Build a Motion-Activated Guard Robot (BlueBot Project #1)

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p024/robotics/guard-robot
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Experimental Procedure

Note: This engineering project is best described by the **engineering design process,** as opposed to the **scientific method.** You might want to ask your teacher whether it's acceptable to follow the engineering design process for your project before you begin. You can learn more about the engineering design process in the Science Buddies Engineering Design Process Guide (http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml).

Assembling Your BlueBot Chassis

1. Follow the instructions in the video to assemble your robot chassis.
    a. Note that your kit does come with printed directions for assembling the chassis, but we recommend watching the video so you fully understand how all the parts fit together.
    b. Note that we recommend using double-sided foam tape to attach the battery holder to the top of the chassis, as shown in Figure 4. The printed directions recommend putting the battery holder in-between the two chassis plates, but this makes it harder to change the batteries.

https://www.youtube.com/watch?v=SBeGl_IgWwY (https://www.youtube.com/watch?v=SBeGl_IgWwY)

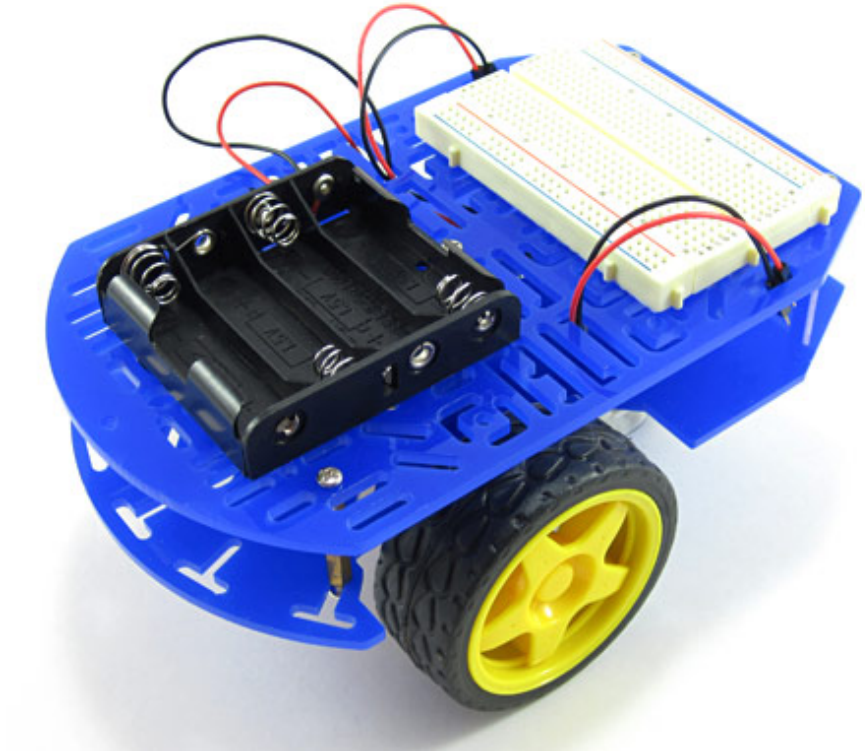


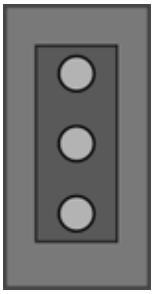
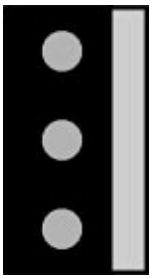
Figure 4. A completed BlueBot chassis with breadboard and battery pack on top.

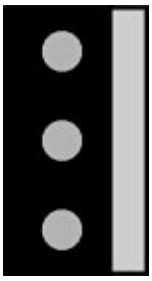
Assembling Your Circuit

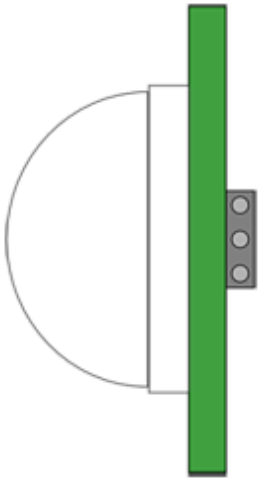
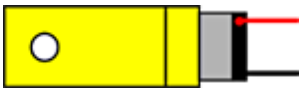
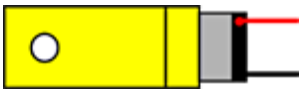
1. To build your circuit, you will need to know how to use a breadboard. Watch the video and see the Science Buddies reference How to Use a Breadboard (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-breadboard).

   https://www.youtube.com/watch?v=6WReFkfrUIk (https://www.youtube.com/watch?v=6WReFkfrUIk)

2. Now that you know how to use a breadboard, you are ready to assemble your BlueBot circuit. Table 2 shows a list of all the components in the circuit and where they go on the breadboard. You can download and print a PDF (http://www.sciencebuddies.org/Files/7275/8/checklist-Robotics_p024.pdf) of this table—complete with checkboxes to track each step—to use while you are building your robot. You can also view a slideshow (#breadboard-slideshow) that shows breadboard diagrams of the circuit. Follow along in the table and/or slideshow to build your circuit one component at a time. Your finished circuit should look like the one in Figure 5 (#figure5). Pay attention to these notes:
   a. Remember to push all components *firmly* into the breadboard.
   b. All references to orientation (up, down, left, and right) assume you have the breadboard "right-side up," so the writing is facing you.
   c. Your jumper wire kit comes with an assortment of colors, and the colors may vary. It does not matter what color jumper wires you use. Your colors do *not* need to match the colors in the diagrams. In general, you should use the shortest wires possible, to help keep your circuit neat.
   d. You will use male-female jumper wires to connect the PIR sensor to the breadboard. These wires act like "extension cords" that allow you to attach the sensor to the front of your robot. You *do* need to keep track of the wire colors when connecting the PIR sensor, since you need to connect the three pins in the right order.
   e. Insert the batteries *last*. If you see or smell smoke when you insert the batteries, you have a short circuit somewhere. Immediately remove the batteries and re-check your wiring.

Component	Picture	Symbol	Breadboard holes	Note
Power switch			F1, F2, F3	Direction it is facing does not matter, but make sure to slide switch down (toward row 30, away from row 1), this is the "off" position.
Jumper wire			J2 to (+) bus	Color does not matter.
Jumper wire			Left side (+) bus to right side (+) bus	Color does not matter.
Jumper wire			Left side (-) bus to right side (-) bus	Color does not matter.
MOSFET			C11, C12, C13	Writing should face to the left, large silver tab should face to the right. Note: the writing on your MOSFET may not match the picture exactly. This is OK.

