

Description: The Bugbot is a clever little robot that is programmed with solder. In other words, there is no way to reprogram Bugbot after it has already been assembled. Instead, the behavior of Bugbot is determined during operation by the direction of the flow of electricity through the Bugbot's motors.

Name:

Partner's Name:

Can you draw a circuit diagram that describes the forward and reverse motion of Bugbot? On a separate sheet of paper, give it a try. Hint: Remember to take into account the position of the momentary switches.

Inventorying Bugbot's parts

Anytime you begin an assembly project, it is wise to locate each part in the kit. The parts that should be in your Bugbot kit are:


1. Two DC motors
2. Two momentary switches
3. 1 piece of Aluminum
4. 1 piece of 18 gauge wire
5. 4 pieces of shrink tubing
6. 1 wooden bead
7. 3 paper clips
8. 1 AA battery holder
9. 1 slide switch

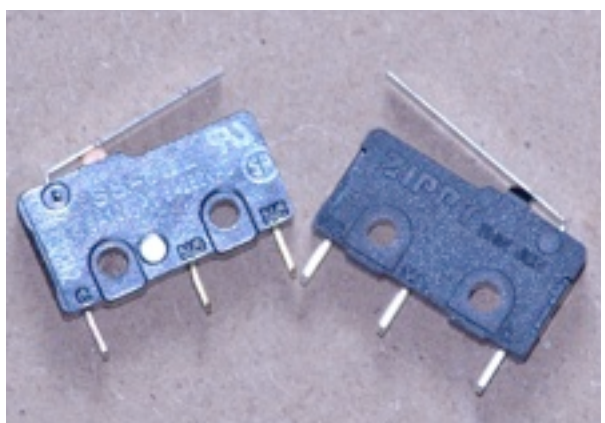

Parts and Tools


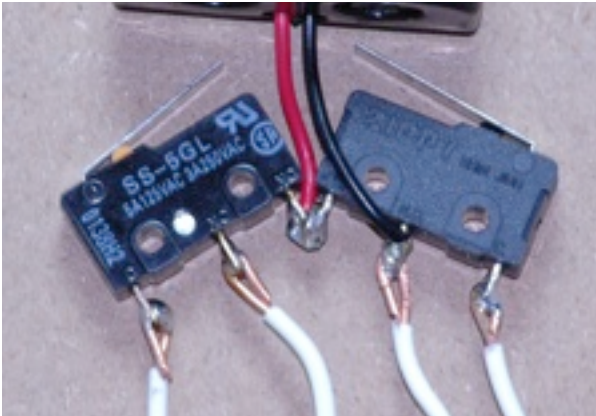




Required Tools:

1. Needle nose pliers
2. Hot glue gun
3. Soldering iron
4. Side cutters
5. Safety lighter
6. Wire strippers

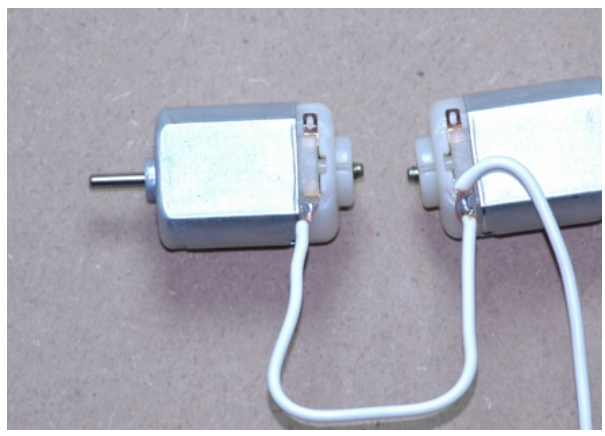
| Preparation | Prepared Lengths of Wire |
|---|--|
| <p>Bugbot requires very little preparation before you begin to build.</p> <ol style="list-style-type: none"> 1. Cut five 4" pieces of 18 gauge wire. 2. Cut one 3" piece of 18 gauge wire. 3. Strip 1/2" of insulation off of each end of each piece of wire. <p>The next few instructions will guide you through preparing Bugbots subassemblies.</p> |  |

