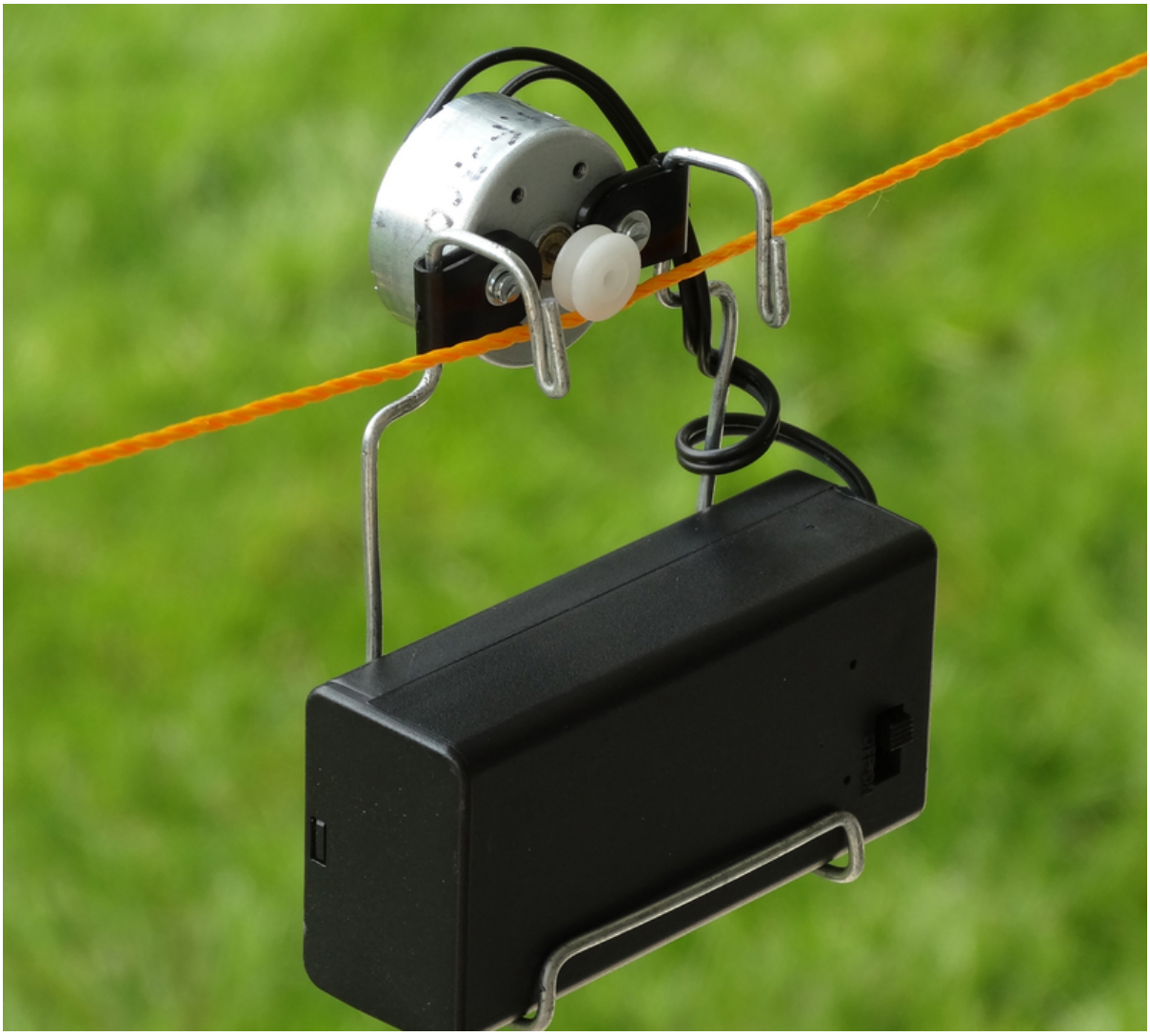
Basic String Car Racer

Created by Jan Goolsbey



https://learn.adafruit.com/basic-string-car-racer

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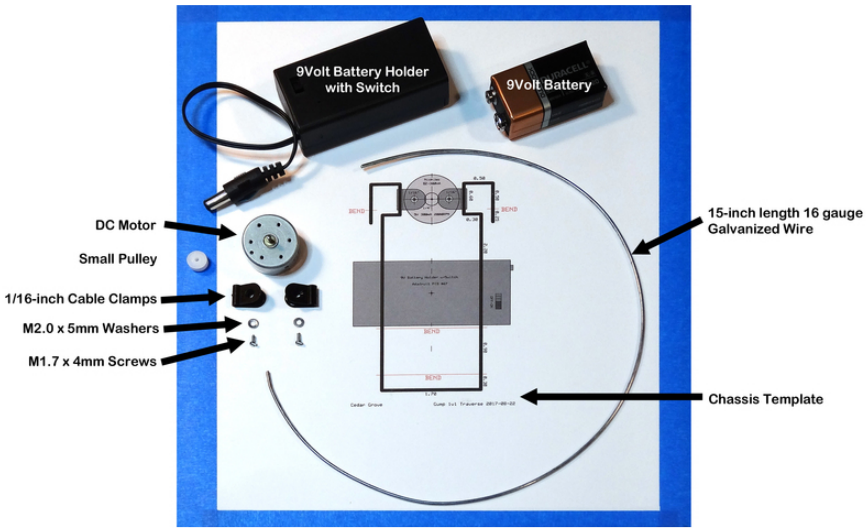
Overview

