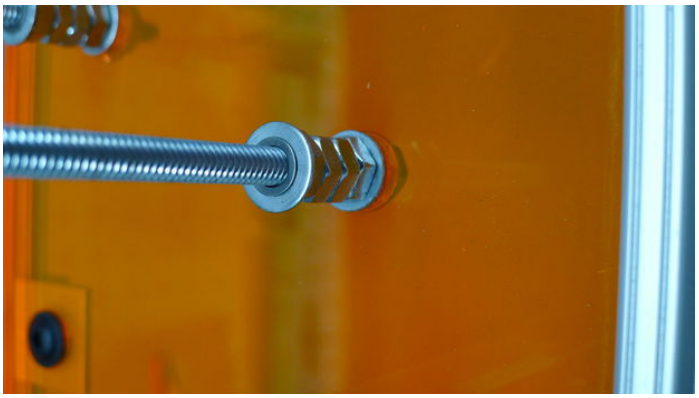
5. Cut 4x 4" lengths of the 1/4-20 threaded rod and assemble the posts in the holes as shown. There should be one 1/4-20 nut and 1/4-20 washer on the bottom side of the acrylic. On top, lay a washer, 4x 1/4-20 nuts, another 1/4-20 washer and add a bearing shim on top. The order and number of these nuts and washers can be adjusted later to align the rollers with the height of the film as it comes off of the reels.











Step 5: Gate Assembly

The gate provides illumination and a structure for guiding the film into position for photographing.

NOTE: This is the area that needs the most improvement and will be the focus of future iterations. It's a hack, I know. But it works, I promise.

1: Align and mount the LED panel onto a circuit board as shown with small machine screws and nuts to hold it in place. You will need to drill small holes for the bolts. Add a bit of hot glue to the back if you want to make it more secure.

2: On the back of the circuit board, connect the white leads (ground) and grey leads (power) as well as a piece of wire leading to each side for connecting to our Arduino circuit later.

3: Cut out the gate pieces from the 6" of acrylic leftover from the gate platform with this file. There are 3 pieces. The largest is the main gate and is attached directly to the circuit board and LED assembly. The other two are gates. The one with the larger window is for 35mm and the smaller one is for 16mm film. Currently there is not gate for 8mm.

4: Put 4x 1.5" 1/4-20 bolts through the four holes around the main gate window and tighten with nuts on the front side (Looking at the front, the window is on the right side). On the left side, put two 90-degree braces underneath the heads of the screws (see image).

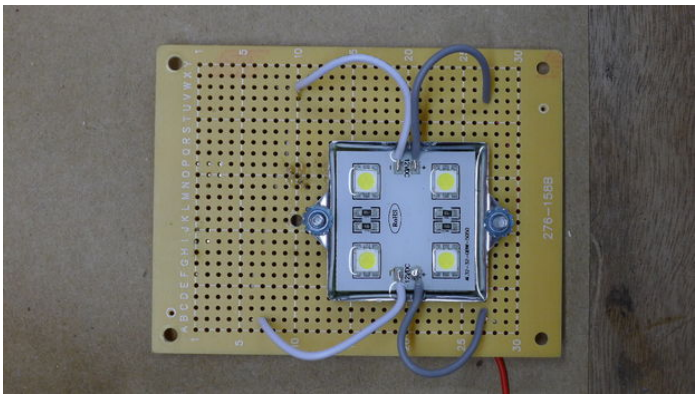
5: With epoxy, glue a piece of magnetic strip on either side of the window. This will be used later to attach film guides.

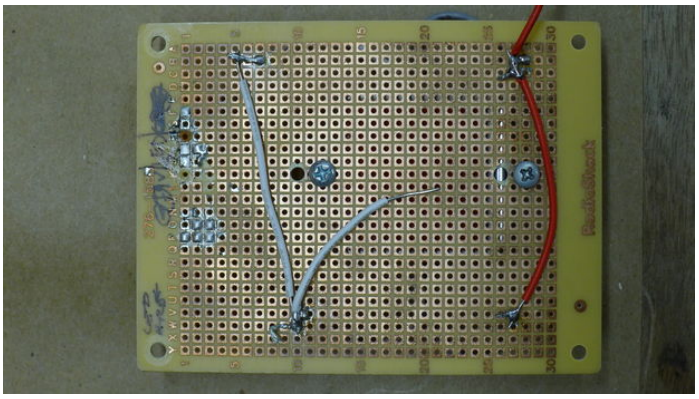
6. Thread two 0.75" standoffs facing backwards through the top holes of the main gate.

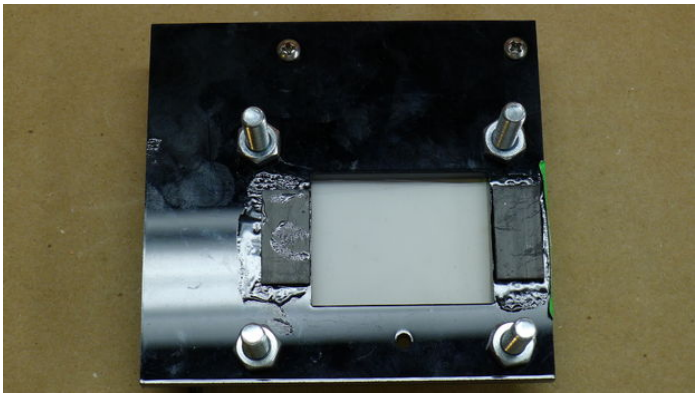
7. Attach diffusion material to the back of the window of the main gate. In my case, I took the LED diffusion film out of an old monitor and cut it into small squares. I stacked 6-8 of them and taped them to the back of the gate.