| Soldering the Momentary Switches | Switch Orientation and wire bend. |
|---|--|
| <p>In this step we will assemble Bugbot's sensors. Each sensor is made up of an antenna attached to a momentary switch that acts as a "feeler." We'll assemble the antennae later, for now we are just going to worry about the momentary switches.</p> <p>NOTES:</p> <ol style="list-style-type: none"> 1. Be careful not to lay the soldering iron on plastic parts of the switches. 2. Be careful not to over heat the switch tabs. Over heating can cause the switches to melt. 3. Try to keep the insulation of the wires as tight against the solder joint as possible to prevent short circuits. <p>Let's get started:</p> <ol style="list-style-type: none"> 1. Lay the momentary switches flat on the work surface so the switch levers face each other. |  <p>Notice the "NC" label on the switch.</p>  |

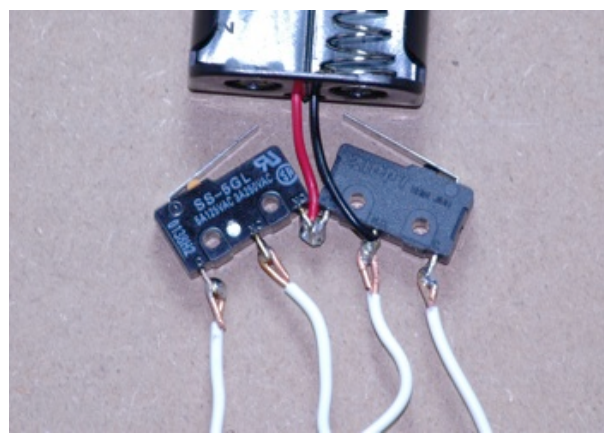
| Momentary Switches Continued | Finished Connections |
|--|--|
| <ol style="list-style-type: none"> 2. Turn the switches so they form about a 70 degree angle between them. The two “NC” tabs should be touching. 3. Lay the battery box in front of the switches so the red and black wire are facing the switches. 4. Bend a “J” shape into the red wire and hook it through the “NC” tabs on both momentary switches. 5. Solder the 2 “NC” tabs and the red wire together. 6. Bend the ends of the 3” piece of wire into “J” shapes. Hook one end through each of the two center tabs on the momentary switches. 7. Bend the end of the black wire from the battery box into a “J” shape and hook it through one of the center tabs on one of the momentary switches. 8. Solder both center tabs to the wires looped through them. 9. Bend a “J” shape into one end of two of the 4” pieces of wire. Hook the end through each of the outside tabs of both momentary switches. 10. Solder both wires in place. 11. Set the assembly aside for now, we’ll come back to these parts after we’ve finished preparing the motors. |   |

| Preparing the Motors | Motor Orientation |
|--|--|
| <p>NOTE: It is important that there be at least 3" between the motors once soldered together.</p> <ol style="list-style-type: none">1. Place the motors flat on the work surface so the metal contacts are facing up.2. Arrange the motors so the rear of the motors are facing each other.3. Choose any of the 4" pieces of wire, and bend a "J"-shape into both ends. Attach the wire to the two metal contacts nearest to you. The 18 gauge wire will fit through the holes in the contacts, but you must be delicate.4. Solder the two motor contacts to the wire looped through them.4. Choose another one of the 4" pieces of wire, and bend a "J" shape into one end. Attach this wire to the right motor at the contact nearest you. It is easiest to wrap the J-shape bend around the solder connection that was just made.5. Solder the wire to the motor contact. |   |