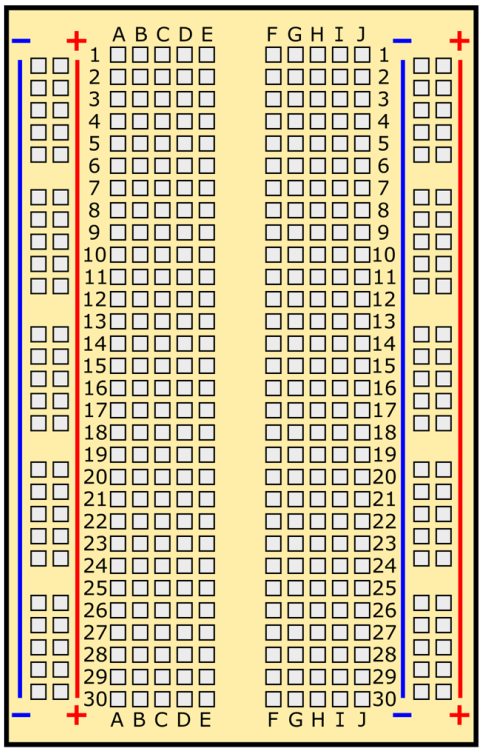
Component	Picture	Symbol	Breadboard holes	Note
MOSFET			C18, C19, C20	Writing should face to the left, large silver tab should face to the right. Note: the writing on your MOSFET may not match the picture exactly. This is OK.
Jumper wire			A13 to (-) bus	Color does not matter.
Jumper wire			A20 to (-) bus	Color does not matter.
Diode			A12 to (+) bus	Gray band must face to the left. Optional: Shorten the leads (see Figure 5).
Diode			A19 to (+) bus	Gray band must face to the left. Optional: Shorten the leads (see Figure 5).

Component	Picture	Symbol	Breadboard holes	Note
PIR sensor			(-) pin to (-) bus OUT pin to J15 (+) pin to (+) bus	Color-code wires to make connections easier. Connect black wire to (-), blue wire to OUT, and red wire to (+). See slides 13 and 14 in slideshow.
Jumper wire			E11 to G15	Color does not matter.
Jumper wire			E18 to F15	Color does not matter.
Top motor			Red lead to (+) bus Black lead to E12	When the robot is driving forward, this is the "right" motor
Bottom motor			Red lead to (+) bus Black lead to E19	When the robot is driving forward, this is the "left" motor.

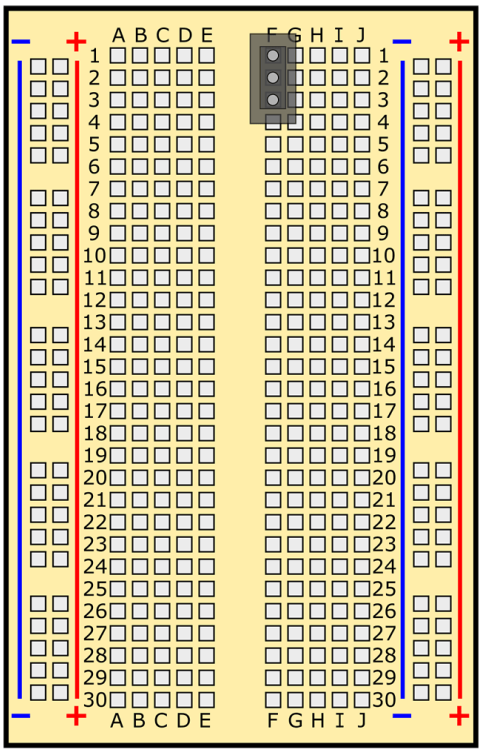
Component	Picture	Symbol	Breadboard holes	Note
Battery holder			Red lead to J1 Black lead to (-) bus	Do not insert batteries until circuit is complete.
AA battery			N/A	Insert into battery holder. Make sure (+) signs on batteries line up with (+) signs in battery holder.

Table 2. List of circuit components and locations. A printable PDF version (http://www.sciencebuddies.org/Files/7275/8/checklist-Robotics_p024.pdf) is available.

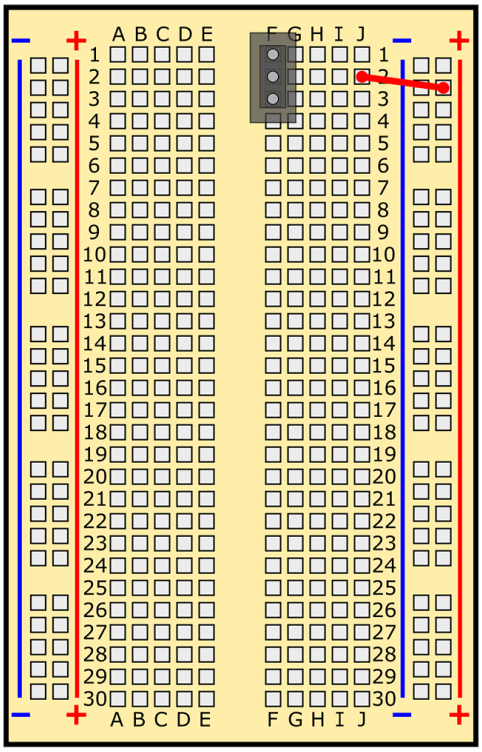
Slideshow Images



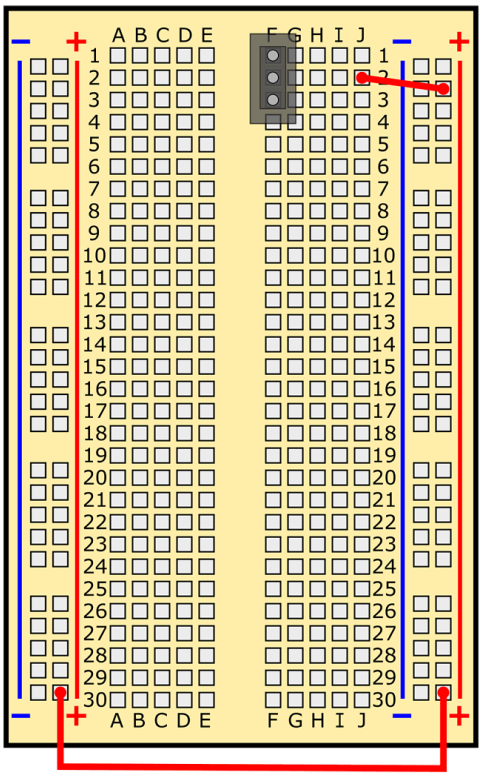
1. Blank breadboard.



