Build a Speedy Light-Tracking Robot (BlueBot Project #2)

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p022/robotics/light-following-robot (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p022/robotics/light-following-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. Your kit comes with printed directions for assembling the chassis, but we recommend watching the video so you fully understand how all the parts fit together.
    b. The blue plastic parts come with a thin layer of protective plastic coating. Peel this coating off before assembling your chassis.
    c. We also recommend using double-sided foam tape to attach the battery holder to the top of the chassis, as shown in Figure 5. The printed directions recommend putting the battery holder in-between the two chassis plates, but this makes it harder to change the batteries.
    d. You will have some extra parts when you are done, including screws, nuts, and blue plastic gears. Put these parts aside for now; you will not need them for this project.

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

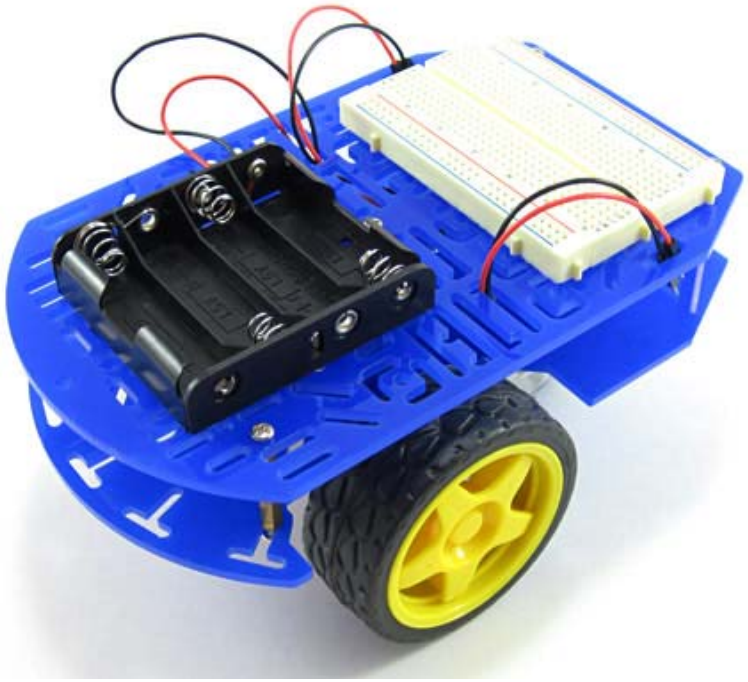


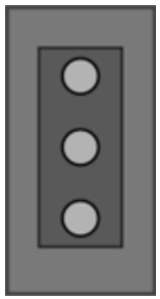
Figure 5. A completed BlueBot chassis with breadboard and battery pack on top.

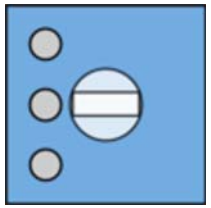
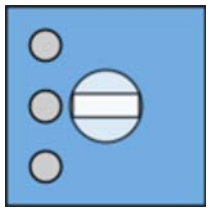
Assembling Your Circuit

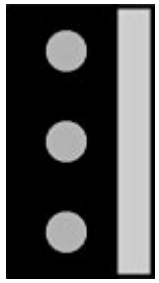
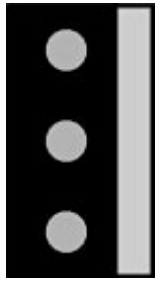
1. To build your circuit, you will need to know how to use a breadboard. Watch the video and see the Science Buddies reference How to Use a Breadboard (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-breadboard) to learn how to use a breadboard.

   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/science-fair-projects/breadboard-checklist.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 6 (#figure6). 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. 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	The direction in which it is facing does not matter, but make sure to slide the 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			J12 to (-) bus	Color does not matter.
Jumper wire			J19 to (-) bus	Color does not matter.

Component	Picture	Symbol	Breadboard holes	Note
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.
Potentiometer			G11, G12, G13	Direction matters; pins should be on the left.
Potentiometer			G18, G19, G20	Direction matters; pins should be on the left.