The Basic String Car Racer is a simple project that consists of a battery, pulley, a reclaimed motor, and a bit of fence wire. The original string car was made from repurposed parts and materials found in Grandpa's basement workshop. This version uses more commercially-available parts, but could be hacked with parts gleaned from old DVD players, for example. What modifications and improvements would you make?

Project Components



Adafruit Components:

- 1 each 9 Volt Battery Holder with Switch, Adafruit PID #67 (https://www.adafruit.com/product/67) (http://adafru.it/67)
- 1 each 9 Volt Alkaline Battery, Adafruit PID #1321 (https://www.adafruit.com/product/1321) (http://adafru.it/1321)
- Printed Chassis Wire Bending Template (.pdf download included in this guide)

Other Components:

- 2 each 1/16-inch Nylon Cable Clamp, Digi-Key RP322-ND (https://www.digikey.com) (https://adafru.it/yFq)
- 1 each reclaimed DC Motor, nominal 6 to 12 volt, 2mm shaft, Nichibo RF-300 or similar
- 1 each Small (10mm) Pulley, 2mm shaft, Hobbymasters SVM-203 or similar
- 2 each M1.7 x 4mm Machine Screw (sized to fit DC Motor threaded mounting holes)
- 2 each M2.0 x 5mm Flat Washer
- 1 each 15-inch length of 16 gauge Galvanized Steel Wire, Home Depot SKU #396235 (http://www.homedepot.com) (https://adafru.it/yFr)

Supplies and Tools:

- Soldering Iron and Solder

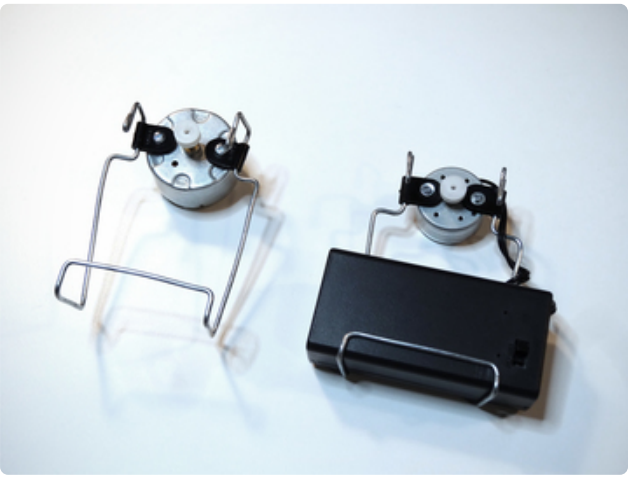
- Wire Stripper/Cutter (for motor power wires), Adafruit PID #147 or similar (https://www.adafruit.com/product/147) (http://adafru.it/147)
- Small Screwdriver
- Sturdy Needle Nose Pliers (for bending steel wire)
- Steel Wire Cutters, such as Fencing or Ironworker's Pliers

Sourcing the DC Motor

Almost any small DC motor with an operating voltage between 6 and 12 volts can be used for this project. Threaded mounting holes in the face of the motor (the side with the motor shaft) are needed to mount the motor to the bent wire chassis. The DC motor and mounting screws used in this project example were reclaimed from an old DVD drive.

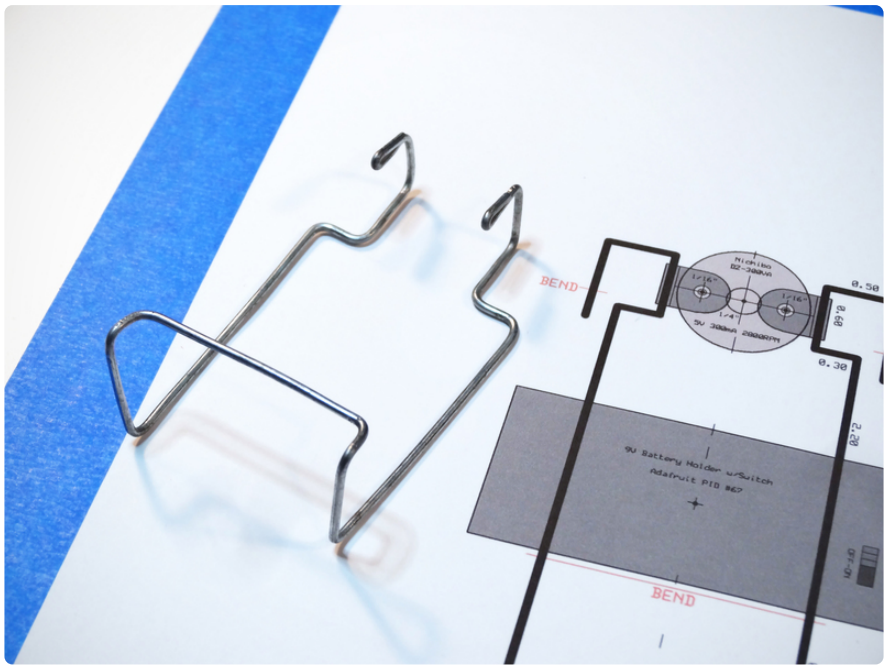
When removing a DC motor from a DVD/CD drive, save the mounting screws in case they aren't a common size. Also, there may be a useable pulley already attached to the motor. Reclaiming and repurposing can be fun and rewarding!