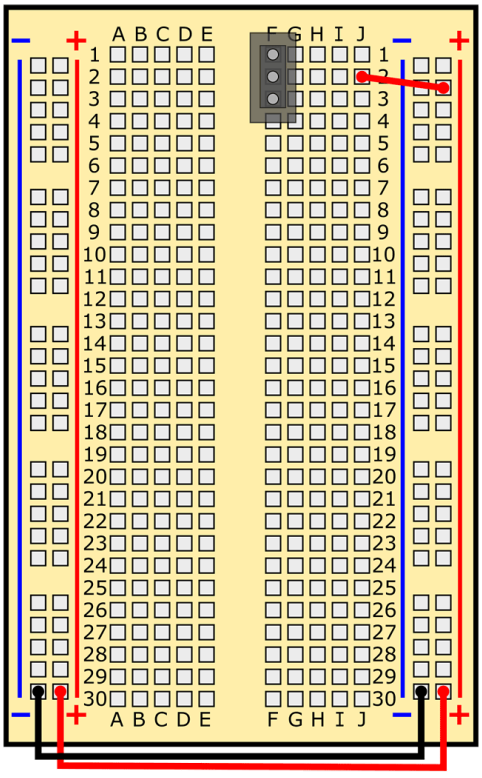
2. Insert power switch into holes F1, F2, F3. Direction of switch does not matter.



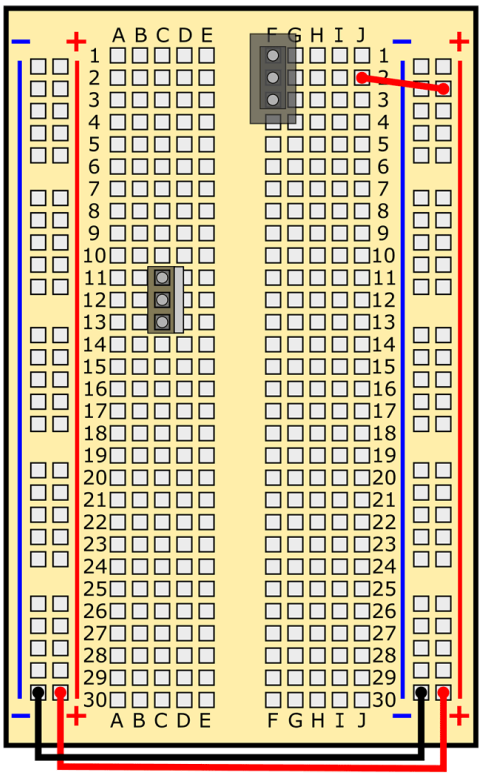
3. Connect jumper wire from hole J2 to (+) bus.



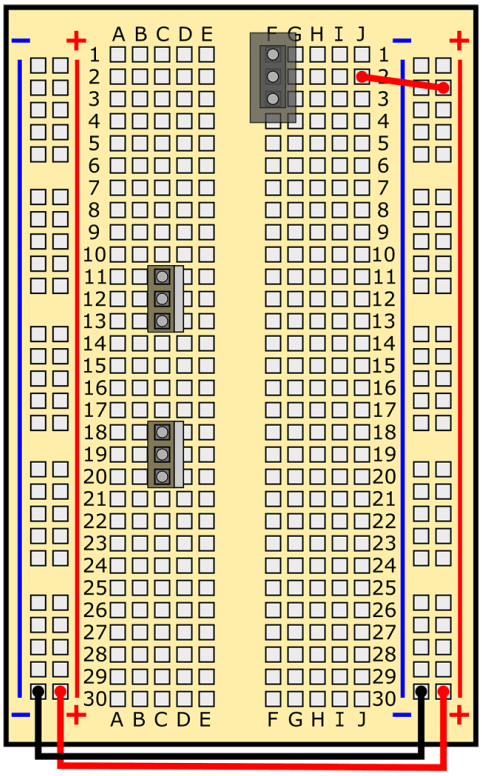
4. Connect jumper wire from left (+) bus to right (+) bus.



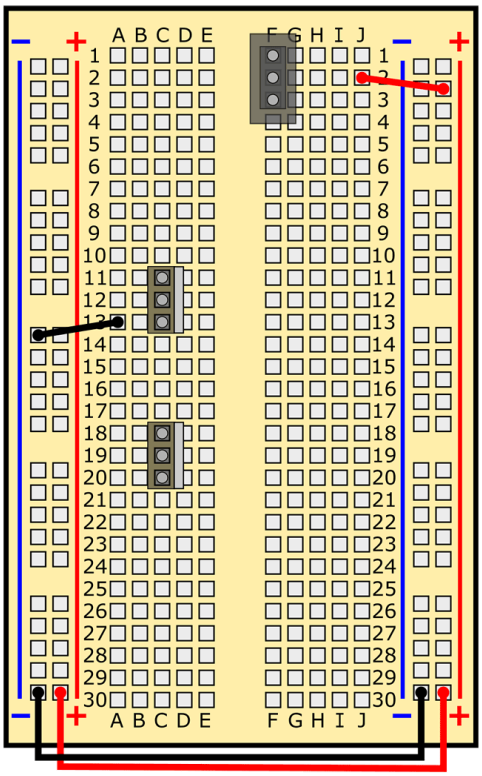
5. Connect jumper wire from left (-) bus to right (-) bus.