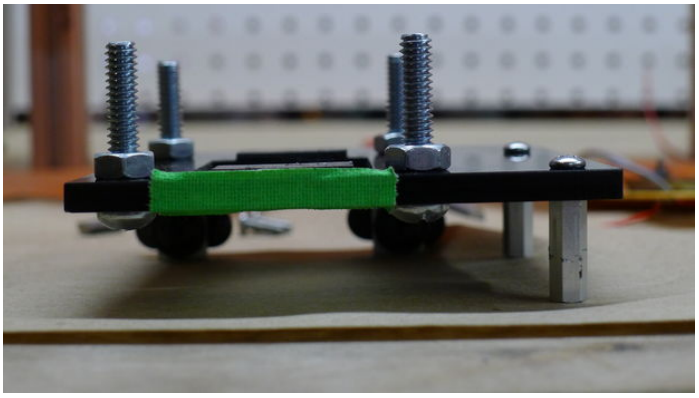
8. Cut a 4.5" length of T-slot aluminum and tap one side with the 1/4-20 tap.

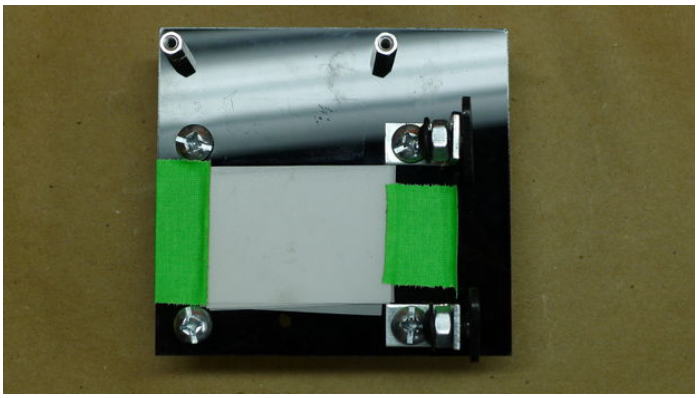
9. Using T-slot nuts and bolts, attach the main gate to the aluminum post. Attach the post to the gate platform.

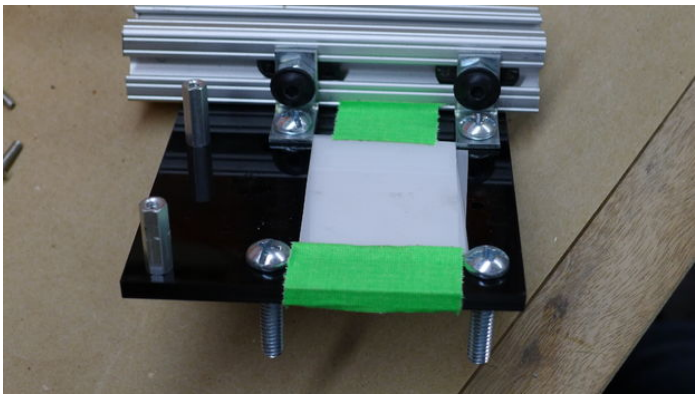


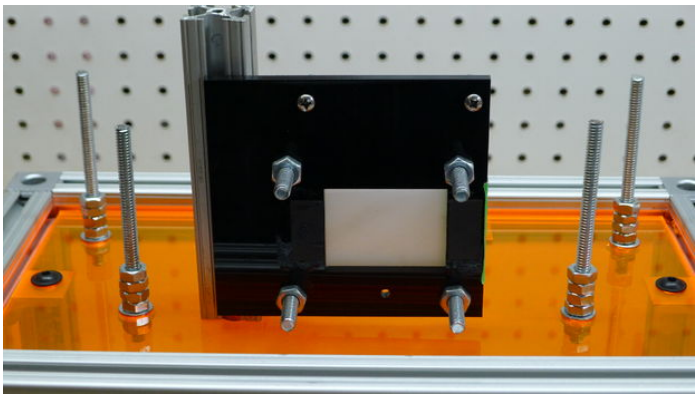


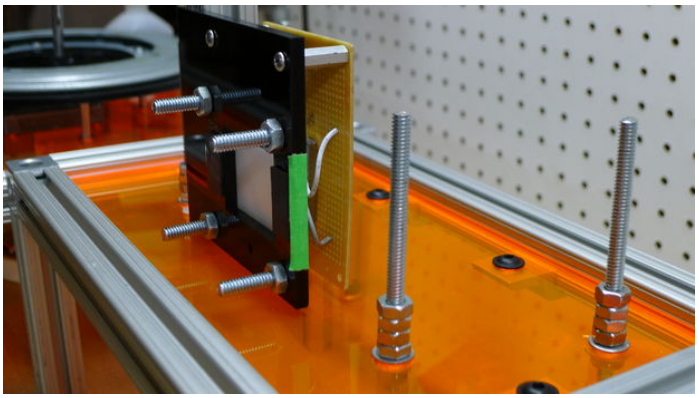


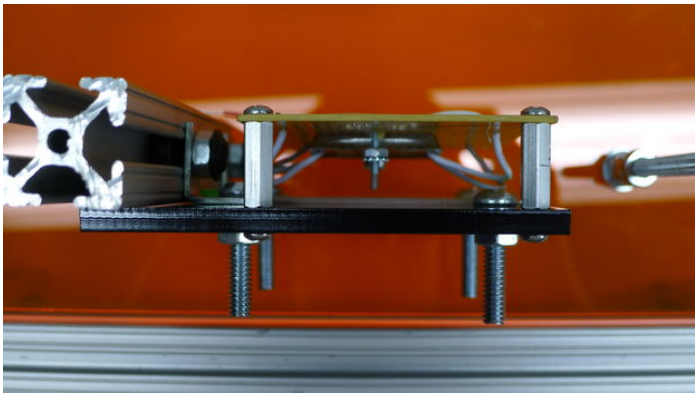












Step 6: Rollers

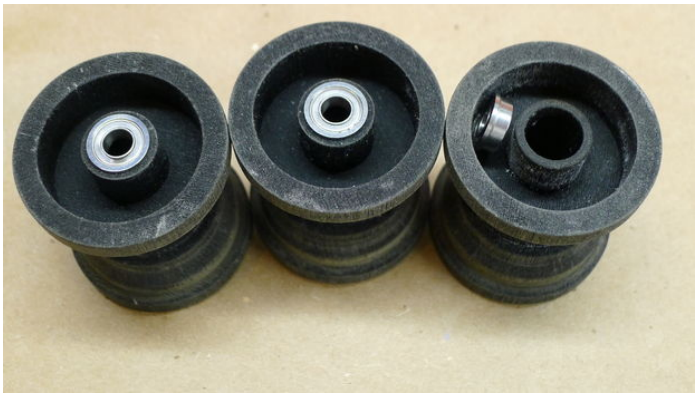
The rollers were designed in a 3D program, Rhinoceros. They were printed on a high-quality 3D printer (Object Connex500) with Vero Black plastic. You can print the rollers on any 3D printer, or turn them on a lathe.

