

Mark's Haunted Garage

<http://www.markshauntedgarage.com/halloween/techinfo/spider.php>

Lowering Spider Info

The spider prop is fairly simple in terms of mechanical setup. Where it gets somewhat complicated is in the electronics setup. It is based around a stepper motor. By their very nature, stepper motors are non-trivial to control. By that, I mean that you can't just apply power and expect them to turn. They need a controller of some type, such as a computer or a microcontroller. However, the advantage of a stepper motor is that the controller has a very high degree of control over the position of the motor's shaft. By keeping track of the number of steps executed, the controller knows exactly how far the spider has been unwound, and so it knows exactly how many steps it needs to execute in the other direction to wind it back up.

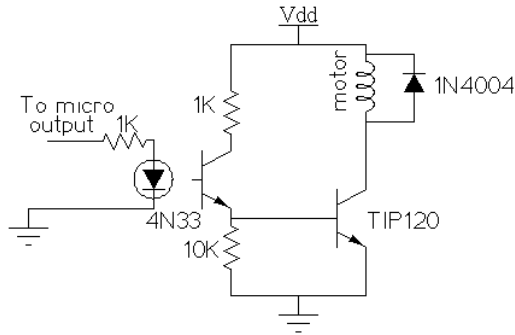
As I mentioned earlier, the mechanical set up is pretty basic. Attach a couple of L-brackets to the motor, and attach the motor to a small sheet of plywood. Drill a hole about the size of the motor shaft into the end of a dowel that is three inches long or so. The diameter of the dowel is up to you. The thicker the dowel, the faster the spider will wind and unwind. Glue the dowel onto the motor shaft. Drill a hole in the piece of plywood the motor is attached to. The hole should be directly under the dowel attached to the motor shaft. Run a string through the hole and attach it to the dowel. I stuck a thumbtack into the dowel and tied the string to that. Tie the other end of the string to the spider, or whatever else you want to go up and down.

Now, for the electronics side. The stepper motor I use has 6 leads. Two of them are to supply power to the four coils within the motor. Each of the other four leads is connected to one of the four coils. By connecting each of the four leads to ground, one at a time, in the proper order, the motor shaft rotates. Reverse the order, and the shaft rotates the other direction. In the future, I will provide details on how to determine which leads are which.

The four leads are not control leads, like that of a servo. These leads have a lot of current going through them -- more current than a typical microcontroller can handle. Also, the stepper motor I use runs best at 12 volts, while my PIC microcontroller runs at 5 volts, so I need separate power supplies for the two. As a result, I have a separate board to supply power to the motor.

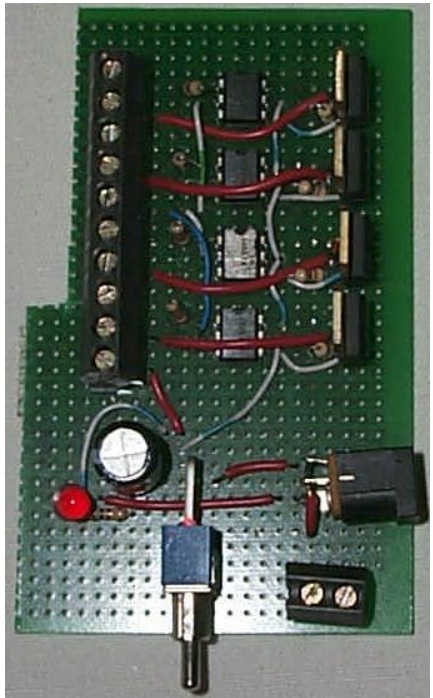
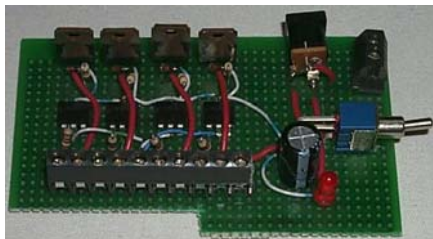
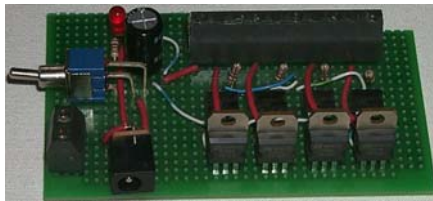
Each of the four leads from the stepper motor (not counting the two power leads) is connected to a TIP120 power transistor. Since the motor is on a separate power supply from the PIC, however, I don't want the PIC directly controlling the base of the transistor. Instead, I use an optoisolator to keep the two power supplies completely

isolated. So, each of four PIC outputs are connected to the LED side of the optoisolator, with a 1K current-limiting resistor. When the PIC turns on one of its outputs, the LED lights up, which turns on the transistor side of the optoisolator. This turns on the TIP120, which closes the circuit for one of the motor coils, energizing the coil.



Here is a schematic for one of the four coils in the stepper motor. The real circuit has four copies of this circuit, as you will see in the pictures that follow it.

Technically, this schematic isn't quite accurate. Both the 4N33 optoisolator and the TIP120 are actually Darlington transistors but I only show one transistor. The idea is still the same, though.



Here are a few pictures of the actual circuit board from different angles.

Obtained from
Omarshauntedtrail.com

In this last picture, you have the four 4N33 optoisolators running down the middle. The four TIP120 power transistors run down the right side. A terminal strip along the left side provides connection points for the stepper motor leads and the control signal leads from the PIC. At the bottom are a couple of power connectors, a toggle switch to turn the power on to the circuit, an LED to indicate that power is on, and a 220uf capacitor. I probably should use heat sinks on each of the TIP120s. The fact that the motor doesn't really run that much and that it's typically fairly chilly on Halloween night prevent it from overheating.



Here is a (slightly blurry) picture of the complete setup. Click on the thumbnail to get a larger picture. In this picture, you can see the two power supplies at the bottom towards the left, the PIC board (top left board), motor control board (top right board), and the accessory board in the middle. The stepper motor is on the right. You can also see a small amount of the spider at the bottom hanging below the board. At the top right, you can see the home-made "network hub" of sorts that connects individual props to the rest of the "network" of props in the garage.



Here is what it looks like from the other side. The paint stick provides the mechanism for detecting when the spider has hit the top. The stick is on a hinge. It has a hole in it. The spider's string goes through the hole. The other end of the stick has a magnet on it. Above the magnet is a magnetic switch. When the motor winds the spider up, the body of the spider lifts the stick, bringing the magnet close enough to close the magnetic switch. The PIC detects this and stops rewinding the spider. This allows the PIC to verify the location of the spider, in case there has been slippage and such.

Also, not very visible in the picture is an LED and a kill switch. Since this is up in the rafters of the garage, it would not be very easy for me to get to it in an emergency. So, I put a momentary pushbutton on the bottom of the platform, which I can push with a long stick. This tells the PIC to immediately stop what it is doing and go to sleep. It also turns on the LED to indicate that it is in this mode.

Obtained from Omarshahid.com