If you are having trouble finding a motor to reclaim, you may consider purchasing one from a vendor such as Jameco. Search for motors with a compatible operating voltage range and a drive shaft diameter of 2.0mm. For example, the Jameco 2173044 6 Volt 2100 RPM motor (http://www.jameco.com) (https://adafru.it/aIJ) makes a great general-purpose string car motor. Another option would be to talk to someone in your local makerspace -- there's usually someone there with a box full of reclaimed DC motors.



The wire chassis is flexible enough to accommodate a variety of motor sizes, so feel free to experiment!

Bend the Wire Chassis

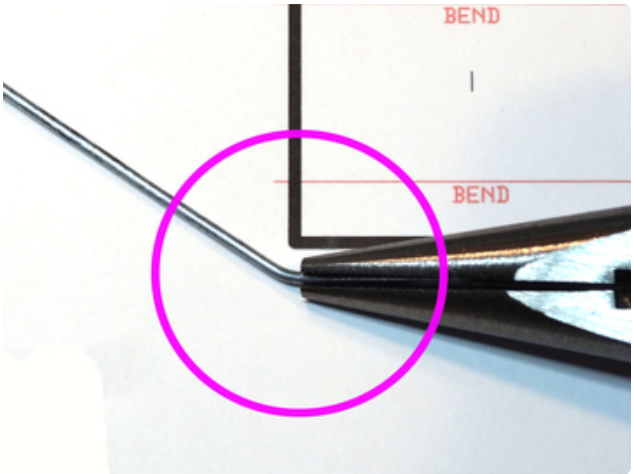


Download the actual-sized template file, print it, and place the template on a flat surface. Secure with painter's tape so it won't move during the bending process.

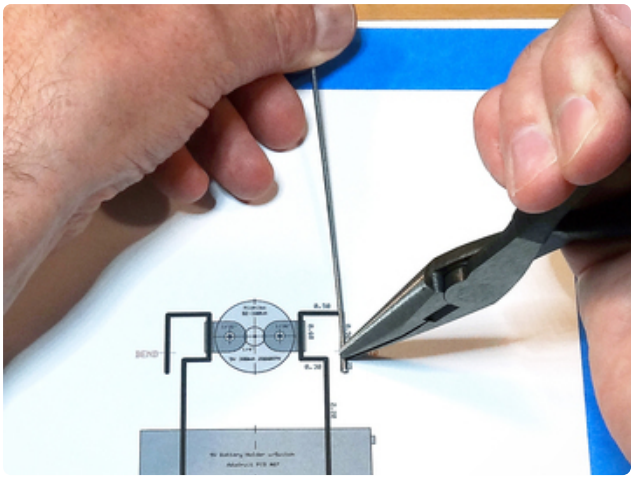
Download Chassis Template .pdf

https://adafru.it/yEG

Measure and cut a 15-inch length of galvanized wire using heavy duty fencing or steelworkers' pliers. (Fencing pliers are shown in the photo.)
Make the wire as straight as possible before bending. It'll make bending the wire into the chassis shape a lot easier.

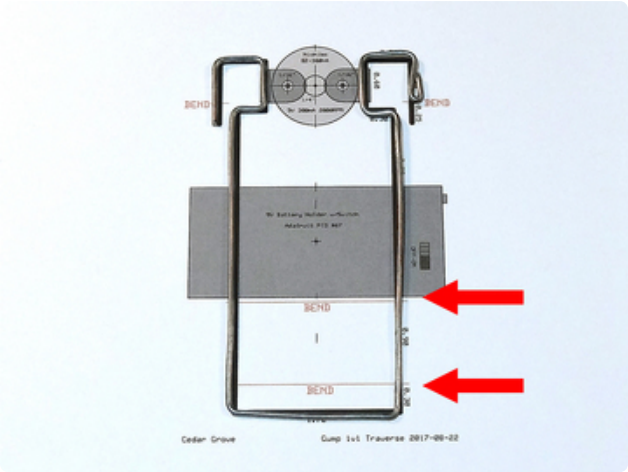


Hint: To make an accurate bend, clamp the needle nose pliers on the wire slightly behind the intended bend by approximately one wire width.