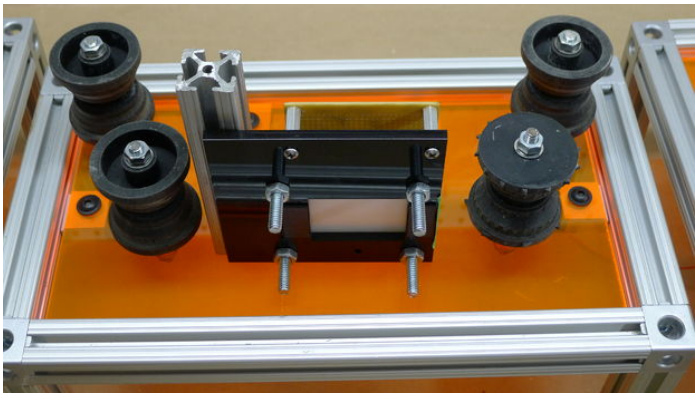
1. Print the roller files, found here. Print 3 of the smooth idle rollers, and one with sprockets on it.

2. Insert a flanged bearing into both the top and bottom of each roller.

3. Slide the rollers on to the posts. The sprocket roller should be placed on the post immediately to the right of the main gate assembly.

4. Add a bearing shim on top of the flanged bearing and add a hex nut to hold the roller in place. Do not tighten.

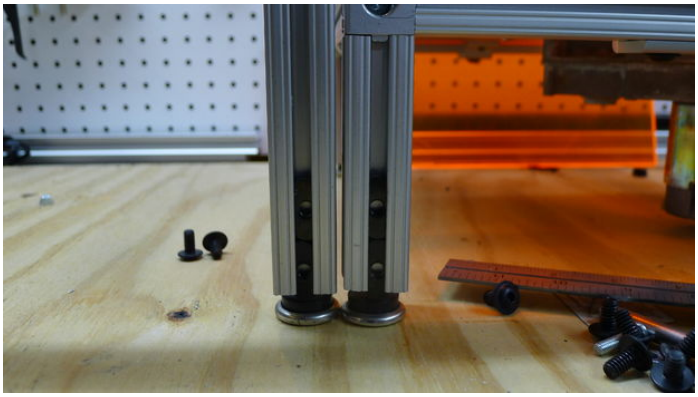


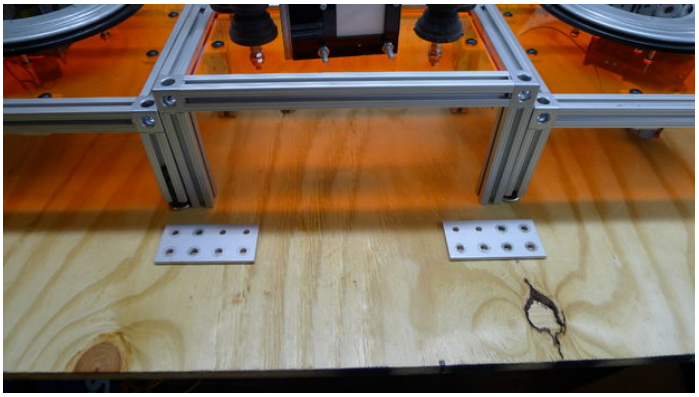


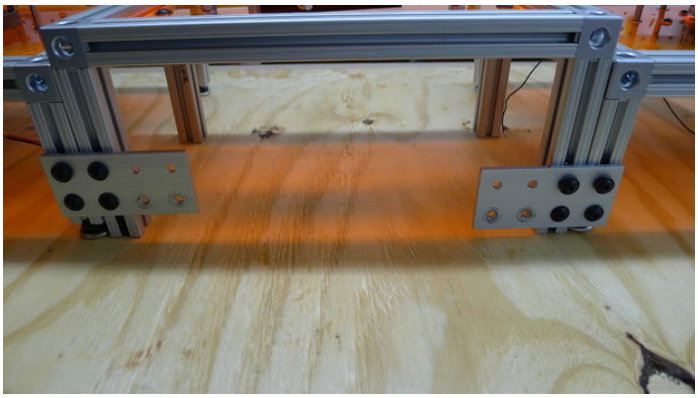
Step 7: Frame Assembly

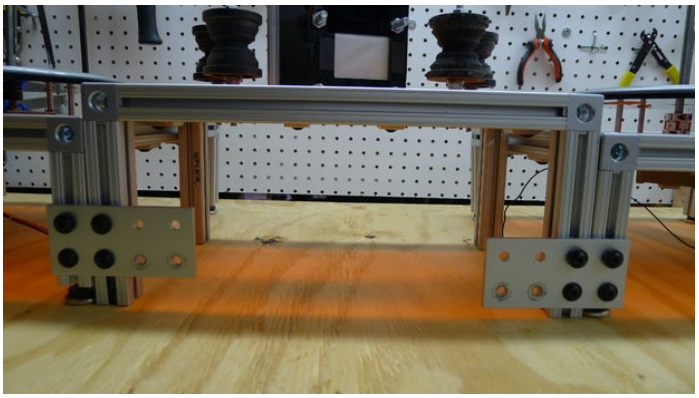
Put the frames together and level everything, and add the camera rail.