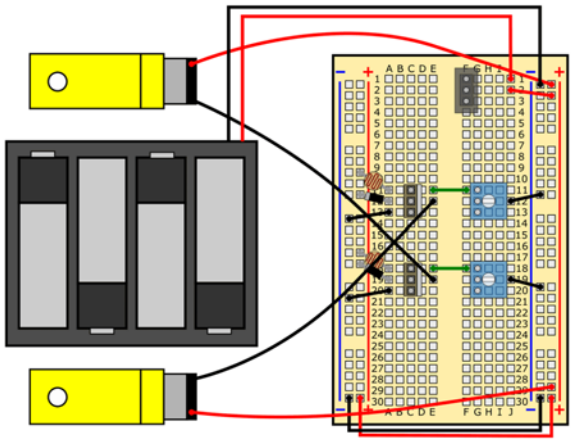
Component	Picture	Symbol	Breadboard holes	Note
Jumper wire			E11 to F11	Color does not matter.
Jumper wire			E18 to F18	Color does not matter.
MOSFET			C11, C12, C13	Writing should face to the left, large silver tab should face to the right. Note: the writing on your MOSFET may differ from the picture. This is OK.
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 differ from the picture. This is OK.

Component	Picture	Symbol	Breadboard holes	Note
Jumper wire			A13 to (-) bus	Color does not matter.
Jumper wire			A20 to (-) bus	Color does not matter.
Photoresistor			A11 to (+) bus	Direction does not matter.
Photoresistor			A18 to (+) bus	Direction does not matter.

Component	Picture	Symbol	Breadboard holes	Note
Diode			A12 to (+) bus	Gray band must face to the left. Optional: Shorten the leads.
Diode			A19 to (+) bus	Gray band must face to the left Optional: Shorten the leads.
Top motor			Red lead to (+) bus Black lead to E19	When the robot is driving forward, this is the "right" motor.
Bottom motor			Red lead to (+) bus Black lead to E12	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 the 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/science-fair-projects/breadboard-checklist.pdf) is available.



Slideshow with step-by-step instructions viewable online.