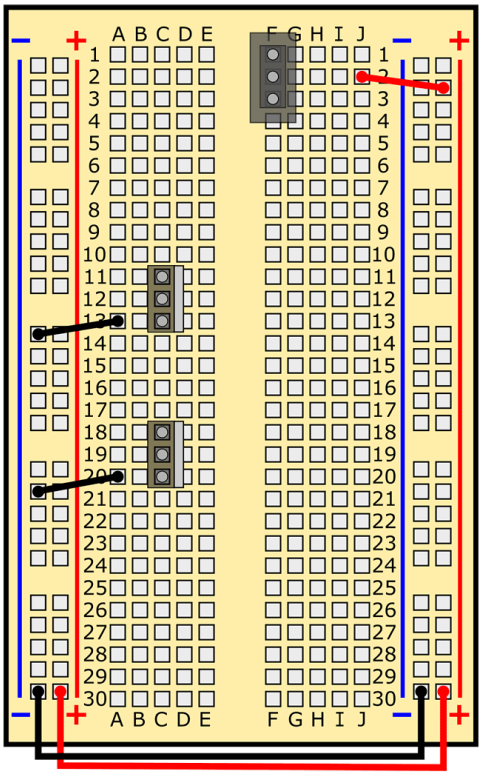
6. Insert MOSFET into holes C11, C12, C13. Writing must face to the left.



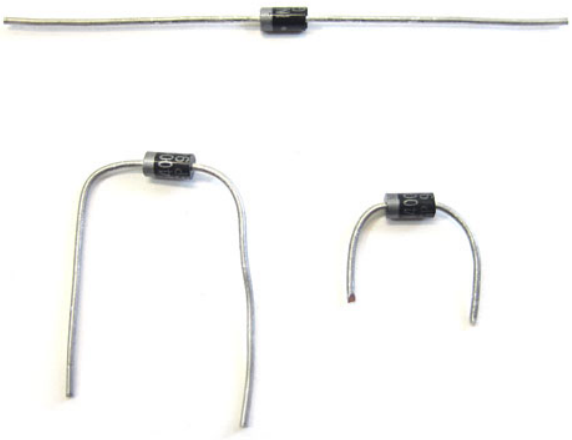
7. Insert MOSFET into holes C18, C19, C20. Writing must face to the left.



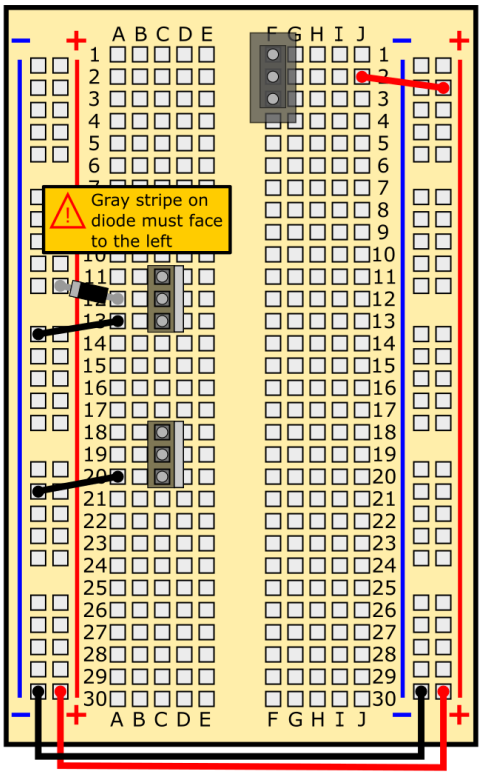
8. Connect jumper wire from hole A13 to (-) bus.



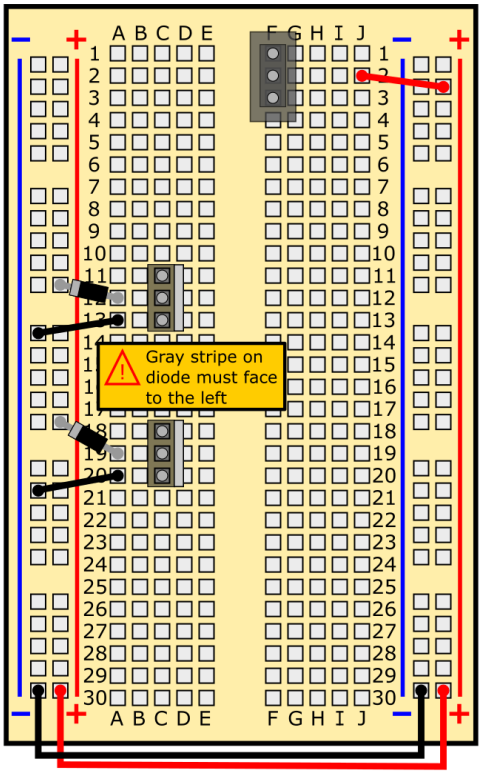
9. Connect jumper wire from hole A20 to (-) bus.



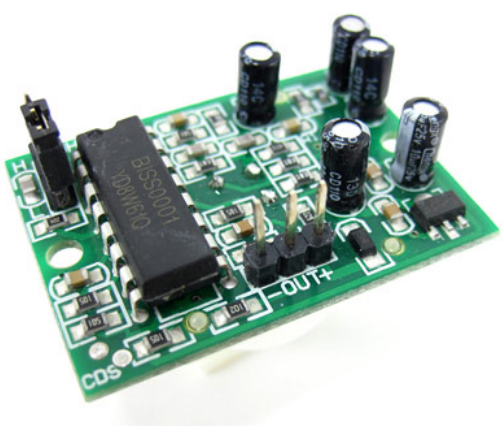
10. Bend the diode's leads down by 90 degrees and trim them so they fit into the breadboard.