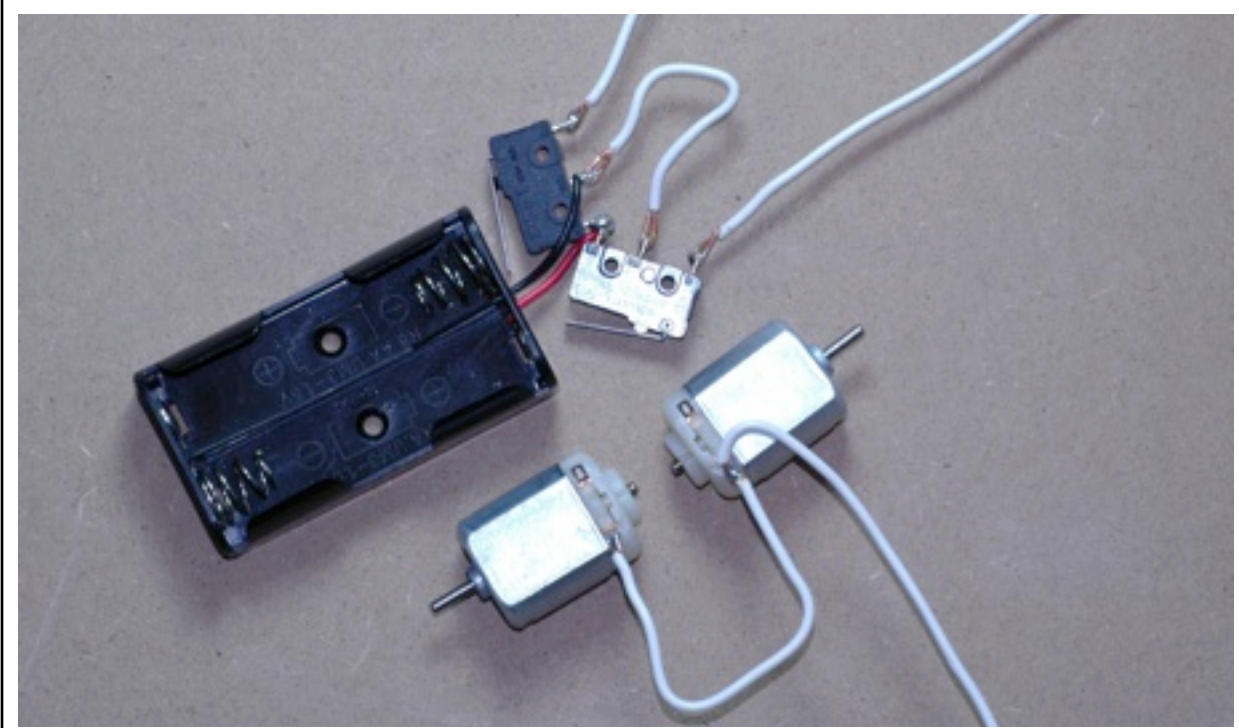
Prepared Motors



Momentary Switches



Bugbot Assemblies

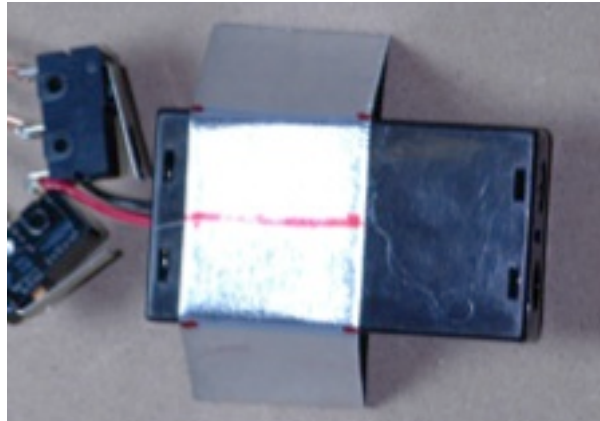


Building Bugbot's Body

In this step, we will assemble Bugbot's body. Bugbot has two main body parts, the chassis and the motor carrier. The chassis is the battery box, and the motor carrier is the strip of Aluminum. We'll add Bugbot's tail later.

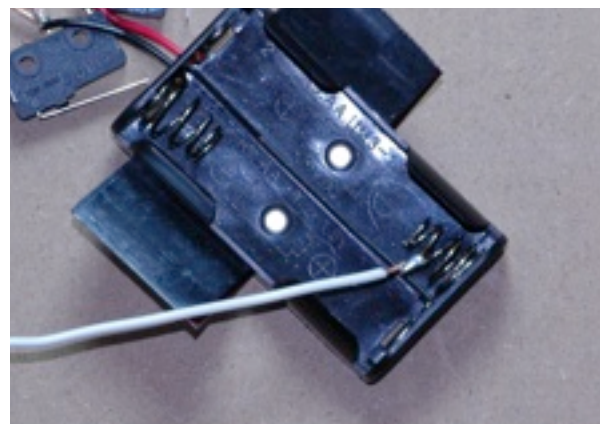
1. Place a mark down the middle of the Aluminum strip and line this mark up with the middle line of the battery box. The Aluminum should make a T with the battery box.
2. Mark the edges of the battery box on the Aluminum.
3. Bend the Aluminum at the marks to create a wide "U" shape.
4. Place a bead of hot glue in the center of the battery box about 1" away from the edge with the red and black wires.
5. Press the Aluminum onto the glue, positioning the strips so that the ends can be wrapped around the battery box.
6. After the hot glue cools, adjust the angle of the motor carrier bends until you are satisfied with Bugbot's height. Remember, you will be gluing the motors onto the carrier as well.
7. Use the remaining 4" piece of wire and bend a "J" shape into one end.
8. Hook the wire around the spring in the battery box on the end away from the red and black leads.
9. Solder this wire to the spring.