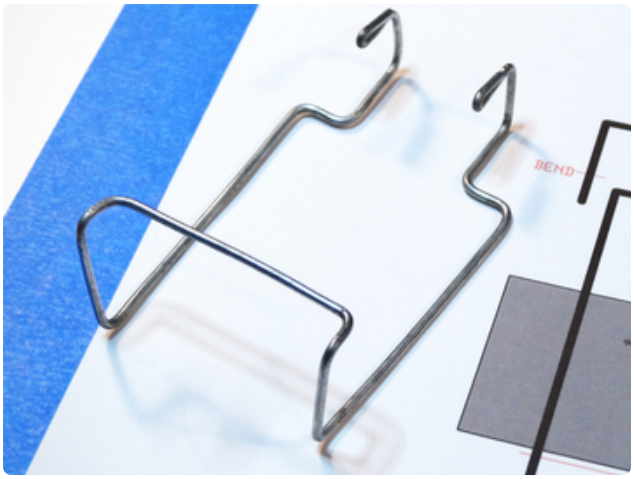


The large black line on the template indicates the outline for the bent wire chassis. Start bending the right guide, then work your way around the outline to the left guide, bending each corner in succession.

The first bend folds back 1/4-inch of the wire on itself to hide the sharp cut end.

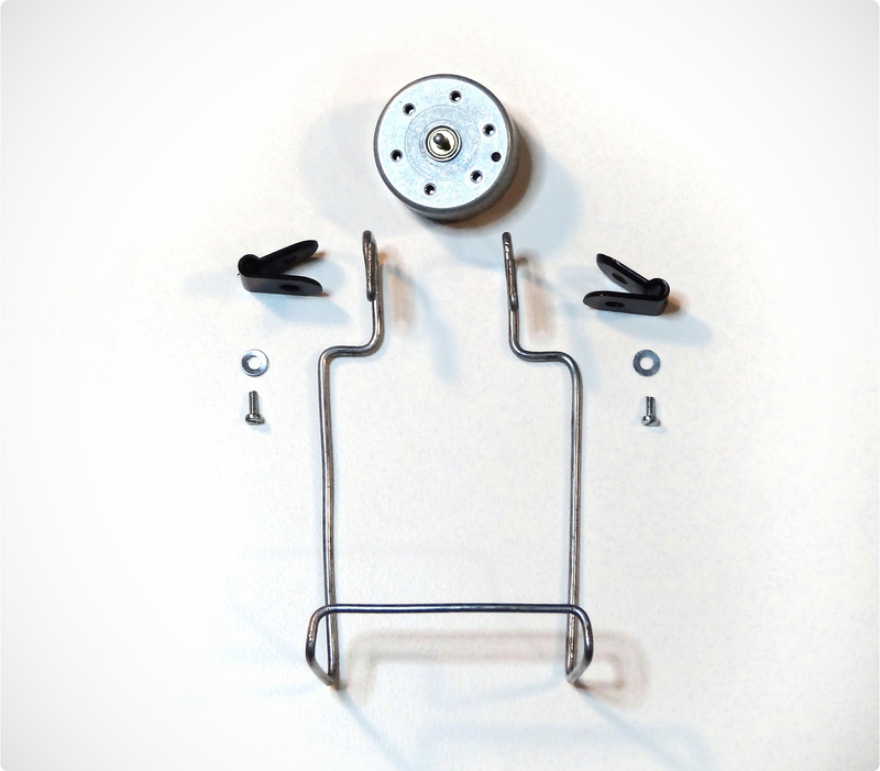


Save these bends for last. They create a cradle for the battery holder.



When finished, you should have one of these. Test the fit of the battery box and adjust the wire cradle to hold it tightly.

Attach the Motor and Battery Box

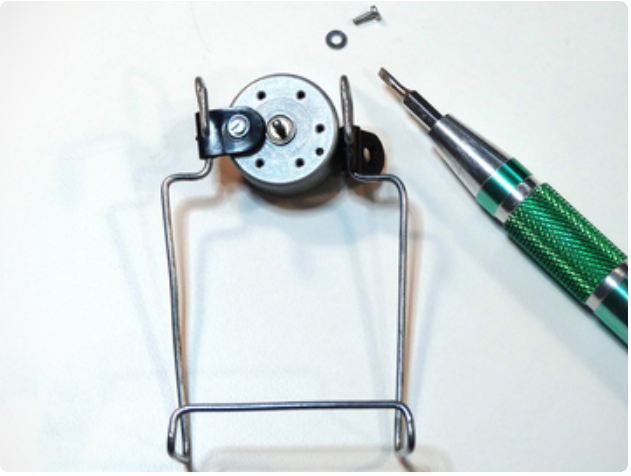


This string car design employs 1/16-inch nylon cable clamps to mount the motor to the chassis. Your motor must have threaded mounting holes for this mounting technique to work properly.

The motor shown was repurposed from an old DVD drive along with its special M1.7 x 4mm mounting screws. The M2.0 washers were added to keep the screw from damaging the cable clamps.