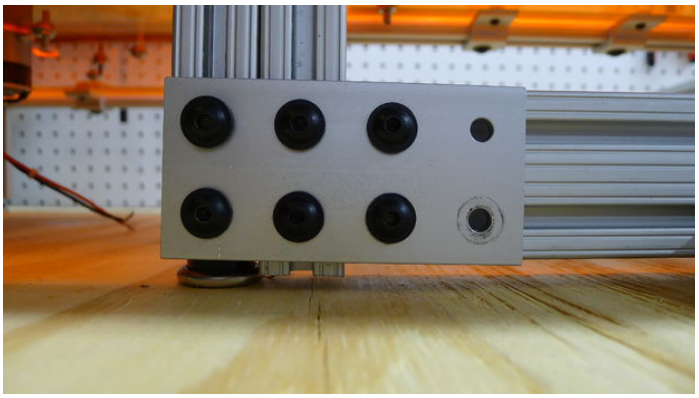
1. Add two T-slot nuts to the front legs of the gate platform. Do the same for the front left leg of the left platform and the front right leg of the right platform. To hold them in, insert the adjustable leveling feet.
2. Add leveling feet to all remaining legs on the platforms
3. Cut a 12" piece of 2" t-slot aluminum and insert 2 t-slot nuts on the top track and 4 on the lower track (see photo).
4. Attach the 8-hole plates to the legs of the reel platforms and the gate platform as shown.
5. Attach the 2" t-slot cross bar to the 8-hold plates.
6. Cut a 12" piece of 2" t-slot and slide 1 t-nut slot into each track, facing up. Attach the 4-hold 90-degree brace.
7. Attach the camera track arm (the 2" x 12" t-slot) to the 2" cross bar.
8. Using a level, adjust the leveling feet so that everything is level.

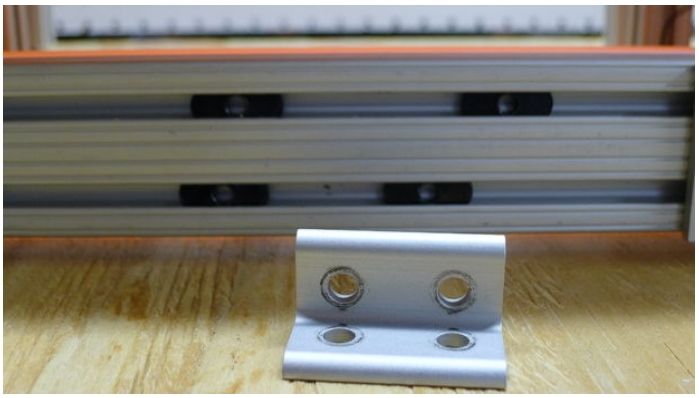


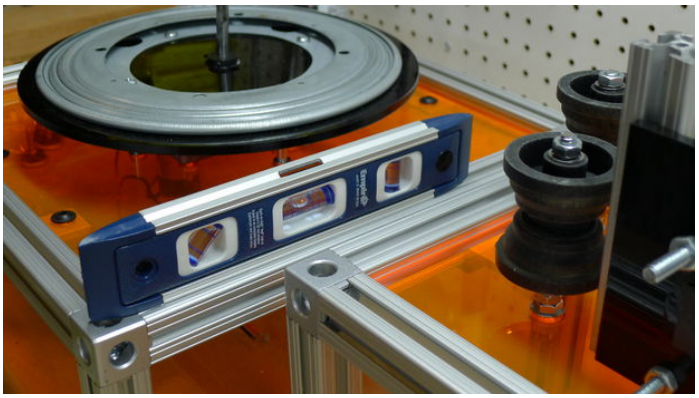


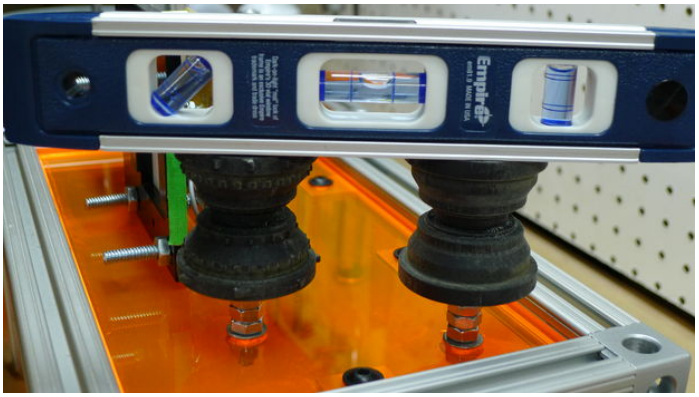











Empire

Step 8: Camera Mount

Here's where it gets really "hacky." For the camera mount, it's important to have fine adjustments so you can get as much of the film image in your camera's field of view as possible. This increases the final resolution of the movie file. In other words, the closer you get the more pixels you will capture. But when you're that close you need to make very small adjustments to your camera's position. The cheapest way I could find to have fine controls was to disassemble a microscope for the vertical positioning, and use a macro photography plate for the horizontal positioning.

Why a microscope? It has fine-tuning knobs for positioning, is made with parts that are guaranteed to be exactly vertical and horizontal, and it was cheaper than buying separate parts and making one myself.

If you go the microscope route, you will need to build a mounting plate to affix the post to the slider bearing that fits on the t-slot rail. I've posted some pictures of my solution here, which was made of two acrylic plates glued together, then mounted to the sliding bearing. Your solution may have to be different, but the following general steps are what need to happen.