Wire Attachment


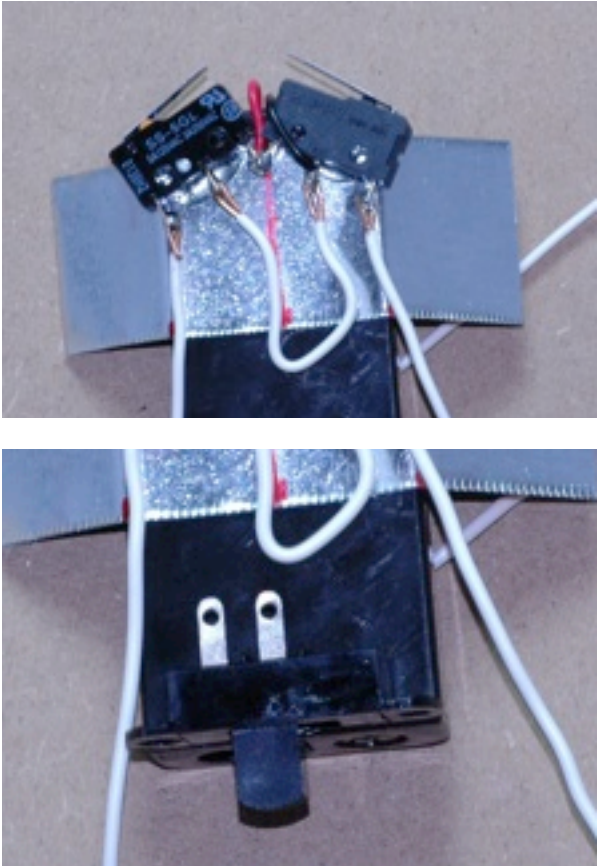


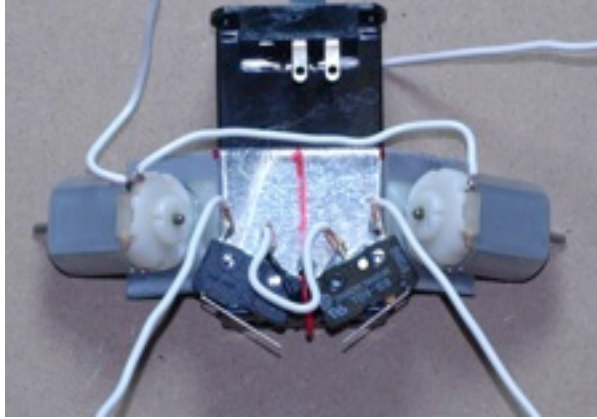
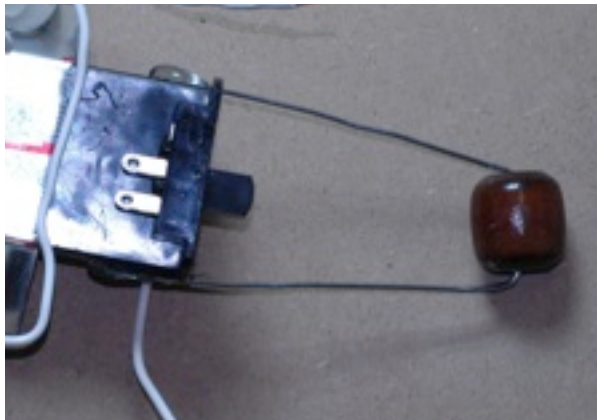
NOTE: Be careful not to heat up the spring too much, it may melt the battery box.

