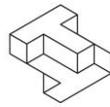


# Robot Sensors

Lab Related Activity: *Social Robots*



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Students learn about how human eyes work compared to bird eyes. They are then introduced to how engineers use the sense of vision to create sensors for robots. Finally, students get an opportunity to think about how visual sensors currently work in robots and other ways these sensors could be used in the future.

**Grades:** 1-5 | **Estimated Time:** 45-60 Minutes

## Student Outcomes

Students will be able to:

- Diagram the eye of a human and an eagle
- Describe how an eye functions
- Create a robot design that includes a vision sensor

## Next Generation Science Standards

*Molecules to Organism* **Grade 1:** 1-LS1-1.A & D; **Grade 4:** 4-LS1-2, LS1.D

*Engineering Design* **Grade K-2:** K-2-ETS1-2

## California State Science Standards

*Life Sciences* **Grade 3:** 3.a

*Investigation and Experimentation* **Grade 3:** 5.e; **Grade 5:** 6.g

## Common Core ELA Standards

*Speaking and Listening* **Grade 1:** 1, 5; **Grade 2:** 1, 3, and 5;

**Grade 3:** 1, 3, 5; **Grade 4:** 1, 5; **Grade 5:** 1, 5

## Vocabulary

*Familiarity with these terms and concepts will enhance students' experience in the activity.*

- **Biological:** Something that is living or a part of a living organism.
- **Cornea:** Front of the eye that helps let in light.
- **Iris:** Opening behind the cornea that lets light through to the lens.
- **Lens:** Curved tissue that helps focus light and images on the retina or the light-gathering device of a camera.
- **Optic Nerve:** Transmits information to the brain from the retina and from the brain back to the retina.
- **Retina:** Back layer of the eyeball that contains cells that respond to light and trigger nerve impulses that travel to the optic nerve.
- **Sense:** The parts of the body that take in information from the world and transmit it to the brain.
- **Sensor:** The part of a machine or robot that takes in information from the world and transmits it to a device or computer.
- **Triangulate:** Use a triangle to figure out a position or a place.
- **Vision:** The ability to see things.

## Materials (one set per group of 4 students)

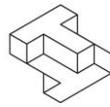
- Computer or Device to access online games and images
- Whiteboard and markers
- Paper and writing utensils
- (Optional) Projector or proxima

## Teaching points:

1. *What senses do we have as humans?*  
(Answers include: sight, smell, touch, hearing, and taste. Other answers might be: balance, pain, temperature, pressure, proprioception, time, chemoreceptors, etc.)
2. *Today we are going to play a game and I'd like you to think about what sense or senses you use as you play.*  
Have students play a spot the difference game. Some examples of these online include:
  - a. <http://www.thekidzpage.com/learninggames/spotthedifference/>

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- b. <http://www.neok12.com/games/photo-game/photo-game.htm>
- c. <https://www.coolmath-games.com/0-spotthedifference2> (Starts easier)
- d. <http://www.spotthedifference.com/>

3. *What sense or senses did you use to play this game?*

(Answer: Sense of sight to spot the differences. Sense of touch to use the mouse and make selections. Maybe hearing to ask a classmate or teacher for help and get the information to do the task.)

## Procedure:

4. *The game we played is like how one specific animal species searches for food. These animals tend to look for food in small spaces or across large distances, so they have amazingly strong eyesight that they use to look for little differences in details or movements. What species do you think this might be?*

(Answer: Birds)

- a. (Optional Video on bird eyesight) Birds and Their Amazing Eyesight (4:21 min): <https://youtu.be/sRK-2kPpa6o>

5. *Several species of birds like owls, vultures, and pigeons use their amazing eyesight to see differences in movement, color, or shapes to find possible food. They then use head movements and their hearing to pinpoint, or triangulate, where to go to catch their next meal.*

*An eagle for example, can see 4 or 5 times farther than a human. That means an eagle can see prey from the sky or in a tall tree up to 3 miles away. Sometimes when we say someone has good vision we say that they have an 'eagle eye' because eagles see so well.*

*For more eagle vision facts check out one of these sites:*

- a. <http://kids.nationalgeographic.com/animals/bald-eagle/#bald-eagle-closeup.jpg>
- b. <http://www.audubon.org/news/are-bald-eagles-good-anti-drone-strategy>
- c. <https://www.livescience.com/18658-humans-eagle-vision.html>

6. Have students fold a sheet of paper into thirds.

- a. Draw a model of eyes on the board or use an online source to show the differences (See "Human Vision vs. Eagle Vision" in the reference section)
- b. Explain the basic parts of an eye.
- c. On one third have students diagram a human eyeball
- d. On one third have students diagram an eagle eyeball.
- e. Save one third for now.