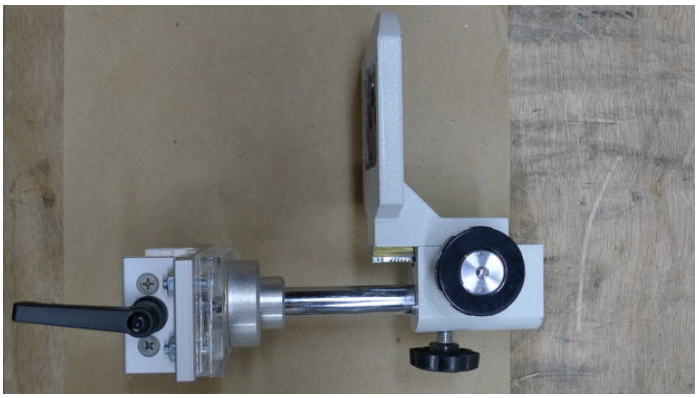
1. Disassemble the microscope so you have a post, the adjustment housing, and a horizontal plate.

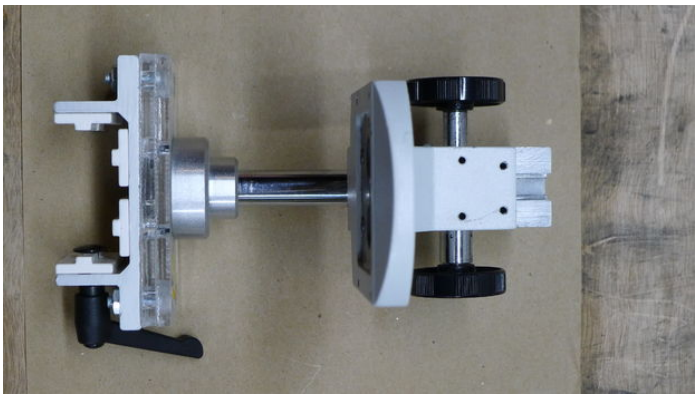
2. Mount the microscope post to the slider bearing. You will have to fabricate your own and its design will depend on the microscope you got.

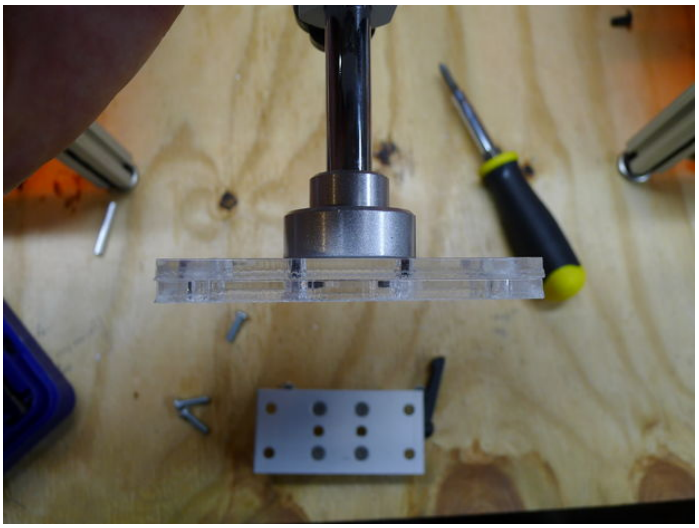
3. Mount a standard camera plate to the macro-adjustable camera plate.

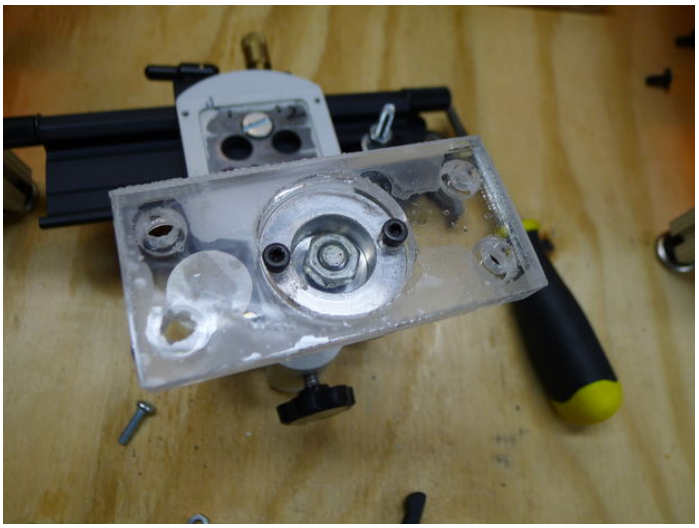
4. Mount the two plates to the microscope's horizontal platform.

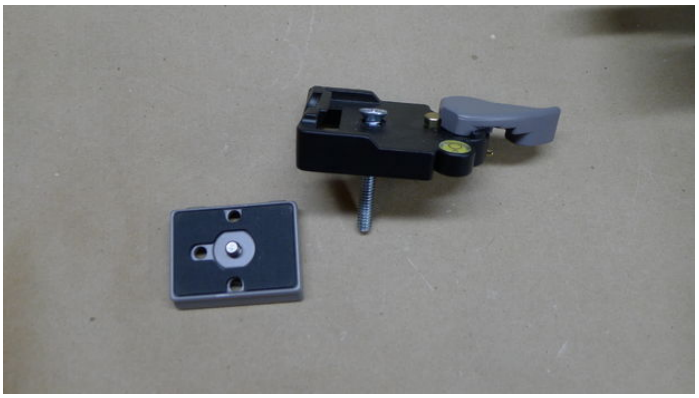
5. Slide the camera mount assembly onto the 2" t-slot rail and tighten the bearing's brake arm to hold it in place.