Assembled Body



Interesting fact: "Procter & Gamble chemical and packaging engineer, Paul Cope invented thermoplastic glue around 1940..." Source: about.com

| Building Bugbot's Tail | Bugbot's Tail |
|---|---|
| <ol style="list-style-type: none">1. Straighten one of the paper clips.2. Slide the bead to the middle of the paper clip.3. Bend the paper clip around the bead so the paper clip forms a "U" shape around the bead.4. This is Bugbot's tail. You may want to try different shapes to make sure the bead can still roll, while the bead stays at the bottom of the tail. |  |
| Attaching the Switches | Switches Mounted on Bugbot |
| <p>The momentary switches are going to be mounted on the top front of Bugbot with the switch levers facing front.</p> <ol style="list-style-type: none">1. Rotate the momentary switches so the red and black leads from the battery box come over the top of the switches and the switch levers are facing the front of the robot.2. Place a bead of hot glue on the bottom of each switch.3. Press the momentary switches onto the top of the battery box on the side nearest the red and black wires.4. Next put a bead of glue on the bottom of the slide switch.5. Press the slide switch onto the top of the battery box on the end furthest from the red and black wires so the slide faces the rear of Bugbot |  |

| Attaching the Motors | Correctly Positioned Motors |
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| <p>The motors were wired in the previous step to allow for simple mounting in the correct configuration.</p> <p>NOTE: The front of the robot is the side with the red and black battery box wires.</p> <ol style="list-style-type: none"> 1. Place the motors so the wire that joins the two motors together faces the rear of Bugbot. 2. Place a bead of hot glue onto right side of the motor carrier. 3. Press the right motor onto the bead of glue so that the motor shaft extends past the edge of the motor carrier. 4. Once the glue sets, repeat these steps for the left motor. |  |
| <p>NOTE: Bugbot should be supported entirely by the motor shafts and the tail bead.</p> <ol style="list-style-type: none"> 1. Place a bead of hot glue on one rear side of the battery box. Press one side of the tail into the hot glue. 2. Repeat this process with the other side of the tail. 3. You will need to be patient while holding the tail in place and allow the hot glue to cure. |  |

Final Electrical Connections

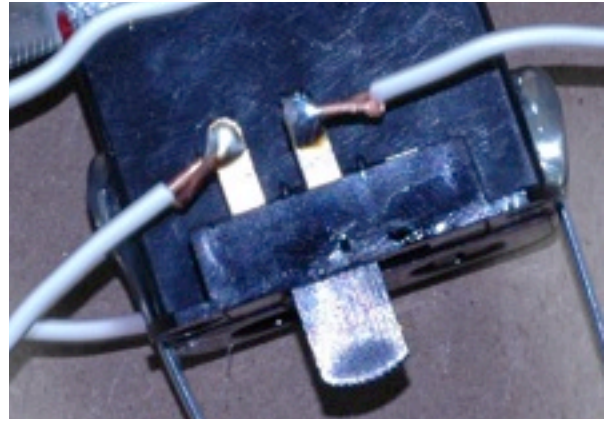
There are a few more electrical connections that must be made to complete Bugbot's "nervous system."

NOTE: Be careful not to overheat the switch tabs. Overheating can cause the switch to melt.

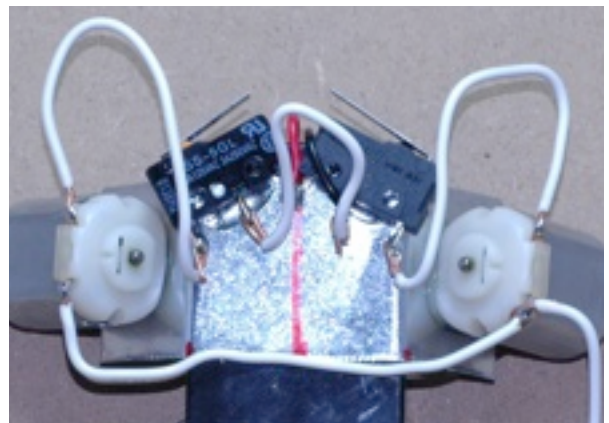
1. Following the same procedures for soldering as before, begin by soldering the loose wire from the motor to the slide switch.
2. Solder the wire connected to the battery box spring to the other slide switch terminal.
3. Next, solder the loose wire from the right momentary switch to the free terminal on the right motor.
4. Repeat step three with the left momentary switch and the left motor.