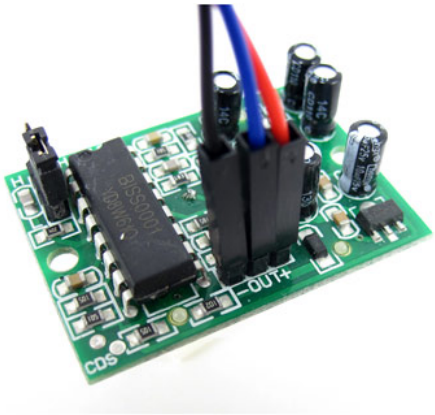


11. Insert diode into hole A12 and (+) bus. Gray stripe must face to the left.

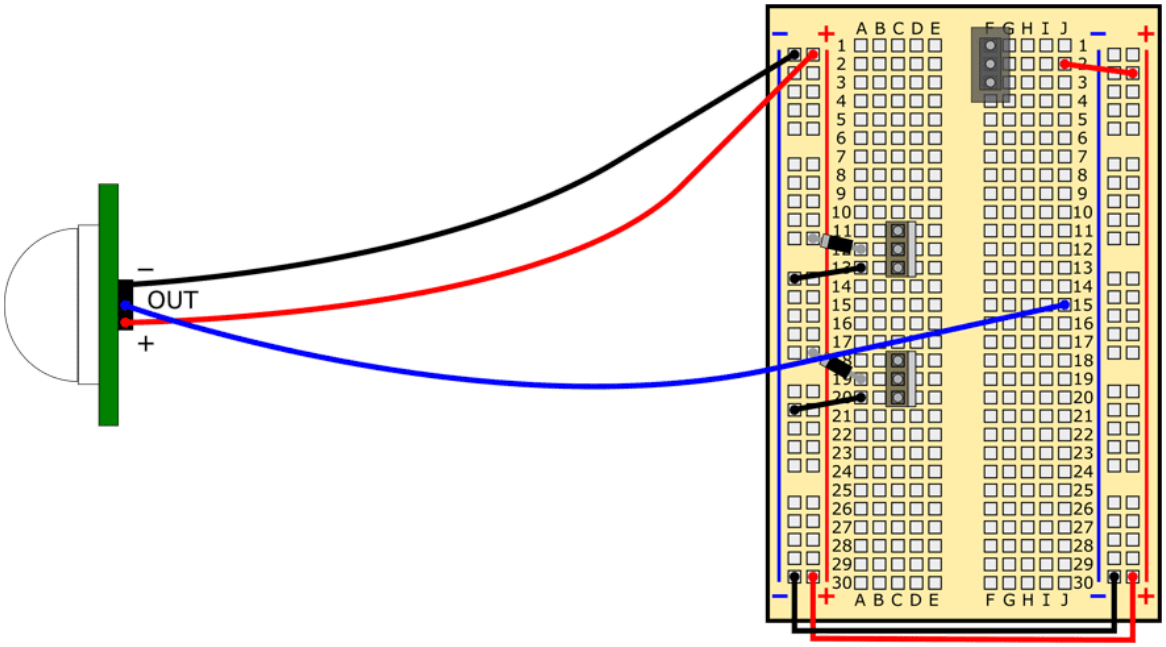


12. Insert diode into hole A19 and (+) bus. Gray stripe must face to the left.

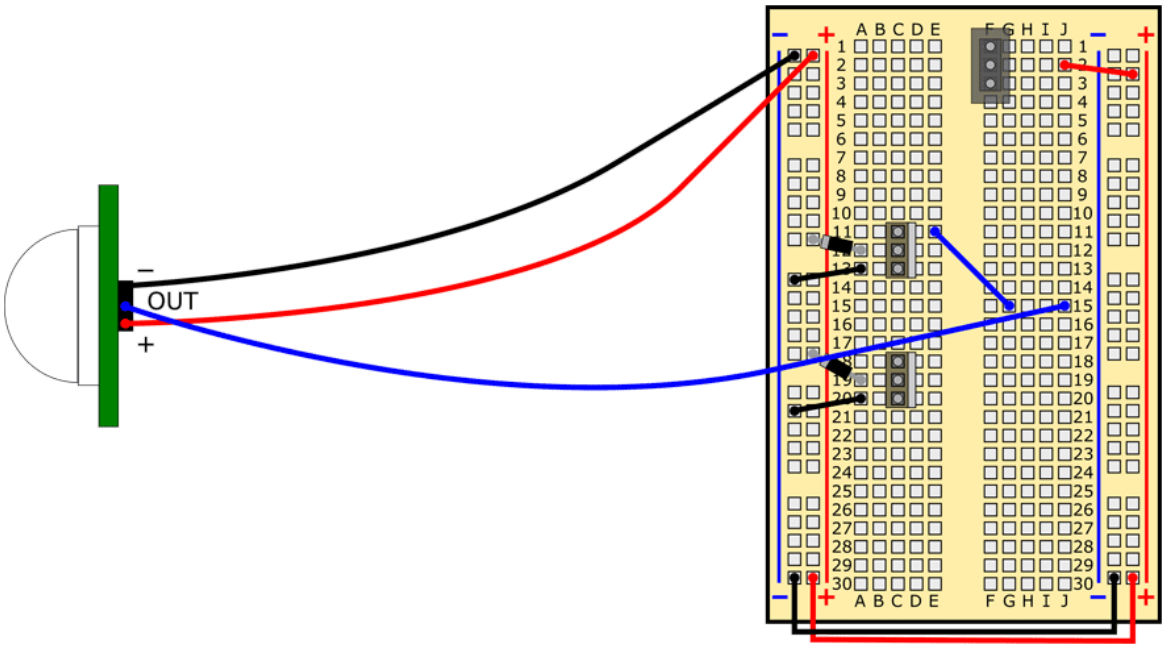




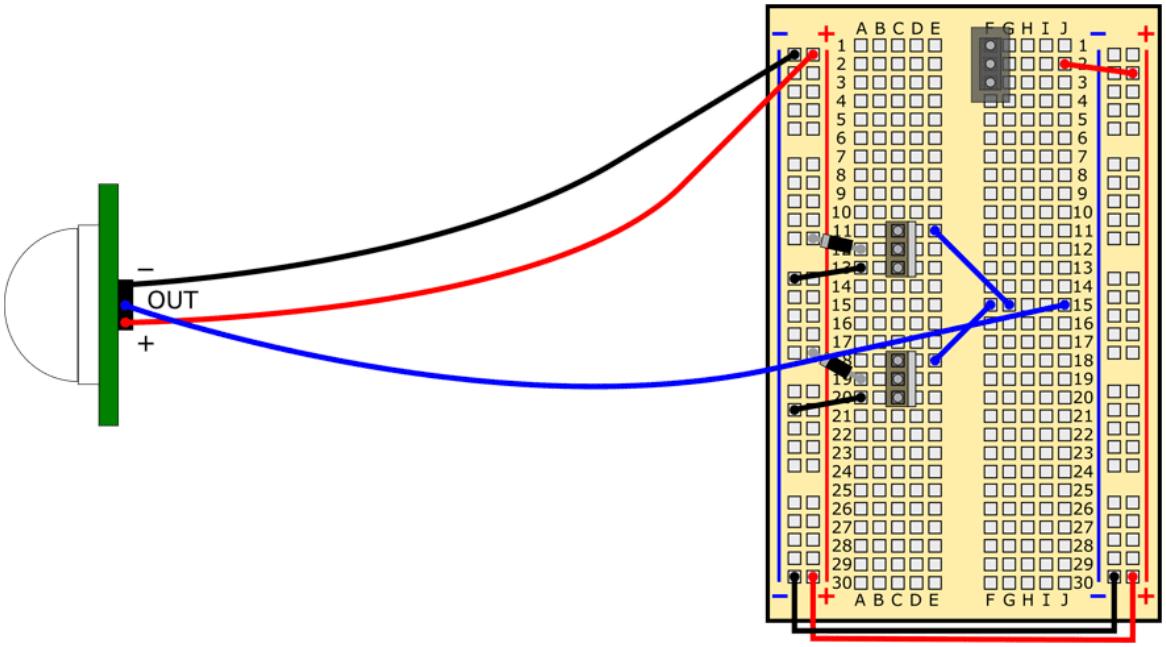
13. Connect a red male-female jumper wire to the (+) pin of the PIR sensor, a blue wire to the OUT pin, and a black wire to the (-) pin.