Do not use motor mounting screws longer than 4mm. Longer screws will protrude too deeply into the motor and could damage it permanently.

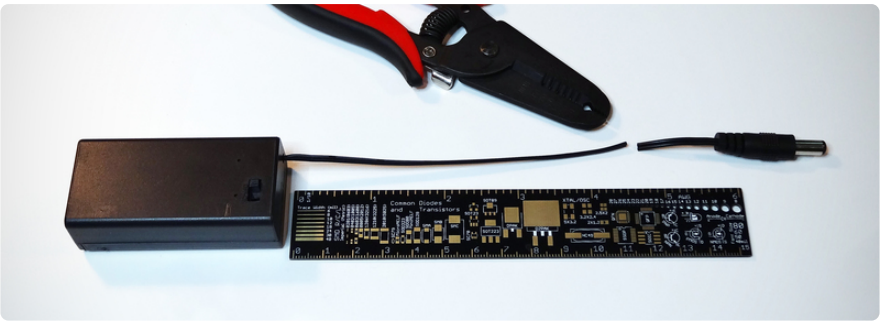
Snap the 1/16-inch cable clamps on the upper ears of the chassis as shown. The motor will be mounted to the clamps using the 4mm long screws.



With your fingers, pinch one of the cable clamps closed. Place the washer and insert the screw through the washer into the motor's threaded mounting hole. Carefully tighten the screw until snug. Test to see if the shaft of the motor turns easily -- if it does not, use a shorter mounting screw.

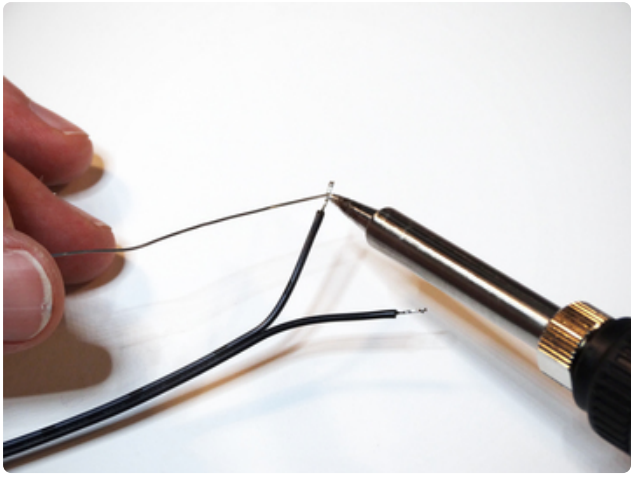
Repeat the process on the opposite threaded mounting hole.
Do not overtighten; the mount only needs to be secure enough to keep the motor from twisting in the chassis.
Test the motor shaft to confirm that the second mounting screw is not limiting motor operation.

Slide the pulley onto the motor's shaft, keeping about 1/4-inch clearance between the back of the pulley and the face of the motor.
Turn the pulley and verify that it isn't rubbing against a cable clamp.

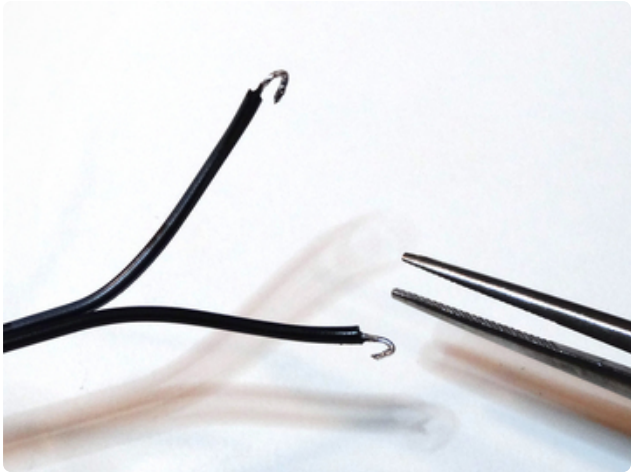


- Cut the battery holder's wire to 4-3/4 inch in length. We won't need the 2.1mm connector, but you may want to put it in your spare parts bin for another project.

Split the dual wire pair apart approximately 1-inch.
Using wire strippers, remove about 1/8-inch of insulation, exposing the stranded copper conductors.



Twist the exposed copper strands together and put a small amount of solder on the exposed copper of each wire to hold the strands together. This technique of preparing a stranded wire for soldering is called "tinning" the wire.



Using needle-nose pliers, bend the exposed portion of each wire into a U-shape.

Place the battery box into the cradle with the on/off switch showing face-up and the wire exit on the right-hand side.
Wind the wires around the chassis twice as shown.

Slide the "U" of each wire into the holes of the two motor terminals.
With the needle nose pliers, squeeze each "U" to crimp in place.