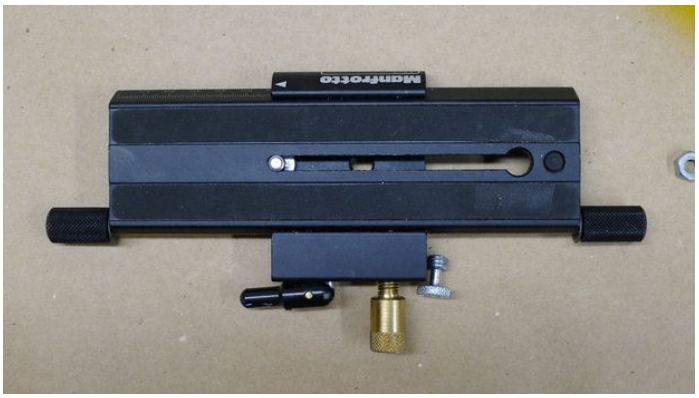


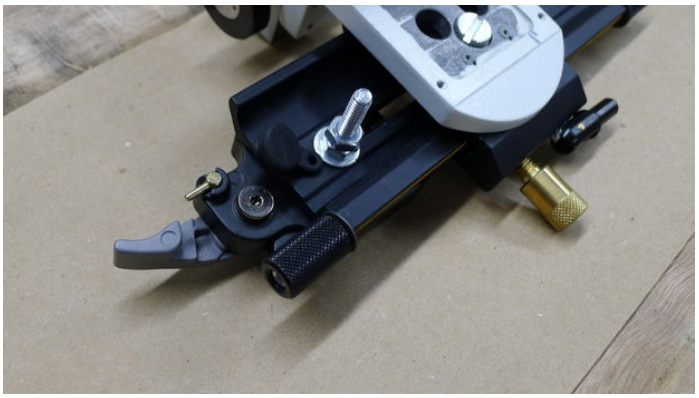


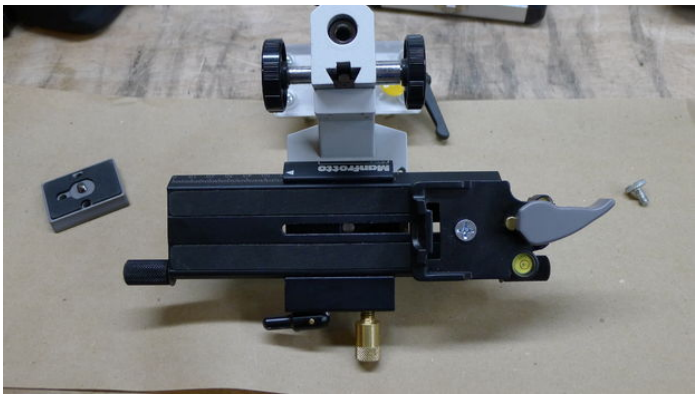







Manfrotto

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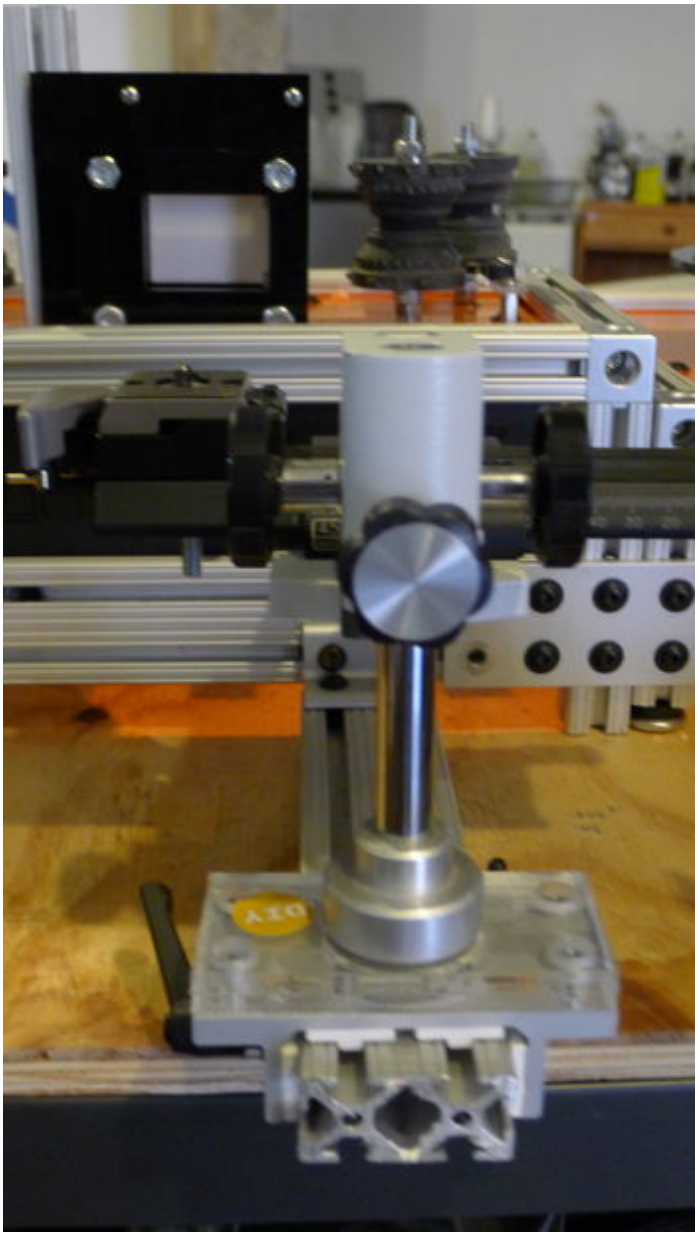
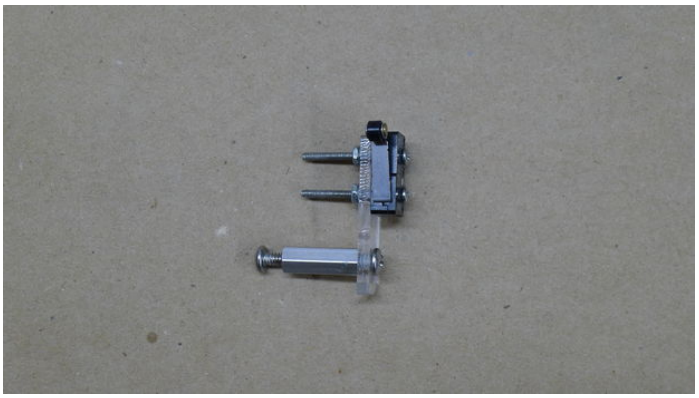