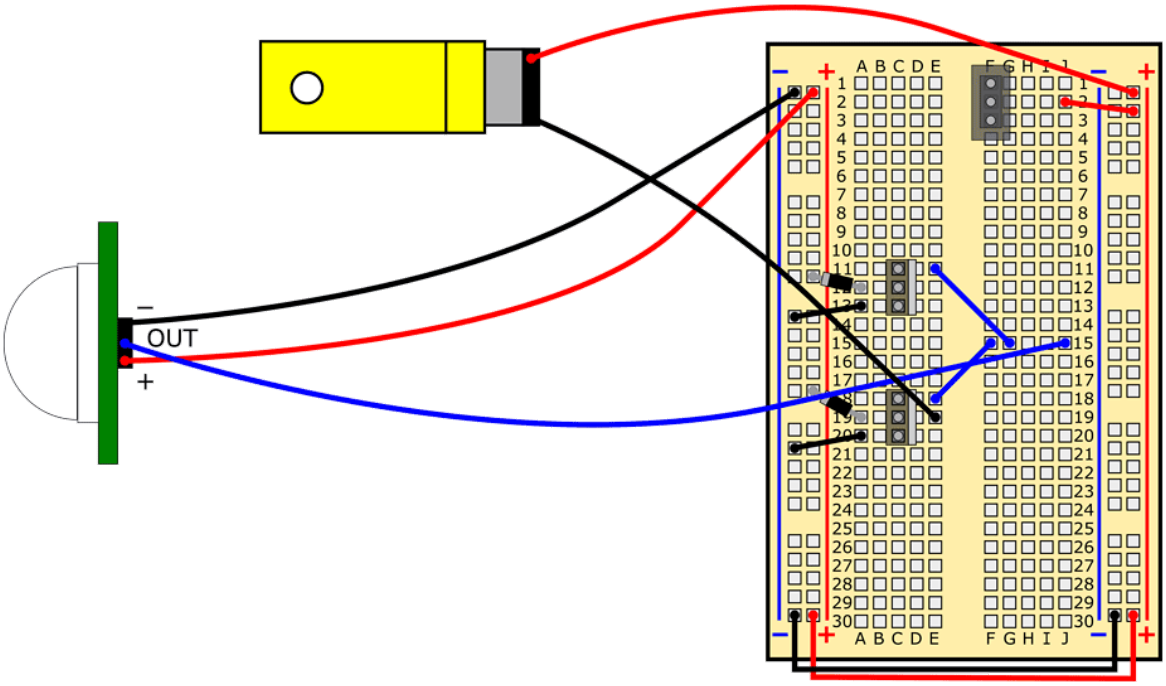
14. Connect PIR sensor: (-) pin to (-) bus, OUT pin to J15, (+) pin to (+) bus.



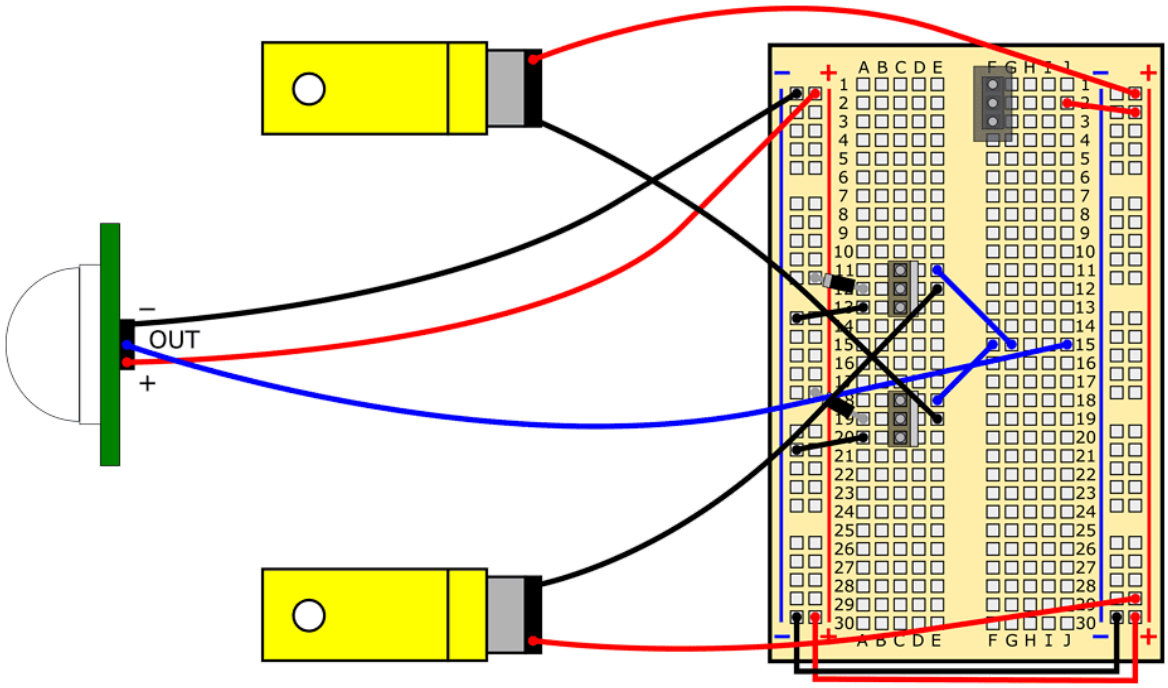
15. Connect jumper wire from hole E11 to G15.