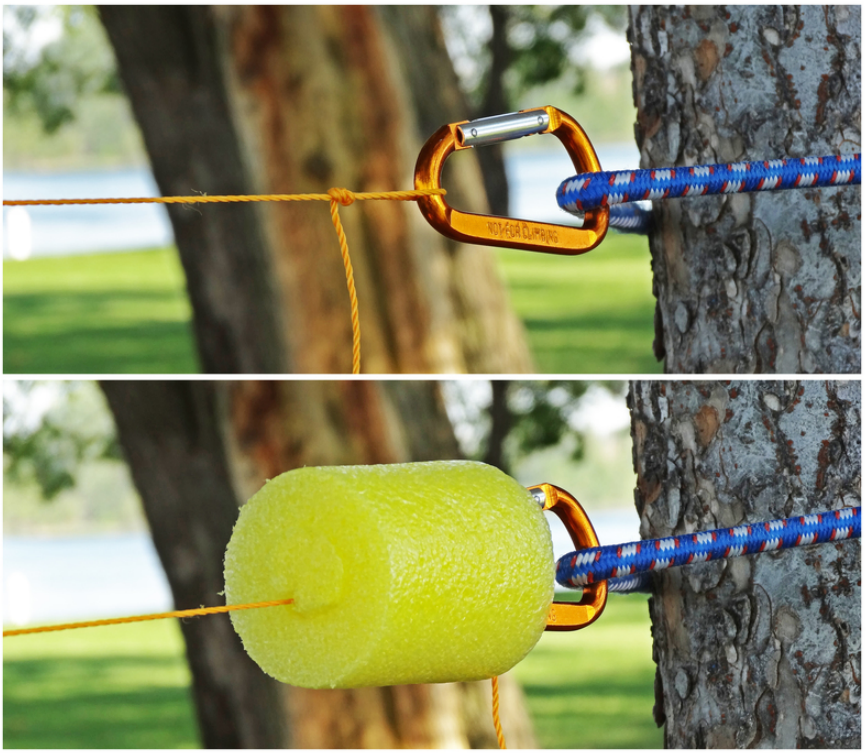
Solder both wires onto the motor terminals.

Insert the 9 volt battery into the box and press it into the snap connections.

Close the battery box cover and place it into the chassis cradle.
Flip the on/off switch to the ON position and listen for the motor to spin.

If the motor doesn't spin, check the soldered connections on the back of the motor. Is the battery fully seated into the snap contacts?

String a String, Balance the Car, and GO!

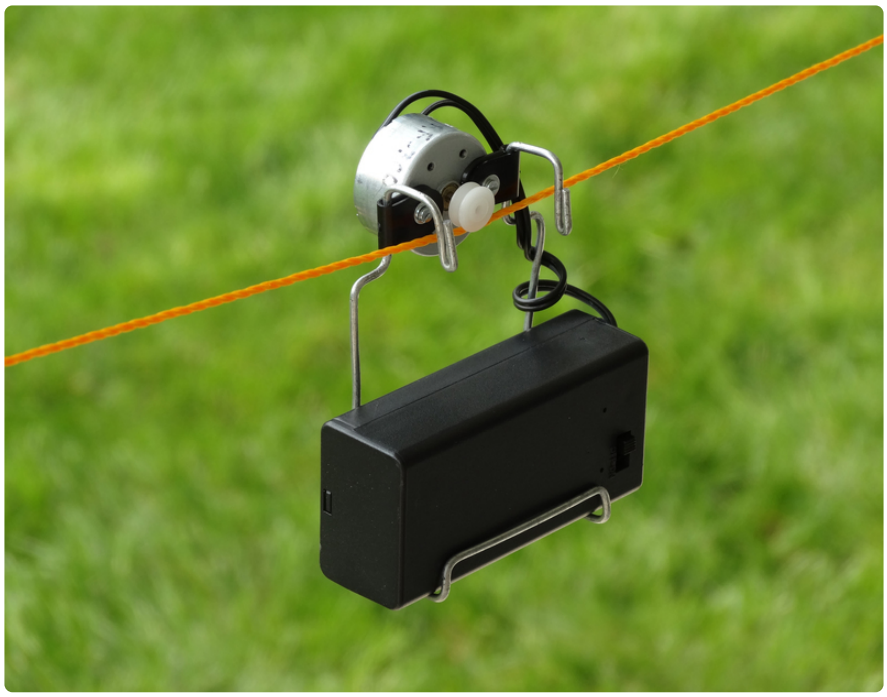


Stretching a string between two trees is relatively simple. Here's a technique we use that is easy to set-up and remove, doesn't cause tree damage, and provides some end-of-string crash protection for the string car!

- Wrap a bungee cord around a tree or post and link the hooks together. Tie a loop in one end of the string and slip it into a miniature carabiner that's been

clipped into the bungee cord. A short length of a swimming pool noodle with the string passing through the middle provides a cushion for the inevitable collision.
- Repeat the process on the other end of the string. Shorten the string a bit before tying the loop. The bungee will stretch and keep the string taut.

The string car will be more stable if it is balanced on the string. To balance the car, move the pulley on the motor shaft closer to or farther away from the motor. If moving the pulley doesn't balance the car, try bending the wire chassis to change the relative position of the battery and motor.