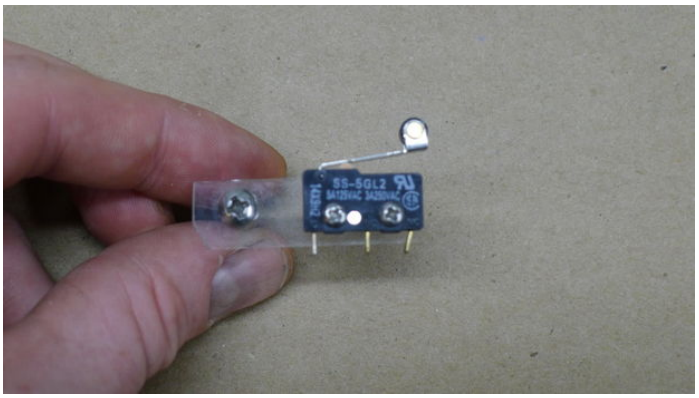
Step 9: Electronics

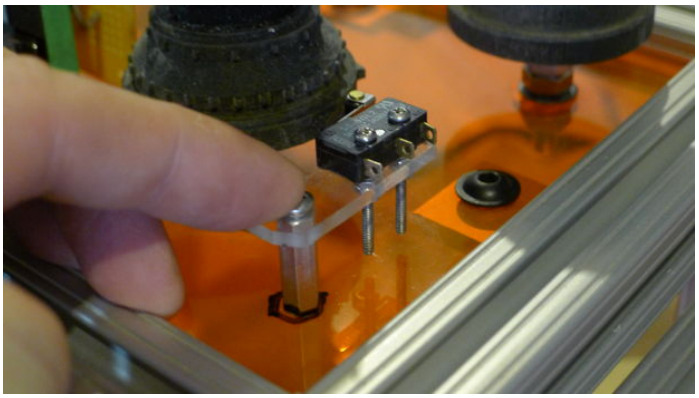
The roller switch is activated by the ramps built into the sprocket roller. The Arduino is used to activate the relay. The relay activates the camera shutter cable when the roller switch changes states. See the last photo in this step for a diagram of all wire connections.

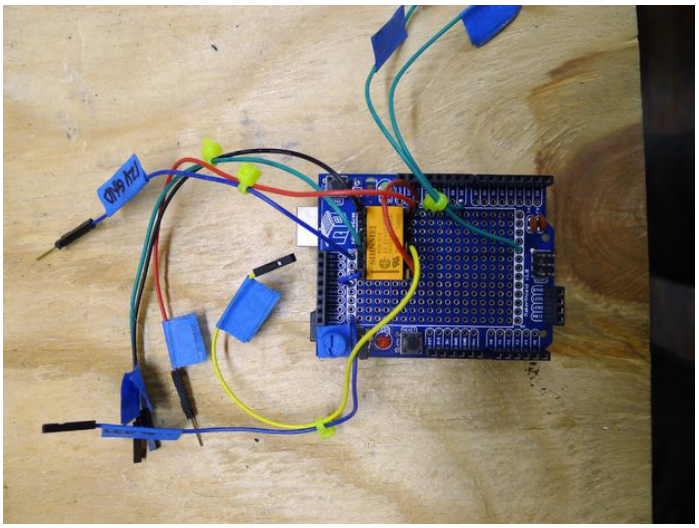
1. Mount the roller switch to a piece of acrylic or wood and use a 1.25" standoff to mount the switch arm to the gate platform. NOTE: the standoff height changes depending on the gauge of film your scanning. A higher standoff is used for 16mm than 35mm - depending on how accurate your legs are on the gate platform you may have to cut or extend yours.
2. One a breadboard or a blank prototyping Arduino shield (pictured), wire the relay. In my case, I'm using jumper wires and connecting everything with alligator clips so it can be quickly disassembled if necessary.
3. Splice your camera's shutter cable. You will likely find 2-3 wires inside. As a test, plug in the cable and turn your camera on. Find out which two wires, when crossed, trigger the shutter. If there is a third wire, it might be for triggering the auto-focus mechanism and should not be used. I bent it backwards and wrapped it in heat-shrink tubing. The two wires you will be using should be soldered to pins so that they can be plugged easily into the relay circuit.
4. Connect the roller switch's connections to the circuit (see the drawing for a map of all connections).
5. Plug in your 12VDC power supply to the circuit.
6. Connect your camera to its cable and make sure all connections to the circuit and Arduino are complete, especially the connections to common ground. To test the circuit, plug in your Arduino to your computer (for power) and hit the roller switch. If the camera takes a picture then everything is working! If not, go back and check your wiring.
7. Using the diagram provided, make your motor circuit and hook it up to power and Arduino. You can incorporate this circuit into the relay circuit or keep it separate. Either way works. This circuit controls the motor using PWM (pulse-width-modulation). It changes the speed of the motor to meet the frames-per-second variable set in the software. In some cases, you may want to control the motor manually. While this is a feature I plan to integrate, it is not currently available. To have full manual control, hook up your motor to an adjustable power supply according to its power requirements and adjust the voltage to change the speed.