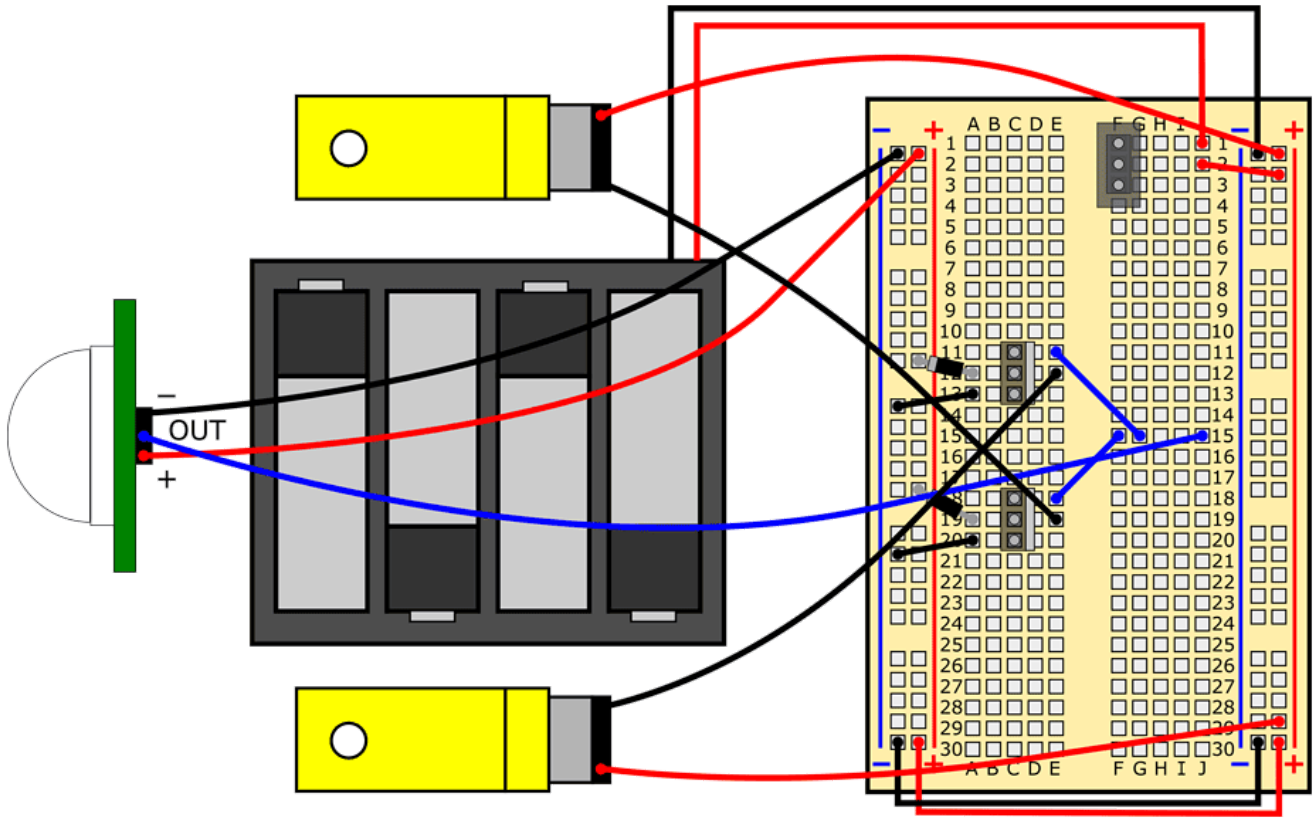
16. Connect jumper wire from hole E18 to F15.



17. Connect top motor's red wire to (+) bus, black wire to hole E19.



18. Connect bottom motor's red wire to (+) bus, black wire to hole E12.



19. Connect battery holder's red wire to hole J1, black wire to (-) bus.

End of Slideshow Images

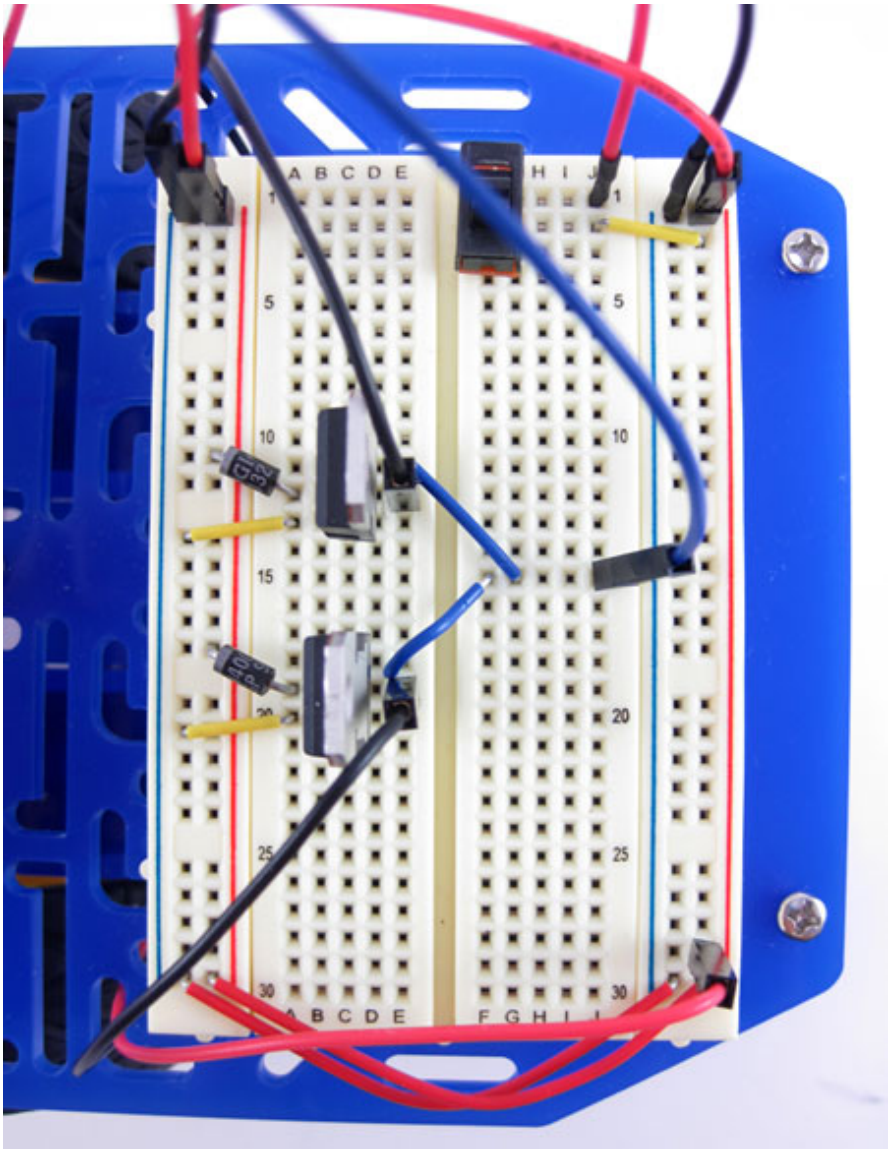


Figure 5. Your completed circuit should look like this.