7. *When we design robots we often look to our own experiences and nature for ideas on how to design and make robots to help us with tasks. So far we have talked about humans and birds having senses, do you think robots have senses and why?*

(Answer: Yes, so they can help us; yes, so they can be more like us; yes, because that's what makes sense to us; no, because they aren't alive)

8. *When we create electronic components to give robots information on the world around them, we call these sensors.*

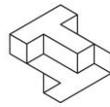
- a. Show students an image of a robot light, motion, or visual sensor.  
(For one example see "How Does Thermal Vision Work" in the reference section)
- b. Have students draw a diagram of the sensor on the third section of their paper.
- c. Discuss the similarities and differences between the three diagrams as a class.  
(Similarities: They all have lenses, they all have something to do with light or seeing, they all have something like an optic nerve and brain, etc.)  
Differences: The retina is a different shape for the bird and person, and the robot doesn't have a retina. The robot's sensor does not look like an eyeball, etc.)

9. *If you were to design a robot, what type of visual sensor would you give it and why?*

- a. Give students 10-15 minutes to draw their idea for robot with a visual sensor.
- b. Have students share their ideas with their classmates at table groups or as a class.
- c. (Some possible answers: find people lost in the woods, help count animals, work as part of the navigation)

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system of a drone, find new stars in the sky, etc.)

10. *Sensors for robots do not always work exactly like eyes in a human or an animal. Sometimes they do parts of what a biological sense does.*
  - a. *Remember the "Spot the Difference" game we played, we make sensors for robots called motion sensors that look for differences, especially in movement. Can anyone think of anything in your everyday life that might have a motion sensor?*  
(Possible answers: doors at the grocery store, lights at a home or certain buildings, etc.)
  - b. *Other times we want robots to know if it is light or dark outside, so we give them a light sensor. Can anyone think of anything in your everyday life that might have a light sensor?*  
(Possible answers: street lights, lights on the outside of a house, barcode scanners, laser mazes, some security systems)
  - c. *There are many other visual sensors, some see: heat or thermal differences like a snake, some can see at night using infrared or ultraviolet light, and some can see color, and those are just a few. Using sensors like this can allow a robot to navigate at night or in the dark; and to compile groups like items, such as: all green Legos or red M&M's.*

## Teaching Points:

11. *As engineers, we use what we have around us and what we have already learned to make new ideas come to life. We have figured out how eyes work, how visual sensors have some of the same parts, and we have imagined things robots could do with the ability to see like us. What other problems do you think we could solve if we could make robots that have similar senses to us or other animals?*

## Taking it Further

- Explore sensors and echolocation. <https://www.nationalgeographic.org/activity/making-sense-robot-sensors/>
- Explore other senses and create an experiment to see if plants have senses too.
- Research how senses of a specific animal give it an advantage in its environment.
- Have students make an Arduino color detector: [https://create.arduino.cc/projecthub/mjrobot/arduino-color-detection-57e4ce?ref=tag&ref\\_id=color-detector&offset=2](https://create.arduino.cc/projecthub/mjrobot/arduino-color-detection-57e4ce?ref=tag&ref_id=color-detector&offset=2)
- Make a laser maze with your students using string and tape in a hallway, or create one with lasers like this: <https://create.arduino.cc/projecthub/samhorne/halloween-laser-maze-2128f6>

## References

- Agarwal, Arjit. "How Does Thermal Vision Work." Emaze presentations, [www.emaze.com/@AFZWCLTL/How-Does-Thermal-Vision-Work](http://www.emaze.com/@AFZWCLTL/How-Does-Thermal-Vision-Work). Accessed 22 Aug. 2017. <https://userscontent2.emaze.com/images/dc2c67ba-79ee-496e-9950-c774f12bcb18/1f309927-f315-478e-8f02-dc96dfa6e5c2.jpg>
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