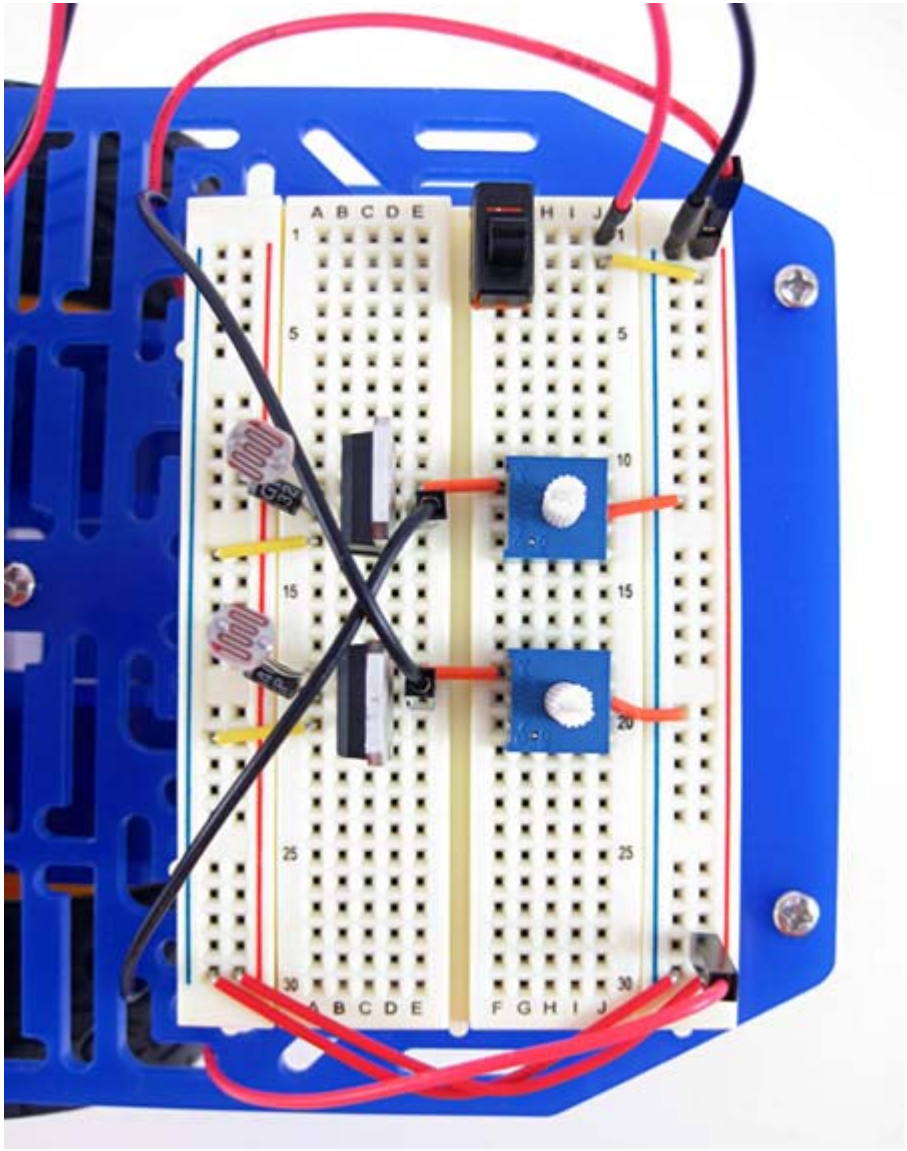


Figure 6. Your completed circuit should look like this.

Testing the Robot

You are finally ready to start testing your robot! Remember that now you will need to follow The Engineering Design Process (http://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps) 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. Turn the robot's power switch "on" by sliding it up, toward row 1 on the breadboard. 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. Re-check your wiring against the breadboard diagrams in the previous section.
The wheels spin forward.	Your robot works! Move on to the next step.
One or both wheels spin backwards.	Reverse the red and black wires for that motor if a wheel is spinning backwards.
The wheels do not spin at all.	Try holding the robot's light sensors up to a bright light. Turn the potentiometer knobs all the way clockwise. The wheels should start spinning.
The wheels still do not spin.	Part of your circuit is connected incorrectly. Re-check your circuit against the wiring diagrams, and see the Help (#help) section for more details.

Table 3. What to do the first time you turn on your robot.

3. The potentiometers adjust your robot's sensitivity to *ambient* light levels (the normal light levels in a room). Your goal is to make sure the robot does *not* respond to regular ambient light, and that it *does* follow around a brighter flashlight beam.
    a. Turn both potentiometers all the way counterclockwise. This should turn the motors off (for more information on how the circuit works, see the Help (#help) section).
    b. *Slowly* turn the potentiometers clockwise, one at a time. This gradually increases the circuit's sensitivity to ambient light. Eventually, the motors should start spinning slowly.
    c. Turn the potentiometers slightly counterclockwise again, until the motors *just* turn off. You have set the motors just below the threshold for detecting ambient light.
    d. Now, aim a flashlight directly at your robot's light sensors, or hold the robot very close to a light. This brighter amount of light should activate the sensors and cause the motors to spin.
    e. Depending on the lighting in the room, you may need to continue to adjust the potentiometers slightly. For example, an open window on a sunny day or a bright lamp in a corner might cause the robot to move. Your goal is to make sure the robot does *not* respond to these light sources, and that it only responds to your flashlight. If your potentiometers are adjusted asymmetrically (one is turned farther than the other), this may cause your robot to steer more in one direction.
4. Put the robot on the floor and try guiding it with a flashlight. Make sure you aim the flashlight *at the photoresistors* and not at the front of the robot or the floor in front of the robot. Can you control whether the robot goes forward, left, or right? It might be rather difficult to steer; go to the next step to find out why.
5. The photoresistors have long, flexible leads that let you adjust their aim. Which way they are facing can have a big impact on how easy the robot is to steer. If they are right next to each other, they will always get hit by the same amount of light, so it will be very hard to steer the robot left or right. If they are too far apart, it will be hard to illuminate them evenly, so it will be hard to make the robot go straight. You can also adjust whether they are aimed forward or up, straight ahead or outward, or even diagonally. Try adjusting the photoresistors to different positions, and see which position makes it the easiest to steer your robot. Figure 7 shows several different positions for the photoresistors.