3. After you have completed your circuit, mount the PIR sensor to the front of your robot chassis using double-sided foam tape, as shown in Figure 6.



Figure 6. Mount the PIR sensor to the front of your robot using double-sided foam tape.

Testing Your Robot

You are finally ready to start testing your robot! Remember that now you will need to follow the engineering design process to get your robot working. Follow these steps to learn how to use your robot.

1. Double-check your circuit against the breadboard diagrams in the previous section. Remember that just *one* misplaced wire can prevent the circuit from working properly.
2. Hold the robot's chassis in one hand, so the wheels are off the ground, and the PIR sensor is facing away from you and any other sources of infrared light, like other people, animals, or an open window (sunlight contains some infrared light).
    a. Turn the robot's power switch "on" by sliding it up, toward row 1 on the breadboard.
    b. Your robot's wheels should spin briefly as the PIR sensor "boots up," then come to a stop. Check Table 3 to see what you should do next.

Observation	What to Do
I see or smell smoke.	Immediately turn your robot off. You have a short circuit somewhere. Recheck your wiring against the breadboard diagrams in the previous section.
Each wheel spins forward when I turn the robot on.	Your robot works! Move on to the next step.
One or both wheels spin backwards when I turn the robot on.	Reverse the red and black wires of the motor if the wheel is spinning backwards. See the Help (http://www.sciencebuddies.org/science-fair-projects/project_ideas/Robotics_p024.shtml#question2) section for details.
The wheels did not spin at all when I turned the robot on.	See the Help (#help) section for troubleshooting steps.

Table 3. Troubleshooting procedure for the first time you turn on your robot.

3. Now, try waving your hand in front of the PIR sensor. This should make your robot's wheels spin. If your robot is not working, see the Help (#help) section.
4. Try to discover other ways that you can activate the robot. What happens if you put the robot on the floor and then walk in front of it? What happens if you wave an inanimate object, like a ruler, in front of the sensor, or throw a crumpled piece of paper in front of the robot?
5. You might discover that it is actually too *easy* to activate the robot, because the PIR sensor has such a wide field of view. For example, if you try to hide the robot under a desk or table, it might jump out too early when someone walks by. This is

where the engineering design process really comes into play. Can you figure out how to modify the sensor's field of view? For example, you could partially cover the sensor with a shortened paper towel tube, like in Figure 7. You can also adjust which way the PIR sensor is facing (forward, down, up, or to the side).

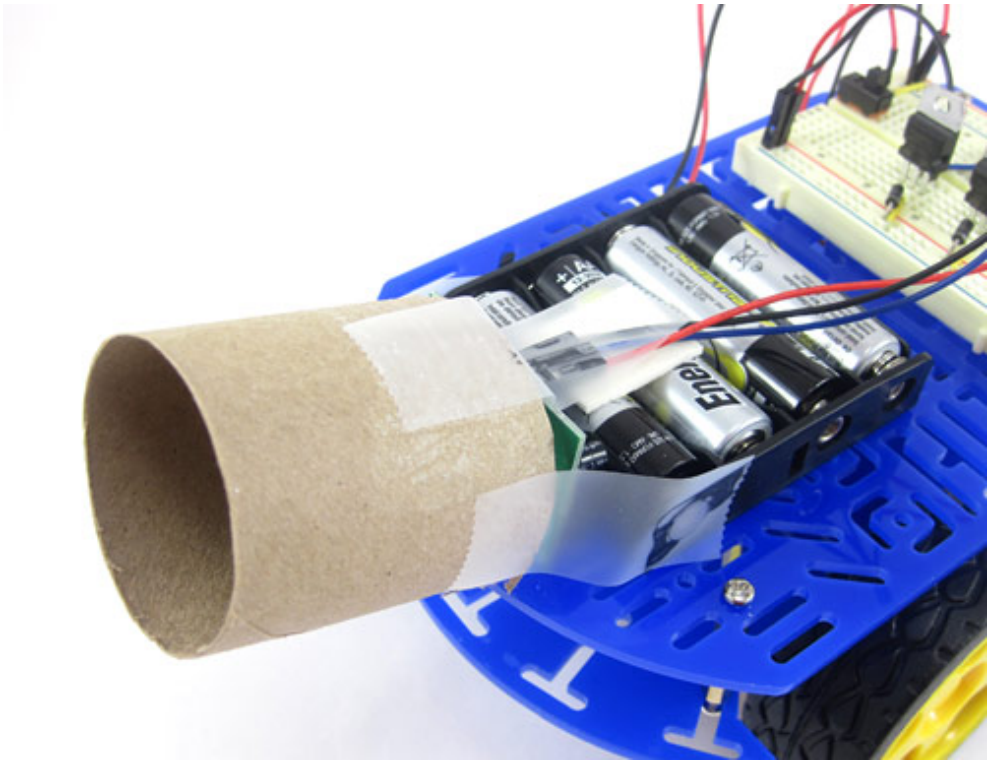


Figure 7. Partially covering the sensor with a shortened paper towel tube will help narrow its field of view.

6. Continue making adjustments to your PIR sensor, as needed. You do not want the robot to activate too early or too late. What works best for the situation in which you want to use the robot? For example, do you want the robot to wait in a room and drive toward whoever walks in? Do you want to hide it around a corner or under a table? Once you have your robot working just the way you like it, leave it set up to "guard" something, and scare away the next person who comes by!

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p024/robotics/guard-robot#help (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p024/robotics/guard-robot#help).