It's time to race! Flip the switch on, place the pulley on the string, and carefully release the car. It will quickly zip to the other end of the string where a friend can catch it. They will remove the car from the string, turn it around, and send it speeding back to you.

The fastest car will have the shortest lap time, so a stopwatch is needed for most single-string races. Placing two strings side-by-side provides a drag race track -- it'll be obvious who won the race!

Racing stripes on the battery box would be a nice touch. It's essential, however, to give your car a name like Speedy or The Zoominator. A fitting name will encourage it to perform at its best!

Video: A String Car Drag Race at The Confluent Makerspace

https://adafru.it/yPA

String Car Racer 101 Study Guide

1. What circuit changes would be needed to reverse the motor's direction of spin?

2. Without making any battery, motor, or wiring changes, how can you make the string car go faster or slower?

3. What is a reliable method for measuring velocity (miles per hour or feet per second)?

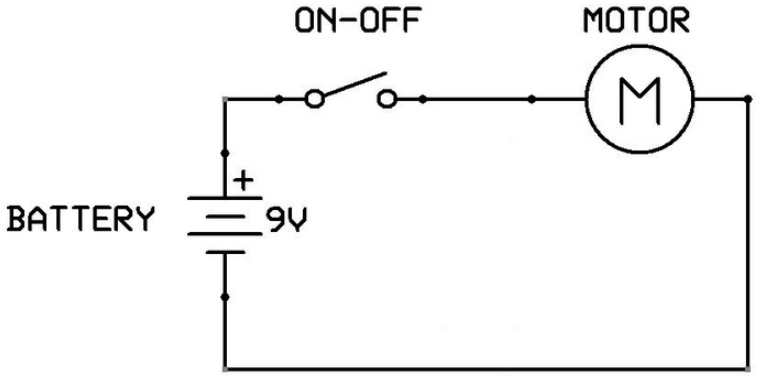
4. What wiring changes are needed to add an LED to the string car?

5. How long will a fresh 9 volt battery last in hours or laps?

6. Does the string car travel faster on a taut or relaxed string?

7. How can pulley traction be increased? What is the resulting change to string car performance?

8. Where might you find used parts to repurpose for your own string car design?



Schematic Diagram

Hack the String Car

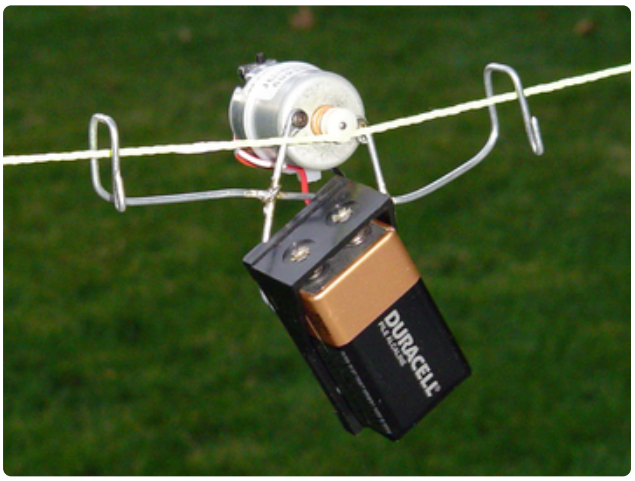
String Car History

In the early 1980s, my college-aged brother designed a simple motor-plus-battery car that raced along a string between our carport post and the street-side power pole. For years now, we've been improving on his basic design, with the initial goal of keeping it really simple: one battery-driven motor, optional flashing lights, and repurposed materials whenever possible. The primary racing objective was speed and stability. The car ran at full speed until it found the end of the string -- then you had to be there to catch it or be prepared to repair it before the next time trial.

We talked about making the car smarter so that it could stop and reverse directions, and came up with lots of schemes and circuits to make it possible, but for many years were more focused on the high-speed "Gump" mode of operation. Run Forrest, run!

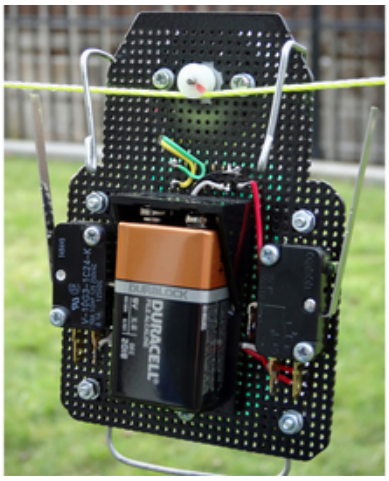
The first version was made from a reclaimed motor with a pulley already attached, a nearly spent battery, and a short length of fence wire to use as the chassis and string guides -- zero cost. Using fence wire as the chassis framework allowed for many design variants from sleek and compact to exceptionally stable stretch versions. The wire bent easily and could be formed into whatever was needed, as long as the designer thought about center-of-gravity, balance, traction, stability, and the simple electrical circuit. One challenge along the way was to create both the chassis and guides from a single length of wire, front-to-back with only bends, no cutting or brazing.