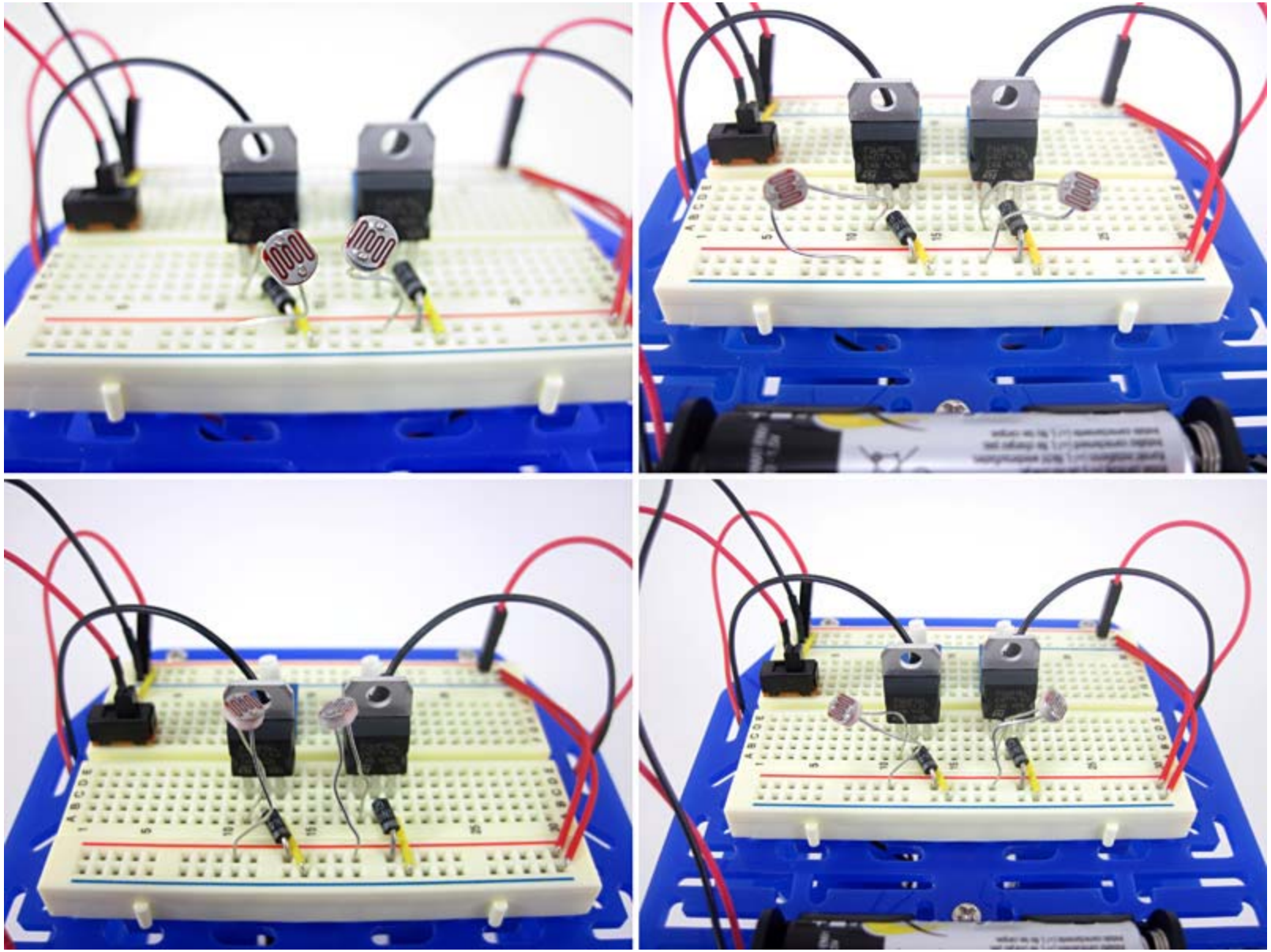


Figure 7. Different positions and orientations for the photoresistors. Top left: Photoresistors close together, facing forward. Top right: Photoresistors spaced apart, facing forward. Bottom left: Photoresistors spaced apart, facing upward. Bottom right: Photoresistors spaced apart, facing diagonally outward.

6. Continue to make adjustments to the photoresistors and potentiometers until you can easily guide your robot around with a flashlight. Can you navigate the robot through a maze or obstacle course using the flashlight?
7. There are several other robotics projects you can do with your chassis. See the Variations (#makeityourown) section for some ideas.

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p022/robotics/light-following-robot#help (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p022/robotics/light-following-robot#help).