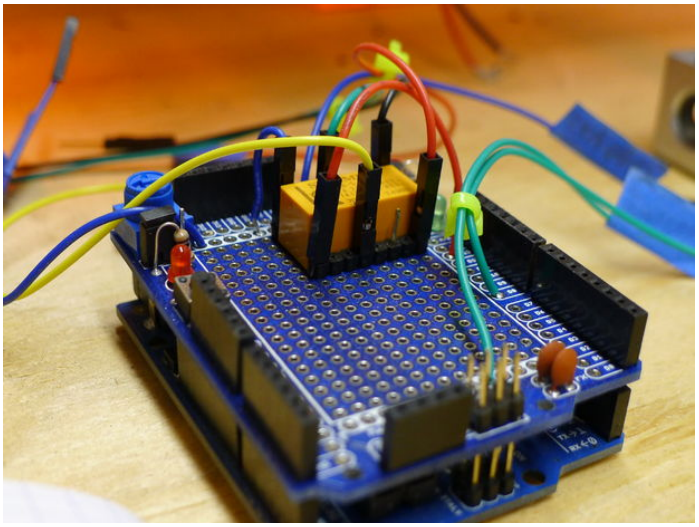
You are now ready to operate the Kinograph. Operating Instructions coming very soon (as of 2/23/2014)

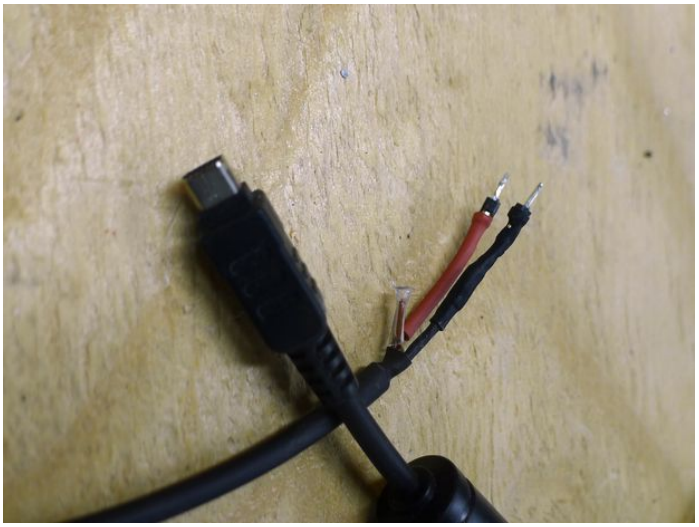


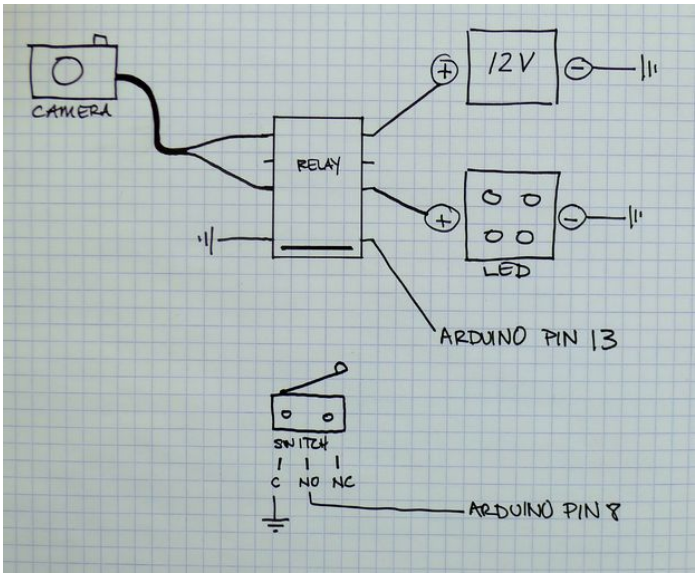

SS-5GL2

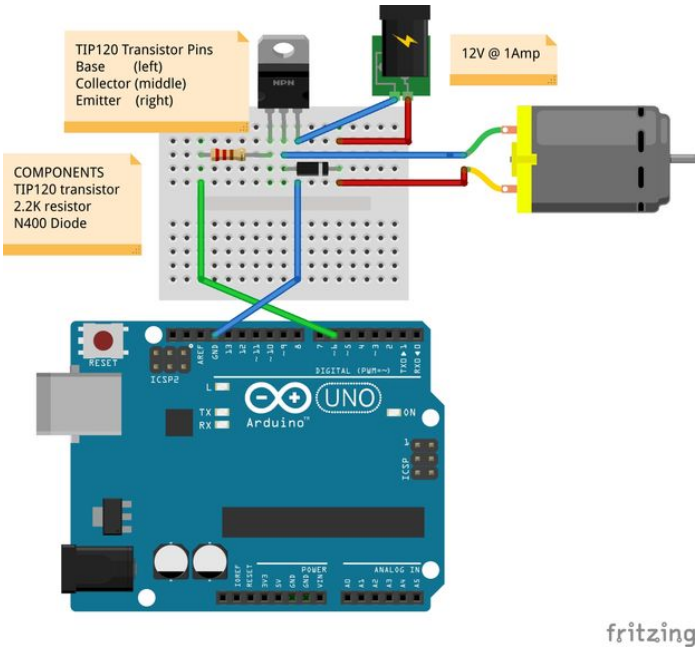



12V GND









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Turn Your Arduino Into an ISP by mr_mac3

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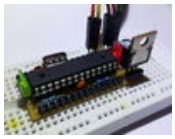
Arduino Powered Nixie Tubes: ArduiNIX Nixie driver shield assembly by Slothfurnace



YABBAS - Yet Another Bare Bones Arduino (on Stripboard) by serisman

Comments

2 comments **Add Comment**

klindsey6 says: Feb 24, 2014. 5:47 AM **REPLY**

This is an awesome looking unit. I would recommend the use of the word telecine in your build description. I've been working on my own machine for years and there is a substantial community out there who would be interested. I just can't say as I've ever he heard the term Kinograph use in the community before. Awesome build though. I noticed much of the cost is in the frame. I assume you built it out of aluminum was for transporting it mostly? Of course it looks awesome.

mepler says: Feb 24, 2014. 6:16 AM **REPLY**

Yes, you're right. The frame is very expensive and truthfully does not need to be made out of extruded aluminum. My choice for that material was based on flexibility since, as I was building it, my designs kept changing. The slots in the aluminum make it easy to for adjusting the position of parts without having to drill. The cost could come down significantly by building the frame with more common hardware found at hardware stores.