This is the very first string car, recently uncovered during a workshop archeological dig. We expect carbon dating to confirm a 1981 build date. It's believed that the motor was repurposed from a 1965 Aiwa TP-30 tape recorder.

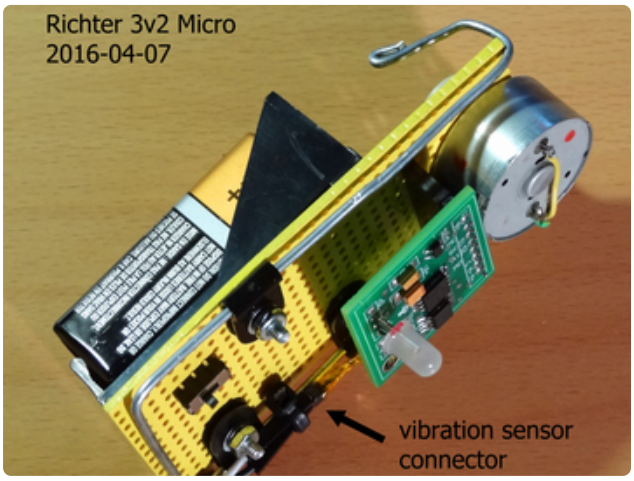


Here's an example of a "Gump" car from 2006 designed with an open chassis so that it could safely race along the edge of a windy lake. The tilt of the battery was an attempt to center as much of its weight under the pulley as possible to help with stability. For traction issues in damp and cold environments, we cut a very thin sliver of surgical tubing (resembles a miniscule rubber band) and snapped it into the bottom of the pulley's groove. We learned that a wider band will cause the car to pop off the string.

Of course, adding flashing lights for nighttime racing was an exciting improvement. This is a recently built version outfitted with flashing outrigger guide lights. Not cat-tested, however.



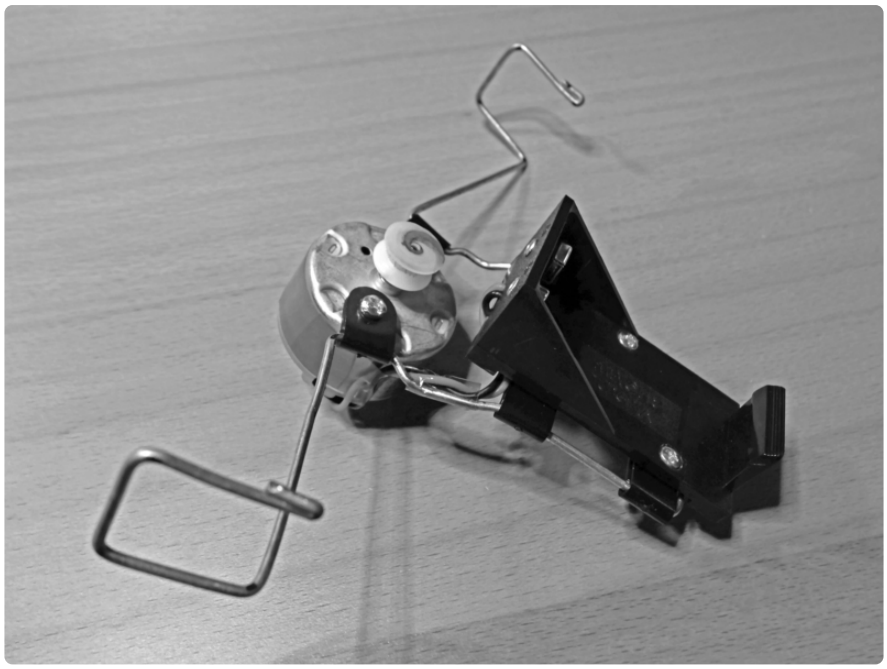
Over time, we upgraded the basic string car with an Adafruit Trinket microcontroller to detect end-of-string and autonomously prevent collisions using a variety of sensors and motor control -- akin to robots. The more sophisticated models learned about string length and applied predictive braking to keep the car from plowing into the tree and falling off the string.



For example, the Richter version replaced the microswitch sensors with a vibration sensor that detected when the car slammed into the end of string cushion. We had to run this one a bit slower so that it wouldn't bounce off the string!

For Richter, the Trinket was replaced with a custom ATtiny-85 microcontroller board to save space.

Most recently, the Trinket-based version was updated with a custom SAMD-21 (M0) controller board designed for CircuitPython. The all-in-one board includes LiPo battery charging and a Stemma-QT interface for displays and sensors.



In spite of the seemingly endless options that come to mind, we continue to be inspired by the original design and, to this day, enjoy reclaiming old motors, turning our own custom pulleys, and devising faster, more stable cars based upon the idea that was hatched up in Grandpa's basement workshop.

We hope you are inspired to take on the challenge to build a better, faster, and smarter string car!