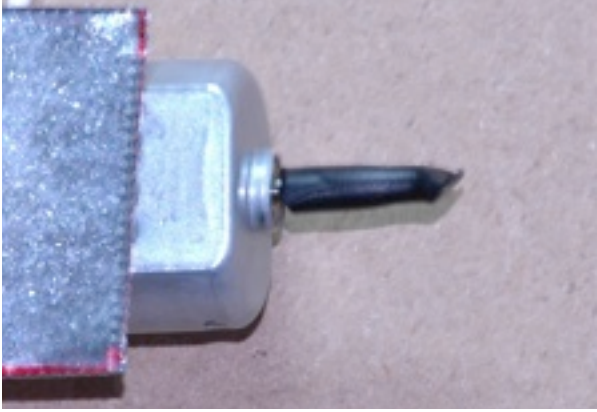
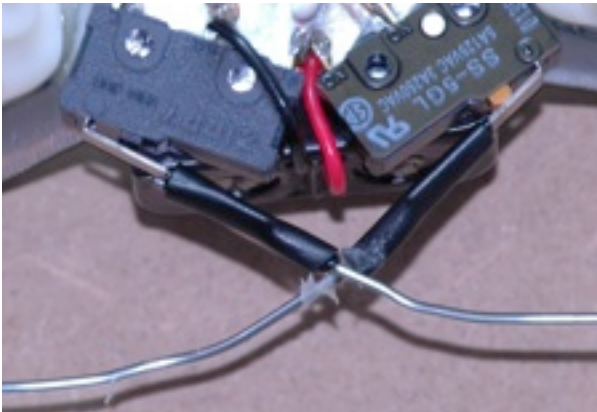
Bugbot is nearly complete! All that is left is to give Bugbot its antennae and some traction.

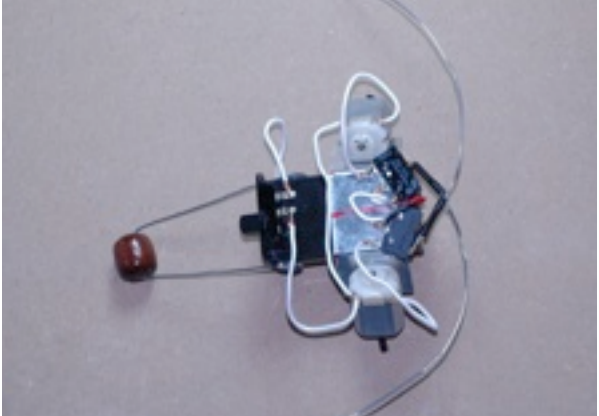
Motor Wires



Switch Wires



| Adding Some Friction | Bugbot's tires |
|--|--|
| <p>Bugbot needs some friction between the motor shafts and the ground. We gain the needed friction by adding shrink tubing to each motor shaft.</p> <ol style="list-style-type: none"> 1. Cut two pieces of shrink tubing so that they are not too long for the motor shafts to seat neatly inside the tubing. 2. Slide the open end of one of the pieces of shrink tubing onto one of the motor shafts. 3. Using a safety lighter or heat gun, heat the shrink tubing until it shrinks onto the motor shaft. 4. Repeat this process with the other motor shaft. |  |
| Antennae | Antennae and Shrink Tubing |
| <p>The antennae consist of the last two paper clips and the last two pieces of shrink tubing.</p> <p>NOTE: Be careful not to heat the switch body while you are shrinking the tubing.</p> <ol style="list-style-type: none"> 1. Cut the capped ends off of both pieces of shrink tubing. 2. Straighten both of the paper clips that are left. 3. Slide one piece of shrink tubing over each paper clip. 4. Position the end of one paper clip against the lever of one of the momentary switches. 5. Slide the shrink tubing down the paper clip and over the lever. |  |

| Antennae Continued. | Completed Bugbot |
|---|--|
| <ol style="list-style-type: none">6. With the lighter, or heat gun, heat the shrink tubing until the tubing shrinks and holds the paper clip in place.7. Repeat with the other switch.8. Once the antennae are attached to the momentary switches, put a bead of hot glue on each antenna where the heat tubing ends. Be careful not to get hot glue under the lever. |  |